PSL UNIVERSITÉ PARIS

THÈSE DE DOCTORAT DE L'UNIVERSITÉ PSL

Préparée à l'institut Jean Nicod, Département d'études cognitives, ENS, EHESS, CNRS, PSL University

Modulation des représentations corporelles par l'hypnose

Soutenue par

Clément APELIAN

Le 20 Mai 2022

Ecole doctorale n° 158

Cerveau, Cognition, Comportement

Spécialité

Sciences cognitives

Composition du jury :

Elisabeth, PACHERIE — *Présidente*
Directeur de recherche CNRS,
Institut Jean Nicod

Steven, LYNN — *Rapporteur*
Distinguished Professor, Binghamton University
Department of Psychology

Andrea, SERINO — *Rapporteur*
Professor, University Hospital of Lausanne
Department Clinical Neurosciences

Jérôme, SACKUR — *Examinateur*
Directeur d'études EHESS,
Laboratoire de Sciences Cognitives et Psycholinguistique

Devin, TERHUNE — *Examinateur*
Reader, Goldsmith University of London,
Department of Psychology

Frédérique, DE VIGNEMONT — *Directrice de thèse*
Directrice de recherche CNRS,
Institut Jean Nicod

Institut | Nicod

ENS

DEC
DÉPARTEMENT D'ÉTUDES COGNITIVES

THIS THESIS WAS MADE POSSIBLE BY

THE SUPPORT OF

ARCHE

FORMATION

https://www.arche-hypnose.com/

REMERCIEMENTS

Tout d'abord, j'aimerais exprimer ma gratitude à la communauté scientifique, aux hommes et aux femmes qui ont consacré leur vie pour faire reculer un peu plus la lisière de l'ignorance. Vous avez planté en moi les graines de la curiosité, l'espoir du progrès, et le goût de l'exigence. Par votre œuvre, je suis, comme le veut la formule, un nain sur les épaules des géants. Aux milliers d'anonymes, héros et martyrs de la science libre, merci.

En particulier, j'aimerais remercier chaleureusement ma directrice de thèse, Frédérique de Vignemont, pour son soutien, sa confiance, et la richesse de nos discussions. Ainsi que Devin Terhune, qui a informellement joué le rôle de codirecteur de thèse au cours de la dernière année. Vous m'avez beaucoup appris, vous m'avez inspiré, et par-dessus tout, vous avez eu la patience de supporter mes erreurs. Merci pour tout.

J'aimerais également remercier l'ARCHE, et en particulier Kevin Finel et Cyrille Champagne, non seulement pour avoir financé cette thèse, mais aussi et surtout pour m'avoir fait confiance et donné la possibilité de contribuer à ce projet fou qu'est l'ARCHE. Le cadre de travail, la qualité des relations et le dynamisme qui règnent en ce lieu ont grandement influencé cette thèse, et pour cela et bien d'autres choses : merci.

J'ai une profonde reconnaissance pour toutes les personnes qui ont contribué aux réflexions de recherche qui m'animent, que ce soit directement ou indirectement. Vous êtes malheureusement trop nombreux pour tous vous nommer, mais j'aimerai en particulier remercier Adrian Alsmith, Victor Pitron et Géraldine Carranante, Jérôme Dokic, Margherita Arcangeli, Elisabeth Pacherie et Valérian Chambon à l'institut Jean Nicod, Guillaume Dumas, Raphaël Millière, David Dupuis et Martin Fortier[†] du groupe de recherche ALIUS, Samuel Veissière et Mathieu Landry de l'université McGill et Yan Vervliet.

C'est avec émotion que mes pensées se dirigent vers ma famille, mes amis et collègues qui m'ont soutenu tout au long de mon parcours. Vous comptez bien plus que je ne peux l'exprimer.

Enfin, merci aux membres du jury pour avoir accepté d'évaluer cette thèse. Je vous souhaite une agréable lecture

RESUME

Près d'un siècle de recherche scientifique sur l'hypnose a révélé ses effets parfois impressionnants sur la perception, la cognition et le comportement. Malgré cela, les mécanismes qui sous-tendent de tels effets sont encore fortement débattus. Dans cette thèse, nous commencerons par brièvement retracer l'histoire de cette discipline. De cette vue d'ensemble découlera un constat simple : l'hypnose n'est pas un phénomène monolithique. Ainsi, nous avons restreint l'analyse à un unique phénomène hypnotique : la modulation des représentations de la taille du corps. Cela permet de réduire la complexité et d'isoler les facteurs déterminants à l'origine du phénomène. Simultanément, cette thèse contribue à explorer les mécanismes responsables des altérations perceptuelles prenant place au sein de l'hypnose. Pour ce faire, nous avons conduit trois études expérimentales qui comparent l'effet de la suggestion hypnotique à d'autres manipulations des représentations de la taille du corps. L'effet de la suggestion hypnotique a été comparée à une illusion vibro-tactile (illusion de Lackner) dans la première expérience, et à une instruction d'imagerie mentale dans la seconde. Enfin, dans la troisième expérience nous avons permis aux participants de voir ou toucher la partie du corps ciblée par la suggestion, et nous avons quantifié l'effet résiduel issue de cette contradiction entre perception et suggestion. Dans chaque étude, les effets sur la représentation du corps ont été mesurés avec un rapport perceptuel du changement de taille, ainsi qu'une tache motrice. Nos résultats révèlent que la suggestion hypnotique est une manipulation fiable et robuste des composantes perceptuelle et sensorimotrice de la représentation de la taille du corps. De plus, nous avons proposé un modèle explicatif de cet effet basé sur nos données expérimentales, ainsi que sur la littérature. Notre modèle reconnaît le rôle majeur des facteurs contextuels et des traits personnels, mais il met en exergue l'importance de l'imagerie mentale en conjonction avec le monitoring de source. Dans cette perspective, l'imagerie mentale prise pour de la perception justifie les attentes procurées par le contexte hypnotique et s'impose contre les connaissances *a priori* sur la taille du corps. Une des principales implications de ce travail est de révéler l'influence majeure des facteurs cognitifs sur les représentations corporelles de bas-niveau.

Mots-clefs : hypnose, suggestion, représentation de la taille du corps, image corporelle, schéma corporel, imagerie mentale, monitoring de source

ABSTRACT

Almost a century of modern scientific inquiry into hypnosis has revealed that it can have dramatic effects on perception, cognition, and behaviour. The mechanisms by which such effects come into play, however, are highly debated. In this thesis, we first briefly review the history of the field. This global view argues against hypnosis being a unitary phenomenon. Therefore, we focused on studying a single effect of hypnotic suggestion, namely modulating body-size representations. Restricting our scope to this effect reduces the number of mechanisms operating, and therefore the complexity of isolating key determining factors. At the same time, this study contributes to uncover the mechanisms responsible for perceptual alterations in hypnosis, which is an enduring question of the field. To that end, we report three experimental studies contrasting the effect of hypnotic suggestion with other manipulations of body-size representations. In our first experiment, the effect of hypnotic suggestion was compared with a vibro-tactile illusion (Lackner illusion), while in the second experiment it was contrasted with imagery instruction. Then, the third experiment tested how much of the suggested effect remained if we introduce visual or tactile feedback about the body-part size contradicting the suggestion. In each study effects on body representation were assessed both with a report of the perceived size modulation (visuospatial component), and a motor task (sensorimotor component). Our results revealed that hypnotic suggestion is a reliable and robust manipulation for modulating both the visuospatial and sensorimotor components of body-size representation. Furthermore, we proposed a plausible model of this effect resting on evidence drawn from our experimental work and from the literature on hypnosis. Our explanation acknowledges the role of situational and traits factors, but it stresses the importance of imagery and source monitoring. In this view, imagery taken for perception serves as justifications for contextually cued expectancies, overthrowing prior knowledge of body-size. One of the main implications of this work is that cognitive factors can have a major influence over primitive bodily representations.

Keywords: hypnosis, suggestion, body-size representation, body image, body schema, imagery, source monitoring

CONTENTS

GENERAL INTRODUCTION..7
1. PRELIMINARY DISTINCTIONS 8
2. A BRIEF HISTORICAL OVERVIEW 9
    2.1. Magico-religious origins (XVI BCE – 1774)..9
    2.2. The first French wave (1774 – 1831)..11
    2.3. Crossing the seas (1833 – 1846)..15
    2.4. The second French wave (1875 – 1897) 18
    2.5. Scientific era (1933 –)..21
    2.6. Hypnosis outside the lab (1922-)..24
3. APPROACHES TO HYPNOSIS 28
    3.1. The technique-based approach 28
    3.2. The result-based approach..29
    3.3. Hypnosis is not a unitary phenomenon 31
    3.4. The coupling-based approach..32
4. OLD ISSUES IN CURRENT CONTEXT 34
    4.1. Levels of explanation..34
    4.2. Two types of outcomes 36
    4.3. Uncertainties regarding the antecedent(s) of hypnosis 36
    4.4. Scope..38
    4.5. Hypnosis and false belief 39
    4.6. Genuine error or self-deception? 39
    4.7. Error in belief or error in perception? 40
5. WHAT IS HYPNOTIC SUGGESTION?..42
6. BODY METRICS 44
7. INTRODUCTION TO EXPERIMENTAL WORK..49

CHAPTER 1: HYPNOTIC SUGGESTION VERSUS SENSORY MODULATION OF BODILY AWARENESS..51
1. ABSTRACT..52
2. INTRODUCTION..53
3. MATERIAL AND METHODS 56
    3.1. Participants..56
    3.2. Materials 57
    3.3. Lackner illusion..59
    3.4. Sham 60
    3.5. Hypnotic suggestion 60

3.6. Procedure 61
3.7. Analyses 61
4. RESULTS 62
4.1. Sample description 62
4.2. Condition differences on finger elongation 63
4.3. Correlations 66
5. DISCUSSION 68
5.1. Effects on body image 68
5.2. Effects on body schema 70
5.3. Mutual influence of body image and body schema 72
5.4. Theoretical accounts of the effect of hypnotic suggestion 72
5.5. Limitations of the study 74
5.6. Clinical significance 76
6. Conclusion 76
CHAPTER 2: COMPARATIVE EFFECTS OF HYPNOTIC SUGGESTION AND IMAGERY ON BODILY AWARENESS 77
1. ABSTRACT 78
2. INTRODUCTION 79
3. MATERIAL AND METHODS 81
3.1. Participants 81
3.2. Materials 82
3.3. Hypnotic suggestion 84
3.4. Imagery instruction 85
3.5. Expectancies and voluntary vs. spontaneous imagery reports 85
3.6. Procedure 85
3.7. Analyses 86
4. RESULTS 86
4.1. Sample description 86
4.2. Hypnotic suggestion vs. imagery instruction on finger elongation 86
4.3. Relation with hypnotic suggestibility 87
4.4. Correlations 90
4.5. Effect of expectancies 92
4.6. Effect of voluntary vs. spontaneous imagery during conditions 92
5. DISCUSSION 93
5.1. Similar effect of hypnotic suggestion and imagery instruction 94
5.2. Theoretical models for the effect of hypnotic suggestion and imagery instruction 95
5.3. Bayesian integration 95
5.4. An epiphenomenal view of imagery 96

5.5. Source monitoring as a modulator? 97
5.6. Differences between competing theoretical models 98
5.7. Limitations of the study 99
6. Conclusion 100
CHAPTER 3: HYPNOTIC SUGGESTION FOR ALTERING PERCEIVED BODY SIZE RESISTS CONFRONTATION WITH THE SENSES AND PRIOR KNOWLEDGE 101
1. ABSTRACT 102
2. INTRODUCTION 103
3. MATERIAL AND METHODS 106
3.1. Participants 106
3.2. Materials 106
3.3. Hypnotic suggestion 108
3.4. Sensory cues 108
3.5. Procedure 109
3.6. Analyses 109
4. RESULTS 110
4.1. Descriptive statistics 110
4.2. Hypnotic suggestion for finger elongation versus contraction 111
4.3. Correlations 112
4.4. Effect of vision and touch on the perceived finger-size modulation 113
4.5. Modulation of the suggestion effects on the line reaching task by vision and touch 115
4.6. Role of hypnotic suggestibility and familiarity in the finger-size modulation effect 116
5. DISCUSSION 118
5.1. Symmetrical effects for elongation and contraction suggestion 118
5.2. Effect of vision and touch 120
5.3. The role of hypnotic suggestibility 122
5.4. Clinical relevance 123
5.5. Limitations 123
6. Conclusion 124
GENERAL DISCUSSION 127
1. CONTRIBUTION TO BODY AWARENESS RESEARCH 127
2. KEY EXPERIMENTAL RESULTS 129
2.1. General effect 129
2.2. Hypnotic suggestibility 131
2.3. The finger-elongation suggestion effect is not mere compliance 132
2.4. Imagery instruction replicates suggested effects 132
3. THEORETICAL ACCOUNT OF HYPNOTIC SUGGESTION FOR ALTERING BODY-SIZE PERCEPTION 133

3.1. The socio-cultural level 133
3.2. The explicit level: cognitive-behavioural strategies 134
3.3. The implicit level: a mechanistic view 136
3.4. The neural level 144
3.5. Bringing the different levels together 146
4. CONCLUSION 147
ANNEX 1: MOVEMENT SPEED AND SUGGESTION REDUCE THE SENSE OF AGENCY IN THE "HAND MOVING TOGETHER" ITEM 149
5. METHODS 150
5.1. Design 150
5.2. Agency questionnaire 150
5.3. Instruction / suggestion scripts 151
5.4. Procedure 152
6. RESULTS 153
6.1. Sample description 153
6.2. General data description 153
6.3. Effect of speed and mode of communication on agency ratings 155
7. CONCLUSION 156
ANNEX 2: EXPECTANCIES DO NOT CONFOUND THE EFFECT OF SUGGESTED FINGER-ELONGATION ON THE LINE REACHING TASK 157
1. PROCEDURE 158
2. RESULTS 159
2.1. Sample 159
2.2. Comparison against non-manipulated participants 159
2.3. Comparison of perceptual and pointing errors correlations 160
3. CONCLUSION 160
ANNEX 3: FRENCH NORMS FOR THE ONLINE SUSSEX-WATERLOO SCALE OF HYPNOTIZABILITY 163
1. ABSTRACT 164
2. INTRODUCTION 165
3. MATERIAL & METHOD 166
3.1. Participants 166
3.2. Materials 167
3.3. Procedure 168
3.4. Analyses 168
3.5. Ethics 169
4. RESULTS 169
4.1. Score distribution 169

4.2. Familiarity with hypnosis 171
4.3. Correlations 171
4.4. Reliability 172
4.5. Item analysis 173
4.6. Taste hallucination 175
4.7. Amnesia 176
4.8. Post-hypnotic suggestion (PHS) 177
5. DISCUSSION 179
BIBLIOGRAPHY 197

GENERAL INTRODUCTION

The unusual manifestations occurring during hypnosis raise fundamental questions concerning principles governing cognitive architecture. In this thesis, I will first distinguish various concepts often referred under the label “hypnosis”. Then, a brief review of the tumultuous history of hypnosis will reveal that the unity of the domain is far from granted. As a consequence, I will argue that a finer account of different hypnotic phenomena is a fruitful endeavour towards integrating the domain of hypnosis within cognitive and social sciences. From there, we will outline landmark questions raised by hypnosis, before focusing on a few specific questions. These questions will then be narrowed to a single hypnotic phenomenon as a proof of concept, namely the suggested modulation of perceived body-parts size. Theoretical background of body-size representations will be presented before moving to experimental work.

1. PRELIMINARY DISTINCTIONS

Definitions of hypnosis can sometimes look like something along these lines: hypnosis happens when a hypnotist uses hypnosis to hypnotize a person, and consequently this person experiences hypnosis. It immediately appears that this is not very informative and that several notions related to hypnosis are actually at play.

First, there is hypnosis **as a technique**, what I will call "hypnotism" here. Hypnotism is what hypnotists use to hypnotize individuals. While the *armamentum* of the hypnotist can vary, *a minima* it most certainly includes the techniques of suggestion and induction. Suggestion does not have a consensual definition. We will return to that issue latter, but for now we can define it as social influence that targets an individual's experiences. For instance, a direct verbal suggestion could be: "you will notice a nice lemon taste in your mouth, faint at first, but growing more intense by the second". Inductions, on the other hand, are procedures supposed to increase responsiveness to suggestions. They often employ relaxation and focused attention, but they can vary extremely depending on the time, location and theoretical views of the hypnotist. In the narrow sense, hypnotism refers to techniques themselves, but by extension hypnotism can also refer to the situation/activity where a hypnotist uses hypnotism on someone.

Secondly, "hypnosis" can refer to **the hypnotized individual's experience**. We will use the term "hypnotic phenomena" as a blanket term covering the diverse experiences that can be obtained through hypnosis. That includes spontaneous and suggested experiences, such as loss of agency, low arousal, hallucinations and many other.

Thirdly, and of most importance for research, "hypnosis" can refer to **the mechanisms** responsible for hypnotic phenomena. For this interpretation, we will simply stick with the term hypnosis as it is often what researcher mean when they use the term. Therefore, hypnosis is meant to close the explanatory gap between hypnotism and hypnotic phenomena.

Lastly, there is the domain of hypnosis delineated by the conditions (experiences, techniques, situations, etc.) under which a given phenomenon or situation can be qualified as hypnotic or "hypnosis". As different communities referring to the term "hypnosis" assume different theories, use different sets of techniques and seek different applications, they are doomed to disagree on the extent of the domain. By default, I shall refer here to the community of professional hypnotists (researchers, clinicians and entertainers).

With these distinctions, we may rephrase the previous sibylline statement of the layman: the domain of hypnosis includes instances in which a person uses hypnotism, leading another individual to experience hypnotic phenomena. Most professionals would agree with the layman: the domain of hypnosis is simply the use of hypnotism to generate hypnotic phenomena. However, the conception of hypnotism and hypnotic phenomena has considerably evolved throughout history and explains the diverging views on what constitutes the domain of hypnosis.

The history of the domain of hypnosis is rich, and it is beyond the scope of this manuscript to make a comprehensive review. The following summary aims at highlighting key changes in techniques, experiences, and conceptions of hypnosis that have still important consequences today.

2. A BRIEF HISTORICAL OVERVIEW

2.1. Magico-religious origins (XVI BCE – 1774)

Hypnotists often trace back their practice to the mythical figure of Franz Anton Mesmer (1734–1815). However, as we shall see, if the role of Mesmer is pivotal, it is nothing of a proper beginning. Let's work backwards from that time to explore the origins of the practices that would eventually evolve into hypnotism.

Johann Joseph Gassner (1727–1779) is our first proximal link. Gassner was a travelling priest, an exorcist with unprecedented fame. With impressive *decorum*, he went from town to town, casting out demons in the name of the Catholic church. Noteworthily, before proceeding to remove demons that were responsible for illness, Gassner used what can be considered one of the first use of a *diagnostic suggestion*. He would declare "*If there be anything preternatural about this disease, I order in the name of Jesus that it manifest itself immediately*" (Ellenberger, 1970, p. 54). If the patient did not react accordingly, he was redirected to a physician, as the ailment was of natural rather than supernatural nature. Conversely, if symptoms ensue, the priest demonstrated his power over the demon by controlling symptoms on command, displacing them from one body-part to another and changing their manifestations. The submitted demon was then cast away and the patient was healed. Modern practice still uses diagnostic suggestion to identify symptoms with psychological origin (functional neurological disorders, LaFaver et al., 2020; Popkirov et al., 2015) and control over symptoms is an integral part of the self-regulation approach (*Clinical hypnosis and self-regulation*, 1999).

The example of Gassner is simply a proximal instance of a long tradition of magico-religious practices that can be traced (at least) throughout Europe and the Mediterranean area. One other example is the "King's touch" (Bloch, 1983). In medieval France (since the XIIth century), Kings performed public rituals where they touched patients afflicted by scrofula (mycobacterial cervical lymphadenitis) and performed the sign of the cross to heal them. These rituals seemed to be particularly effective after coronation, and Kings could lose this ability if they sinned. Supranatural healing techniques were not the only asset of the religious institution. Many "trance" phenomena are recorded, with visions being regularly reported and interpreted as having spiritual origin. Famous mystics certainly had advantageous *traits* for experiencing such visions. For instance, Hildegard of Bingen is told to have her first visions between the age of three and five (Underhill, 1925). Nonetheless, less gifted individuals could still experience them through practicing rituals. Social isolation, sensory deprivation, fasting, singing, repeating prayers are only a few techniques that are still employed today for fostering so called spiritual experiences (Taves, 2009, p. 110-111,152,159-160; Vaitl et al., 2005). If these experiences might seem far from modern hypnotic phenomena, we shall see that that this part of history still exert influence on modern hypnotism.

Regardless, these healing and trance techniques, precursors of hypnotism, can be traced back much further, through ancient Arabic, Greek and Egyptian civilizations. For the sake of brevity, we will only mention the earliest records of these traditions. In the Berlin (Brugsch) papyrus (Wreszinski, 1909), dated of the IIIrd century BCE; one can find evidence of a “trance” involving eye fixation where the subject prophesize events yet to happen. This might be one of the first recorded use of an induction technique that is still part of modern hypnotism. The technique of suggestion can be traced back even further to the XVIth century BCE with the Ebers papyrus (Bardinet, 2001). This source is a repertoire of medical practices, recipes and therapeutic instructions. Amongst pharmaceutical substance and their use, one can find the following instruction : “*Place your hand on the pain and say: now, may the pain go away*” (Bardinet, 2001, group 4 [Eb. 242 to Eb. 260]). The modern hypnotist can indeed recognize here a direct verbal suggestion for analgesia, in this case for treating migraine.

This period from XVIth century BCE Egypt to the second half of the XVIIIth century Europe it marked by supernatural interpretations of “miracles”. Even members of the young medical community like Paracelsus (Theophrastus von Hohenheim, 1493 – 1541) that are regarded as heralds of the medical revolution of the Renaissance were strongly rooted in magico-religious beliefs. However, a radical paradigm shift would occur in the XVIIIth and XIXth century, casting these phenomena out of the supernatural, with Mesmer being the symbolic pivotal point of this revolution.

2.2. The first French wave (1774 – 1831)

In 1774 Mesmer started the treatment of Franzl Oesterline in Vienna. The young woman was suffering from various symptoms. As Mesmer reports: she “*had been subject to a convulsive malady, the most troublesome symptoms of which was that the blood rushed to her head and there set up the most cruel toothaches and earaches, followed by delirium, rage, vomiting and swooning*” (Pintar & Lynn, 2009, p. 14). As ordinary medical techniques were ineffective, Mesmer attempted to use magnets he received from a Jesuit priest who was experimenting with their therapeutic effect. As Pintar and Lynn report in their book: “*Mesmer attached magnets to her body and was able in this way to produce in her, on his* *command, the symptoms he was trying to cure. After a number of encouraging treatments, on July 28, 1774, he finally induced in her the vivid sensation that a fluid was rushing downward out of her body, carrying her illness away. Her improvement after this was rapid and complete*" (Pintar & Lynn, 2009, p. 14). This is reminiscent of the crisis and symptom manipulation that Gassner provoked during his exorcisms. Indeed, by 1775 Mesmer was summoned by the academy of science of Munich as part of a commission investigating the practices of the exorcist priest. By that time, Mesmer had abandoned magnets that he considered only a tool and used touch and hand movements (called magnetic passes). With his techniques, he could demonstrate the same phenomena that Gassner produced. The fundamental difference was that Mesmer had a physicalist theory explaining the effect he produced. In his view, human possessed an invisible fluid he called animal magnetism, and a healer could transfer excess of his fluid to restore the damaged stream of the patient. This theoretical innovation is arguably the most important contribution of Mesmer to the domain of hypnosis. The techniques were not new, but the idea that the underlying mechanism could be natural instead of supernatural was ground-breaking. Apart from that important contribution that he immortalized in his 1779 book, his story is of little importance for our purpose.

In 1784, in pre-revolution Paris, Mesmer had gained unprecedented fame, wealth and influence with his practice of animal magnetism. Two royal commissions were named that year to assess animal magnetism and its practice, comprising prestigious members of the scientific intelligentsia: Joseph Ignace Guillotin, Jean Sylvain Bailly, Antoine Lavoisier, Benjamin Franklin and Antoine-Laurent Jussieu amongst the most well-known. It is interesting to note that the goal was not to judge if animal magnetism was an *effective* cure, but rather if the practice proved the *existence* of the magnetic fluid that Mesmer claimed. As Mesmer refused to have his practice examined, it was Charles D'Eslon (1750 – 1786), one of Mesmer's earliest disciples, who participated in what can be considered the first double blind experiment. D'Eslon magnetized different objects, like a cup of water or a tree. Then participants, blinded to the manipulation, were exposed to different instances of these objects (cups of water or trees), and experienced magnetic crisis that were *independent* of the magnetized instance. The conclusion of the commissions is that *imagination* was responsible for the effect of the practice of animal magnetism, not an invisible magnetic fluid. This is the second heartbeat of hypnosis. In a decade, Mesmer naturalized magico-religious healing and members of the commissions determined that the phenomena were psychological.

In the following years, different strands emerged from the mesmeric core. An important part of the medical community disregarded the work of Mesmer that was supposedly explained away by the "imagination" without further questioning how imagination could produce such unusual manifestations. Charles D'Eslon rightfully argued on that subject: "*if the medicine of the imagination is the most efficient, why do we not make use of it?*" (Pintar & Lynn, 2009, p. 85), prefigurating current research on therapeutic use of placebo (Colloca & Barsky, 2020; Kirsch, 2018). Regardless, mesmerism mostly inspired suspicion despite the impressive demonstrations of the time, and the medical strand would not take root in France for almost a century. The second strand consists of adepts of Mesmer who rejected the physical postulate and reverted to supernatural explanations. These spiritualists, as we will call them, did not leave a strong mark on the discipline at that time and place, but we will encounter this movement again when moving across the Atlantic. Finally, the third strand consists of disciples of Messmer that found interest in the techniques but showed little interest in his theory. Most figures of this movement were happy with psychological explanations and were pragmatic experimenters.

One such figure was Amand de Chastenet, marquis de Puységur (1751 – 1825). Puységur made two innovations as he was using the techniques of Mesmer to heal the families living and working on his estate of Buzancy. First, he discovered that the magnetic crisis central to Mesmer's treatment was not necessary, instead he stumbled on a different set of hypnotic phenomena he called magnetic somnambulism (or magnetic sleep). This quiescent state, according to his writing, was marked with heighten suggestibility and amnesia. This first major innovation is a turning point of hypnotism, and modern practice is still haunted to this day by stereotypes of a sleep-like state (Lynn et al., 2020). The second innovation consisted of highlighting the importance of the relation between the practitioner and the subject. Free from Mesmer's physical interpretation, Puységur could observe that the bond he formed with his subject was instrumental in producing the responses he wished. This bond was called *rapport*: "*an active will to do good; a firm belief in our power; and an entire confidence in employing it*" (Pintar

& Lynn, 2009, p. 25). Apart from these contributions, Puységur and many of his followers noted strange manifestations during magnetic sleep, with seemingly feats of telepathy, clairvoyance, changes in personality (voice, demeanour, knowledge, etc.) and other seemingly paranormal phenomena reminiscent of the magico-religious era. These phenomena would produce multiple schisms in the domain of hypnosis, with important consequences for current research.

Another prominent figure of this epoch was Abbé Jose-Custodio de Faria (1756–1819). Faria shared a lot with Puységur, who he recognized as one of his teachers. However, he rejected the idea that the practitioner exerts an influence over the subject through rapport. In his view, the power to produce the phenomena of magnetic sleep was only *within the subject*, and he observed that some people were better than others to produce these phenomena. In this regard, Faria prefigures the idea that hypnotic phenomena are trait-dependent. In his technique, Faria insisted on repeating suggestions, on exemplifying what is expected (e.g. with a description or demonstration on a trained subject) and on conviction. The first point simply acknowledges that suggestions can take time to be enacted, and repetition keeps the subject on track. Exemplifying is a key aspect of Faria's technique. He carefully prepared subjects by explaining what was about to happen, and in conjunction with an intimidating demeanour, subjects not only had clear expectations, but were also deeply convinced.

Messmer, Puységur and Faria represent the key innovators of this period, both at a technical and theoretical level. Nonetheless, it is worth mentioning three hypnotists of the same strand: Joseph Philippe Francois Deleuze (1753–1835), Étienne Félix d'Hénin de Cuvillers (1755–1841), and Alexandre Bertrand (1795–1831), as they much contributed to spread innovations of their contemporaries. Bertrand insisted on the centrality of suggestion in magnetic experiences, documenting its manifestations throughout history, notably epidemies of religious experiences. On their part, Cuvillers and Deleuze played an active role in convincing the Académie de Médecine to commission another expertise on mesmerism. The commission took five years to examine in detail the effects of mesmerism. In its 1831 report, the commission concludes that the technique is effective for many applications, including *anaesthesia* for painless surgery. However, the head of the commission, Husson, initially a sceptic, became so impressed by the effect of mesmerism that the 1831 report was overwhelmingly positive, to the point that it was considered unbelievable by the Académie de Médecine. Unknowingly, the enthusiasm of Husson and his lack of critical thinking would doom the practice in France for half a century. Indeed, alongside medical evidence about the effect of mesmerism, Husson defended the existence of the magnetic fluid, and that somnambulic subjects had paranormal powers such as telepathy, seeing through objects and foreseeing the future. Several scandals ensued and mesmerism was cast out of the medical establishment in France.

The first French wave briefly covered here seeded the core ideas of the domain of hypnosis. During this brief period, hypnosis passed from supernatural to physical to psychological; the centrality of suggestion and subject's abilities were discovered; and classical hypnotic phenomena were already there. If most central ideas of modern scientific hypnosis were already present at the time, they had a hard time to be conserved and passed on to the next generation of hypnotist. This will be a recuring theme for the domain of hypnosis in France, that is still ongoing. In the decade 1830-1840, mesmerism simultaneously died in France and was born in England and the US.

2.3. Crossing the seas (1833 – 1846)

Mesmerism arrived almost simultaneously, but independently in England and in the US. Two protagonists are responsible for importing mesmerism in England. The first one is John Campbell Colquhoun (1785 – 1854), who translated in 1833 the Husson report and published three years later *Isis Revelata*. Colquhoun was a lawyer and a politician, not a scientist. Though its work would be disregarded by the medical community, its influence on the general public was considerable, spreading spiritual interpretations of mesmerism. The second protagonist is Denis Jules Dupotet (1796 – 1881), a student of Puységur, Deleuze and Faria. He arrived in England in 1837 and impressed John Elliotson (1791–1868) with his demonstrations. Elliotson, a respected doctor at London University, quickly invited Dupotet to the University College Hospital and started to experiment with mesmerism himself. At the same time (1937), the translation of Deleuze's *Histoire critique de Magnétisme Animal* was published in the US and attracted much attention. This coincided with lectures of Charles Poyen (died in 1844) on animal magnetism in the states of Maine and Massachusetts.

While the practice of mesmerism in France had a strong medical orientation, it sparked alternative applications in England and the US: spirituality and entertainment. These applications found a fertile ground in Victorian era England, and in the US with a common desire to experience "*a more directly powerful and spiritually authentic experience than mainstream philosophical systems, religious or political, could offer them*" (Pintar & Lynn, 2009, p. 71). In the US, the philosophy of Emanuel Swedenborg (1688 – 1771), had much influence. His mystic work detailed the development of the soul through a hierarchy of spiritual planes. These practices of mesmerism and swedenborgism would collide with other religious and esoteric movements of the XIXth century, and produce offspring such as Christian science, Theosophy and Spiritism.

The masses were discovering mesmerism through books, such as Colquhoun's *Isis Revelata*, but more so through demonstrations. The line between medical demonstration and freak show was thin. In 1837-1838, Elliotson demonstrated mesmerism on two inpatients of the University College Hospital in London: the sisters O'Key. The O'Keys would "*sing, dance, speak impudently to visiting nobility and collapse cataleptically into their laps, let loose witty one-liners, and increasingly to exhibit complex dissociations of identity. Eventually they were channeling a "negro spirit-guide" with prophetic and diagnostic powers*" (Pintar & Lynn, 2009, p. 37). Criticism from his medical colleagues was growing, and Elliotson finally agreed to let Thomas Wakley (1795 – 1862), the editor of the Lancet, to examine the sisters. Wakley reproduced the typical experiments of the French royal commissions with success, once again demonstrating that the fluidist theory of Elliotson (inherited from Dupotet), was wrong.

Following this event, the majority of the medical community became sceptic of mesmerism. But two individuals can be credited for saving medical hypnosis at the time. The first one is James Esdaile (1805 – 1855), a surgeon in British India, who performed over 300 "pain-free" surgeries, notably amputations, removal of cataracts and massive tumours, over a six-year period (1845-1851). His technique was responsible for a dramatic decrease in post-surgery mortality from 50% to 5%. (Yeates, 2018). Ironically, from a historical perspective Esdaile had nothing to do with mesmerism. He was using *Jhar-*

Phoonk, a folk treatment procedure from India derived from an Islamic exorcism ritual (*Ruqyah*) practiced by *Fakirs* or *Jhar-Phoonk Walas*. The attribution of Esdaile's practice to mesmerism is similar to the move Mesmer did in 1775 were he considered Gassner's exorcisms as a practice of animal magnetism. Moreover, the founding myth of Esdaile's "pain-free" surgeries must be put in perspective. First, the *Jhar-Phoonk* procedure were performed by his assistants rather than himself. Second, this procedure could take hours to days before insensitivity was obtained. Third, "pain-free" is probably an overstatement. Certain patients might have reached complete anaesthesia, but the majority were far from the "coma" Esdaile described, benefiting only from partial pain reduction (Yeates, 2018). Regardless of these facts that are often swept under the historical rug, Esdaile's feats were reported back to England under the term mesmerism and sparked once again the interest of the medical community.

The second saviour of medical hypnosis is no other than James Braid (1795 – 1860), another Scottish surgeon. Braid's innovation rested on a new idea: the effects of mesmerism were not the product of a physical fluid, nor the product of imagination, but rather caused by a *physiological phenomenon*, "nervous sleep". He theorized that eye-fixation induced nervous sleep, a technique that is still used today in contemporary inductions (e.g. Bowers, 1993), and was used at least since the third century BCE (Wreszinski, 1909). Braid can be considered the founder of "altered-state" theories of hypnosis, considering that hypnotized subjects were in a distinct (neuro-)physiological state. Dismissive of other theories of mesmerism, he coined and popularized the term hypnosis, probably not knowing that Cuvillers proposed the prefix "hypno-" two decades earlier (in 1821; Gravitz, 1993). With the term hypnosis, Braid successfully separated his practice and theory from mesmerism, rejecting for instance paranormal phenomena and in the process rid the domain of hypnosis of previous scandals and fantasies. However, mesmerism would not die, but continue to hybridize with contemporary magico-religious practices for decades and continue to mutate to this day. In the 1850s and 1860s for instance, mesmerism and the spiritist movement had strong mutual influences (Pintar & Lynn, 2009, p. 88; Vartier, 1971), with the emergence and popularisation of automatic writing and other involuntary movements (turning table, oui-ja board, pendulum, etc.). Ericksonian style of hypnotism, as we shall see, often uses this type of hypnotic phenomena, which is evidence that the mutual influence of mesmerism and spiritism found its way back into hypnotism despite Braid's efforts.

It is noteworthy to evoke the introduction in the mid-XIXth century of yoga philosophy to westerners, which was readily integrated in popular spiritual syncretism. Mesmerists would see strong parallels between their fluidist doctrine and concepts drawn from yoga. In particular, they interpreted the term prana (Prāṇa, प्राण), a Sanskrit word meaning breath / vital principle, as equivalent to the magnetic fluid postulated by Mesmer. Later in the 1880s and early XXth century they adopted the concept of Kosha (kośa, कोश), meaning sheath, and Chakra (cakra, चक्र), as building blocs of a sort of "energetic health system", specifying the general mesmeric idea of disruption in magnetic stream.

Except for Braid's idea that hypnosis might have some physiological basis, this period was overall a step backward from Faria's theory and techniques. The key event of this period is the inception of the term "hypnosis" to reshape the contours of the mesmeric discipline. Paranormal phenomena were thrown out of the window, but it would not take much time for them to return.

2.4. The second French wave (1875 – 1897)

After a long winter where mesmerism went nearly extinct, hypnotism made its return to France. Charles Richet (1850 – 1935), a future Nobel prize winner (medicine), published in 1875 the result of his experimentations with hypnotism. With the use of the traditional techniques of Mesmer, he produced a variety of classical hypnotic phenomena, notably: involuntary behaviours, hallucinations and amnesia. At the same time, Richet embraced paranormal phenomena, believing in telekinesis, telepathy, phantoms, etc. (Richet, 1922), and saw hypnotism as one way to tap into these abilities. With his experiments, Richet participated to revive hypnotism in France, in particular he inspired Jean-Martin Charcot (1825 – 1893), Chief of Medicine at Salpêtrière Hospital in Paris.

From his experiment at the Salpêtrière, Charcot theorized discrete stages of hypnosis, identical to Braid's: Catalepsy, Lethargy and Somnambulism. He noted that these stages were reminiscent of, or in his view identical to the symptoms of hysteria (functional neurological disorders in modern classifications) and concluded that hypnosis was a manifestation of this disorder. In other terms, for Charcot, the manifestations of hypnosis were explained by “neurological weaknesses” and independent of any form of suggestion. As a result, he actively tried to prohibit the use of hypnotism during the first international congress on hypnotism in 1889. In his demonstrations, Charcot produced at will all manifestations of hysteria in a theatrical manner, exactly as expected by his theory. These “shows”, gathered at their peak crowds of hundreds, displaying inpatients in grotesque situations, like a “*hypnotized woman eating charcoal she believed to be chocolate, rocking a top hat following the suggestion that it was a baby, and barking on all fours on the floor like a dog*” (Pintar & Lynn, 2009, p. 94). Despite some critics, the overwhelming majority praised the Salpêtrière master. Nevertheless, it is not on ethics that Charcot would be attacked, but rather on theoretical grounds.

In 1886, Hippolyte Bernheim (1840 – 1919), a professor of medicine in Nancy, published his first critique of Charcot, after performing the same experiments as Wakley and the royal commissions before him. Bernheim claimed that hypnotic phenomena were the result of normal psychological processes, and demonstrated that most individual could be hypnotized, including men. This was in contradiction with hysteria being rare and at the time it was believed to only affect women. Moreover, Bernheim did not observe the three stages of hypnosis described by Charcot, but he was able to produce them by suggestion. Similarly, amnesia, considered by Charcot a necessary component of hypnosis, was shown to be both rare and reversible. Unknowingly, this debate between Nancy and Paris would end-up in reversing the idea that hysteria is the cause of hypnosis, with current research showing instead that functional neurological disorders are characterised by elevated suggestibility (Wieder et al., 2021). Bernheim also opened a new avenue of research by demonstrating that he could reproduce the symptoms of hysteria with hypnosis, paving the way for current research to use hypnosis as a research tool to emulate and study psychopathologies (Cox & Bryant, 2008).

Evidence against the Salpêtrière was piling up at the beginning of the 1890s, and with the death of Charcot in 1893, his followers would admit that suggestion is indeed central to hypnotism, while minimizing the defeat. For instance, Joseph Babinski (1857 – 1932) acknowledged that suggestion could be used to produce or reduce the symptoms in hysteria, demonstrating the production of stigmata with suggestion. Similarly, Pierre Janet (1859 – 1947) commented that the manifestations of hypnosis at Salpêtrière were the product of training by Charcot's students, and that the master's lack of interest for inpatients kept him blind to his error (Janet, 1923). Alfred Binet (1857 – 1911), distanced himself from Charcot, convinced by the criticisms, and went on to experiment on healthy individuals. He further demonstrated that they could demonstrate the same manifestations as Charcot's hysterics through suggestion. Nonetheless, a "softer" version of the Salpêtrière theory was emerging, considering *trance* as part of the *explanans* (hypnosis) rather than of the *explananda* (hypnotic phenomena).

Binet, Janet and Babinski further conceptualized hypnosis as a *dissociative state*, a state where consciousness, memory, identity and sensorimotor functions were no longer integrated. Since the Nancy's school severed the connection between hypnosis and hysteria, they proposed dissociative states as their common cause. In retrospect, the idea of a dissociative state at the time was more descriptive than explicative. Indeed, it was proposed to explain hypnotic phenomena such as anaesthesia, amnesia and multiple personalities that *appeared* as a lack of integration between different functions. However, there was no proper explanation as to *why and how* hypnotism was supposed to create dissociation or how hypnosis would interact with or explain other phenomena. These ideas had nonetheless an impact on William James (1842 – 1910), that is visible in his *Principles of Psychology*. James' idea that cognitive functions are separated in consciousness would be influential on the later cognitive revolution. In parallel, ideas of psychological plurality inspired another movement that would eclipse hypnosis for over a century in France: psychoanalysis.

Sigmund Freud (1856 – 1939) briefly studied hypnotism with both Charcot (during 1885-1886) and Bernheim (in 1889). He publicly sided with Charcot, integrating his *traumatic aetiology* in his own theory. Freud progressively abandoned hypnotism between 1892 and 1895 and would declare in 1917 that psychoanalysis was born when hypnotism was set aside. The incredible influence of psychoanalysis in the world, and particularly in France, had two effects. First, hypnotism was disregarded as a psychotherapeutic technique, which is ironic since Bernheim coined the termed psychotherapy to identify the practice of using suggestion without a special "hypnotic state". Secondly, ideas about hypnosis were tainted by Freud's view. For instance, while most scholars in the world recognize that

Nancy's school won the theoretical debate, psychoanalysts of the XXth century were prone to declare Charcot the winner, in line with Freud's position (e.g. Chertok, 1965). The only true theoretical contribution of Charcot, is that suggestibility has an aetiology rooted in the life history of the individual (for another take on the aetiology of high suggestibility see: Hilgard, 1979).

This relatively short period saw the rebirth of hypnosis in France, but instead of building on previous knowledge, old debates re-emerged. With the victory of social-psychological views over those leaning on physiological explanations, one could imagine that a period of scientific interest in the phenomena of suggestion would have ensued. However, Bernheim and other fellows of the Nancy school declared that "*there is no such thing as hypnosis*" (Bernheim, 1897), while psychoanalysts disregarded the technique. Hypnotism went nearly extinct once more, but remained lively outside the medical establishment, in shows and spiritual communities. Hopefully, the discipline would emerge once more from its ashes in the US.

2.5. Scientific era (1933 –)

Clark Leonard Hull (1884 – 1952) can be credited with kicking off the scientific era of hypnosis with his book *Hypnosis and Suggestibility* (1933). Hull learned hypnosis from Joseph Jastrow (1863 – 1944). They were critical of each other, since Jastrow was anti-behaviourist and leaned towards a literary style, while Hull was a prominent behaviourist and preferred strict mathematical descriptions. Nonetheless, both worked for disentangling facts from fables in anomalistic psychology, where hypnosis belonged at the time. For instance, Jastrow demonstrated that while focusing on an object, one's hand unconsciously moves in the direction of the object, explaining many manifestations of spiritualism, like Ouija board séance. Hull wanted to establish his approach as *truly* scientific, separating the lab from the clinical setting. In his own words: "*The dominant motive throughout the entire history of hypnotism has been clinical, that of curing human ills. A worse method for the establishment of scientific principles among highly elusive phenomena could hardly have been devised*" (Pintar & Lynn, 2009, p. 100-101, citing Hull 1929). Hypnosis could be dissected and studied, but it did not prevent old debates to return with a renewed strength.

In the lineage of Bernheim and Faria, Hull established that the classical induction of the "hypnotic state" raised only slightly responsiveness to suggestions and that hypnotic and non-hypnotic suggestibility were highly correlated. This fact raised again the question of whether "trance" was an explanatory concept (*explanans)* or merely a descriptive one (*explananda)*. Robert White (1904 – 2001) set in 1941 the foundations of the socio-cognitive position, arguing that trance does not carry any explanatory power. In his article, White described Hypnotic behaviour as a "*meaningful, goal directed striving, its most general goal by the subject being to behave like a hypnotized person as this is continuously defined by the operator and understood*" by the subject (White, 1941). However, another view of trance was on its way, continuing the work of Janet. Indeed, a prevalent question in the work of Janet, Binet, James and their contemporaries, is whether complex behaviours need consciousness for being carried out. For Ernest Ropiequet Hilgard (1904–2001), behaviour is controlled by cognitive sub-systems that operate in a hierarchy, with at the top an executive ego. The executive ego does little but activating or changing autonomous subsystems according to its strategy. In Hilgard's view, hypnosis created a split in the executive ego (the conscious part of the individual), resulting in two streams of consciousness separated by an amnesic barrier (Woody & Sadler, 2008). In Hilgard's theory (neodissociation), trance is an explanatory phenomenon: the amnesic barrier prevents the executive ego from being aware of its own intentions.

Conversely, in line with White's account, Theodore Sarbin (1911 – 2005) understood hypnosis to rely on normal psychological processes, with hypnotized individual simply loosing themselves into a role (Sarbin used the term "role-taking"). This dramaturgic model has sometimes been misunderstood (or straw-manned) as meaning that individuals fake their response to hypnotism or comply (Spiegel, 1998), but socio-cognitive theorists have shown in several occasions that hypnotic phenomena cannot be reduced to mere compliance or faking (Lynn et al., 2008). Researchers of the socio-cognitive movement have spent much effort deflating arguments from their opponents. For example, neodissociationists have devised experiments where they could "contact" a part of consciousness unaffected by suggestion. They named it "the hidden observer". In this type of experiment, hypnotized participants responding to anaesthesia suggestions can have a hidden observer accurately reporting the level of pain "felt".

However, Nicholas P. Spanos (1942 – 1994) and his colleagues demonstrated that they could manipulate the hidden observer in many ways. For example, in the case of pain, they found that depending on the wording supposedly eliciting responses from the hidden observer, they either had no differences with conscious report (no cues), higher pain (more aware hidden observer) or less pain (less aware hidden observer) than conscious report. Overall, the strategy of Spanos and other socio-cognitive scientists is the same as the royal commissions: varying expectancies and assessing the consequences.

Hilgard's neodissociation theory and Sarbin's dramaturgic model represent only two precursors of movements that would grow far beyond their boundaries. Regardless, the second half of the XXth century is marked by these disagreements (whether hypnosis is explained by an altered state or not) and they never have been truly solved since. Instead, most researchers consider the question ill-posed, and the debate fruitless, preferring to examine more specific questions (Jensen et al., 2017).

The altered-state debate was not the only frontline where researcher fought, which contributed to blurring the lines of the altered-state debate. Indeed, scientists also wondered whether response to suggestion was primarily a consequence of personal traits or context. Positions in this debate can be viewed on a continuum. On one side theorists argued that suggestibility is a trait and that it determines to a great extent response to suggestion, with context only shaping the expression of the suggestion. On the other side, theorists argued that everyone can produce any hypnotic phenomenon given the "right" context. Gorassini and Spanos have devised a series of experiments to demonstrate that response to suggestion can be greatly enhanced, arguing for a contextual view of the hypnotic response. In more than a dozen studies (Gorassini & Spanos, 1999), they tested a program designed to educate participants on how to best respond to suggestions: the Carleton skill training program (CSTP). This program aimed at securing cooperation, made clear that participant should try to enact the suggestion and not wait passively (i.e. direct management, see: Gorassini, 2004), and provided strategies for enacting suggestions (involving attention management and imagination for the most part). The CSTP was demonstrated to drastically increase response to suggestion with more than half of participants initially scoring in the low range moving to the high range post-testing. The gains were stable several years after training (Spanos, Cross, et al., 1988), generalized to new suggestions, were found in different countries

(Cangas & Pérez, 1998; Fellows & Ragg, 1992; Niedzwieñska, 2000), and were controlled for mere compliance in different ways (Gorassini, 2003; Spanos & Flynn, 1989; Zivney & Lynn, 1996). However, opponents minimized this work, arguing that the CSTP only allows participant to reach their ceiling level of responding, and that it increases compliance (Laurence et al., 2008).

The altered-state debate and the trait-suggestibility debate are only two prominent examples of the themes that animated the scientific community during the second half of the XXth and early XXIst centuries. With most of the protagonists passing away in the early 2000s, researchers progressively changed their strategy towards a more collaborative and integrative stance. Hypnosis did not stay confined to the lab, and had other developments in clinical and popular settings.

2.6. Hypnosis outside the lab (1922-)

With the work of Hull and the generations of scientist after him, hypnosis became progressively a respectable domain. Nonetheless, today the links between lab research and clinical practice is loose compared to previous eras to say the least. Indeed, while researchers and clinicians of the past were the same individuals, in the second half of the XXth century we observe a specialisation that resulted at times in disconnection between the science and practice of hypnotism. Moreover, applications of hypnotism were not limited to the clinical setting, and they reached into the spiritual, with an uncomfortable grey area between these domains. In this section we will identify three families of hypnotists in the XXth century, that can be put on a continuum between completely traditional to fully syncretic.

Medical doctors and psychologists in need of hypnotism as a secondary tool would often fall on the traditional side of the spectrum. They probably are those with the most link with scientific hypnosis since they receive their training through official institutions such as the APA. As a secondary tool, hypnotism is reduced to produce characteristic hypnotic phenomena such as anaesthesia in medical settings (Cozzolino et al., 2020) or relaxation in psychological setting (Bryant et al., 2005). We will leave aside this family of hypnotists and venture towards more eclectic practices.

The middle ground between conservative practices and complete syncretism is occupied by the post-Ericksonian family. Milton Hyland Erickson (1901 – 1980) was an American psychiatrist and student of Jastrow (Pintar & Lynn, 2009, p. 109). His view that hypnosis consists of a special state and that everyone can be hypnotized had a tremendous impact on the clinical community. However, his main contribution to hypnotism is his prolific creativity in induction techniques and suggestion styles. Erickson is particularly famous for "naturalistic techniques" (Erickson, 1958), insisting on calling or amplifying what he considered as trance phenomena (hypnotic phenomena) that are already there or accessible to the hypnotised person. Arguably, one of his core contribution was to import techniques of social influence into hypnotism into what he called indirect suggestion styles. Some of his students undermined or reframed this aspect of Erickson's work (e.g. Lankton, 2008), when others delved into it (Barber, 1994; Grinder et al., 1977). While scientists were at times critical of his approach (Weitzenhoffer, 2000) for being too vague and too eclectic, it did not prevent it to be highly influential, with most modern hypnotists tracing their lineage to his work (for more details on Erickson's methods, see: Zeig, 1994). However, post-Ericksonians spent much time trying to replicate the feats of the master, but in my view failed to pursue his work on using social influence in hypnotism. Indeed, social influence as a research field has grown substantially since the 1960s (e.g. Pratkanis, 2011). Moreover, post-Ericksonians have an ambiguous relation with research, with some keeping a strong connection to the scientific community (e.g. Kumar & Lankton, 2018) while others distanced themselves from it (for some examples, see: Weitzenhoffer, 1994). By moving further away on the spectrum, this ambiguity will dissolve into a proper anti-scientific or pseudo-scientific stance.

Post-Ericksonians are eclectic in their methods (hypnotism) but seek to produce essentially the same classical hypnotic phenomena that scientists study in the lab. Conversely, the third family we are about to discuss taps into a greater diversity of hypnotic phenomena. When Braid coined the term hypnosis, he cast out so-called paranormal phenomena away. When Hull laid the foundations of the science of hypnosis on century later, he firmly re-established this boundary. However, these symbolic acts were not enough to rid the domain of hypnosis from its legacy. Possession, mediumship, channelling, clairvoyance, psychokinesis and related phenomena were in some form present for the whole history of hypnosis reviewed here. In the XXth century these phenomena became the backbone of esoteric movements falling under the generic term "New Age spiritualities" (Sutcliffe & Gilhus, 2014). In 1922 Alice Bailey (1880 – 1949) founded the Lucis Trust, which marks the beginning of an abundant esoteric literature that served as a common grammar for new age spiritualists to come. Her doctrines were directly affiliated with previous esoteric movements, such as the Theosophical society. These doctrines impacted psychology through several thinkers, eventually creating an entire sub-field: Transpersonal psychology. The filiation of transpersonal psychology to new age spiritualities can easily be traced to Roberto Assagioli (1888 – 1974), a founding figure of the transpersonal movement (Miller, 1998) who was a representative of the Lucis Trust in Italy. In the context of transpersonal psychology, "paranormal" phenomena became markers of spiritual growth and pathways towards psychological well-being. Transpersonal psychology never tested the efficacy of its methods or the soundness of its theories (at least to my knowledge; for some criticism of transpersonal psychology see: Ellis & Yeager, 1989), but it contributed to popularise the idea of altered states of consciousness.

This idea of "altered state of consciousness" originated in 1966 in a symposium on "possession states in primitive people" (Ludwig, 1966), where it is defined as a mental state which is *subjectively* identified by an individual as significantly deviating from *his* wakeful norm. The term was supposed to gather under the same label diverse experiences such as those produced by psychoactive drugs, psychopathologies, religious settings and practices, trances and spontaneous experiences of paranormal phenomena. Given the range of phenomena falling under the altered state banner, it is not surprising that research abandoned the term. Charles Tart (1937 -), a student of Hilgard, popularised the term, especially outside of the scientific community. In his 1986 book, he pushed even further the boundaries of this idea to the point that he considered so-called "normal state of consciousness" as a kind of hypnotic trance produced by society (Tart, 1986).

While dubious, the conceptions of this branch of hypnosis are in direct lineage of magico-religious traditions that gave birth to the domain of hypnosis. Furthermore, practitioners of this branch use the techniques of hypnotism, and they recruit many mechanisms that are thought to be central to hypnosis (Jamieson, 2016; van Elk & Aleman, 2017). Therefore, this transpersonal branch of hypnosis can be considered as a genuine subgenre of the domain of hypnosis. Additionally, many phenomena that are routine in these communities, such as "past-life regressions" are simply equivalent to scientifically studied phenomena (age regression) with a narrative frosting. Many of these phenomena are studied in other scientific discipline such as the *feeling of presence* to explain "spiritual perception" of invisible entities (e.g. Andersen et al., 2019), with other being produced by suggestion, such as autoscopic experiences (out-of-body experiences; e.g. Pederzoli et al., 2018). Which means that the anti- or pseudo-scientific stance of this spiritual branch is not a necessary consequence of the kind of phenomena involved. Rather, it can be viewed as a consequence of conserving certain magical beliefs that do not fit well with a scientific inquiry. Let's highlight the interesting relation that beliefs and hypnotic phenomena entertain in these contexts.

Overall, in this family, we observe two movements. The first one is an instrumentalization of unusual experiences produced by hypnotism to *experientially* justify the belief system of these communities. The second is a contamination of hypnotic phenomena by the mythology of the belief system. Indeed, anthropologists and psychologists have documented several instances of social learning in these communities shaping the experience of participants (Boyle, 2007; Dupuis, 2018), but these processes are not unique to new age contexts and can also be found in traditional cults (Halloy, 2012) and in non-spiritual practices (Somer et al., 2021; Veissière, 2016). For example, loss of agency, a classical hypnotic phenomenon, can serve as justification of spirit possession, and unusual (or not so unusual) bodily feelings such as tingling, chills, warmth, or a knot in the stomach can be interpreted as signs of an invisible entity. Reciprocally, the belief system of the individual can shape classical hypnotic phenomena such as age regression into past-lives regression without explicit suggestions from the hypnotist. If the theoretical views of this third family of hypnotists are more mythical than informative, the practice however reveals interesting co-influence between hypnotism and culture.

This description of the domain of hypnosis outside the scientific study of hypnosis reveals that scientific hypnotism is only a fraction of what is commonly considered hypnotism and that the same goes for hypnotic phenomena. This variety, as we shall see, is the root of many issues in the field of hypnosis.

We will now comment this historical review to reveal different takes on what constitutes the domain of hypnosis and why these accounts fall short of giving a satisfactory account.

3. APPROACHES TO HYPNOSIS

3.1. The technique-based approach

This historical note stressed the development of the domain of hypnosis through time. However, there are different ways of approaching hypnosis that are independent from historical development. The first approach primarily emphasizes the technique itself, starting with definitions of hypnotism. In this approach, the mechanisms of hypnosis are simply consequences of the technique, and the behaviours and experiences (hypnotic phenomena) the consequence of these mechanisms. It is noticeable in Puységur's work, where he used the techniques of Mesmer without being restricted to its classical effects (the crises). When Puységur stumbled upon "magnetic sleep", he did not conclude that he failed to mesmerise his subject, rather he embraced the manifestation as a discovery. Today, many scientists endorse the **technique-based approach**. Indeed, in most standardised experiments, hypnosis is simply assumed to result from using a hypnotic procedure. In some cases, precautions are implemented to limit or control compliance (e.g. debriefing with another experimenter). These procedures are not prevalent and often responses from all participants are analysed together. However, not all responses to hypnotism can be considered as hypnotic phenomena. For example, if an individual is bored during a hypnotic procedure, it can be explained as a consequence of that procedure, but it certainly is not a hypnotic phenomenon.

It would be tempting to restrict hypnosis (the mechanisms) to some hypnotic phenomena that are considered "successful", but it leads to a vicious circle. The rationale behind limiting the range of hypnotic phenomena is that the techniques are not perfect, and they do not always elicit hypnosis. However, in the current approach, hypnotic phenomena are defined by hypnosis. Hence, the mechanisms are defined in terms of the outcomes, and the outcomes are defined in terms of the mechanisms. This appears, for example, when one explains hypnotic phenomena (the outcome) by hypnotic suggestibility (the mechanism), a concept defined as the ability to respond to hypnotic suggestion (i.e. to produce hypnotic phenomena).

Defining hypnotism without reference to hypnosis or hypnotic phenomena has the unpleasant consequence of inflating the domain of hypnosis far beyond acceptable limits. For instance, if we equate hypnotism with suggestion, we end up categorising trivial acts as hypnotism, such as an actor's demeanour to influence the emotion of the public or a politician's speech aimed at changing the representation of a public issue. The technique-based approach is elegantly simple, but it leaves hypnosis under-constrained, likely resulting in a *proliferation of explanatory mechanisms*.

3.2. The result-based approach

At the polar opposite we find the **result-based approach**. The case of Esdaile is particularly telling in this regard. Even if the techniques of Esdaile had no historical connection to mesmerism, being inspired by local magico-religious practices (*Jhar-Phoonk*), his work is still considered a landmark of the domain of hypnosis. This is not because of Esdaile's technique, which was quite different from Mesmer's, but rather its purpose: psychogenic anaesthesia. Tenants of the result-based approach consider hypnotic phenomena first, and then work backwards to uncover the mechanisms responsible for such peculiar experiences (and ultimately the techniques that can elicit such mechanisms).

Two problems are readily apparent with this approach. First, it leads to the same kind of inflation as the technique-based approach. For instance, Erickson's idea of trance indicators (Erickson & Rossi, Chapter 1 Table 1, 1979) led him to multiply the techniques producing these markers (see: "Hypnosis outside the lab" section). Similarly, in an era where hypnosis was assimilated to sleep, hypnotists could press the eyeballs of the patient for inducing somnambulic trance (see Figure I.1; Regnard, 1887, p. 283), taking advantage of the oculocardiac reflex. The second problem is that it is difficult to delineate a coherent set of core hypnotic phenomena. Indeed, even hypnotic phenomena used in hypnotic scales (Bowers, 1993; Shor & Orne, 1963b) are eclectic, without a clear phenomenological feature shared among them. The result-based approach seems intuitive, but it lacks specificity. In particular, it is tricky to define hypnotic phenomena without reference to hypnosis and hypnotism (to avoid the same kind of circularity as in the technique-based approach) and at the same time being able to differentiate them from other alterations of consciousness, such as psychopathologies, or the effect of psychoactive drugs. In short, both the technique-based and result-based approaches lead to an inflation of the domain of hypnosis, either as a consequence of the multiple responses to the techniques, or as a consequence of equifinality (different mechanisms can generate the same consequence).

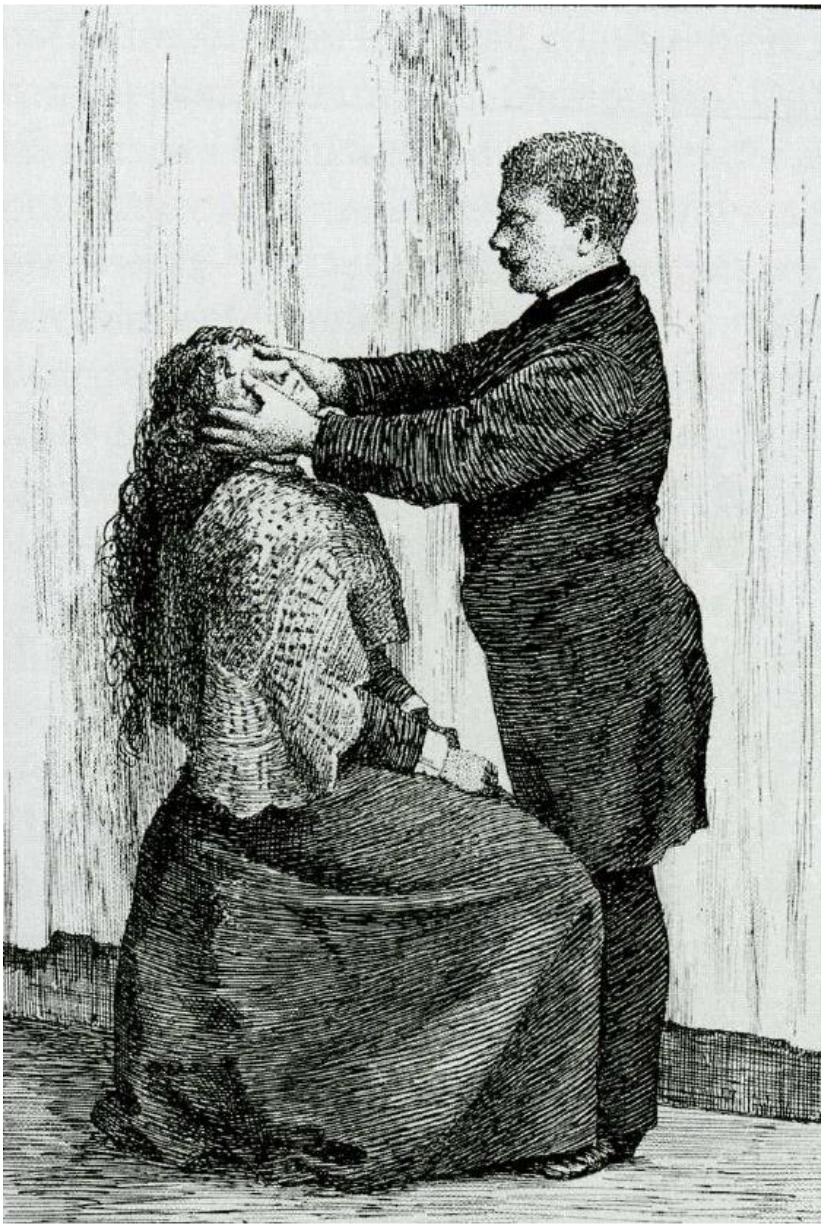

Figure I.1: *reproduction from Regnard (1887) p. 283 (public domain) showing an hypnotist pressing the eyeballs of the hypnotised subject. This process is known to trigger the oculocardiac reflex, leading to a decrease pulse rate and eventually to fainting. The figure is entitled "procédé pour faire cesser l'état cataleptique et pour ramener la somination. // D'après une photographie de l'auteur".*

3.3. Hypnosis is not a unitary phenomenon

Technique-based and result-based approaches fail because they rely on the assumption that hypnosis is a unitary phenomenon. If that were the case, starting either from the technical side or from the outcomes would lead to the same set of mechanisms. However, multiple evidence suggest that it is *not* the case (for a discussion see: Barnier et al., 2020).

First, factor analysis of responses to classic hypnotic phenomena points to a general factor (hypnotic suggestibility) and four distinct subfactors (Woody et al., 2005), namely “perceptual-cognitive”, “motor challenge”, “direct motor”, and “post-hypnotic amnesia”. Each of them can explain unique variance in responsiveness to hypnotic suggestion, lending support to the idea that multiple mechanisms are at work. Interestingly, there are inconsistencies in the pattern of loading of identical suggestions. For instance the fly hallucination of the HGSHS:A and the mosquito hallucination of the SHSS:C, or the arm rigidity suggestion of the HGSHS:A and the same one from the SHSS:C do not load on the same factor. This hints at a deeper layer of complexity hidden behind similar wording.

Secondly, conceptually speaking, somatic response to suggestion and the placebo effect are highly similar. They both are supposed to be a physiological response (e.g. analgesia) in response to expectancies, and hypnosis has been conceptualized by several authors as a non-deceptive placebo (Kirsch, 1999, 2018; Raz, 2007). However, response to hypnotic suggestions and placebo effect are in most studies completely unrelated (Evans, 1989; Huber et al., 2013; McGlashen et al., 1969) and the rare significant correlations fail to be replicated (Lifshitz et al., 2017; Sheiner et al., 2016). In light of these results, one should be cautious before declaring equivalence between two similar techniques.

Thirdly, based on post-experimental debriefing Peter Sheehan, Kevin McConkey and their colleagues found that participants described three different modes by which they responded to suggestion (Sheehan & McConkey, 1982, p. 90-93). They described a concentrative mode focused on the communication of the hypnotist and nothing else; an independent mode reinterpreting suggestions and responding in an idiosyncratic manner; and a constructive mode, actively seeking to produce the suggested experience. Furthermore, they demonstrated that an individual could use different modes for responding to different suggestions. These results are also in line with experiments revealing different profiles of highly suggestible participants. Indeed, Barber identified three excellent hypnotic subjects: the fantasy-prone, the amnesia-prone, and positively-set person (Barber, 1999). Accordingly, other experiments demonstrated the existence of a subgroup of highly suggestible highly dissociative participants using modern statistical methods (Terhune et al., 2011; Terhune, 2015; Terhune & Cardeña, 2018). Collectively, these findings show that subjected to the same context (hypnotism), individuals respond in diverse manners for enacting suggestions, depending on their traits and strategies.

Finally, and most importantly, sometimes hypnotic and non-hypnotic suggestion effects are found to be highly correlated (Kirsch & Braffman, 2001), while in other experiments they are almost independent (Tasso & Perez, 2008). These inconsistencies could arise from wrongly assuming the homogeneity of the different suggestions used. Indeed, the loose contours and diversity of the concept of suggestion almost warrants heterogeneity in the mechanisms they trigger (De Pascalis et al., 2000). Also, following the same line, the Tasso and Perez studies failed to support several expected sub-factors of suggestibility, leading them to conclude: "*What can be concluded from research on the domain of suggestibility? One inevitable conclusion is that there is no domain, but rather domains*." (Tasso & Perez, 2008, p. 30). To further support this idea, attempts to find commonality between neural activity brought by different suggestions failed as well (Landry et al., 2017). Therefore, evidence seems to point away from a unitary set of mechanisms behind hypnosis.

3.4. The coupling-based approach

The approach to hypnosis adopted in the rest of the manuscript combines the insights of the technique-based and result-based approaches and acknowledges the heterogeneity of hypnosis. It will consist in fixing both the technique used and the hypnotic phenomenon that is targeted and then analyse this specific coupling. We will refer to this third approach as **coupling-based approach,** because it attempts to decompose hypnosis into smaller pairs of technique and outcome. It seeks to uncover the link between the technique and the phenomenon using classical methods of psychology (also endorsed by the other approaches): (1) comparison with other techniques producing similar phenomena, (2) comparison with other phenomena, and (3) varying the context to interfere with the supposed mechanisms.

This approach has several advantages. By focusing on a single hypnotic phenomenon, and keeping the technique constant, this approach minimises the problem of aggregating different sets of mechanisms. Furthermore, by lowering the number of interactions between techniques and hypnotic phenomena, researchers can better assess the response to the technique, and identify different routes individuals might take to produce the hypnotic phenomenon. For instance, in one study on arm rigidity, where participants held their arm strait and were challenged to bend it after being suggested stiffness, a team found striking heterogeneity in the muscular response to this challenge suggestion (Galea et al., 2010). Indeed, almost half of participants had no motor responses while the other half had their arm trembling. This is an example of possibly two successful strategies for completing the suggestion, with likely distinct mechanisms. The coupling-based approach might be slower than the other two approaches in generating knowledge since its conclusions only apply to one hypnotic phenomenon generated through one technique, but I would contend that it generates deeper insights into the mechanisms of hypnosis. It is important to realize that this strategy does ultimately seek to uncover general laws of hypnosis, but the first movement is from the general to the particular. It is only when the links between techniques of hypnotism and hypnotic phenomena will be better understood that the movement from the particular back to the general will be the most fruitful.

Moreover, decomposing hypnosis will allow researchers to better integrate their work within other fields, which is a direction most researchers support (Jensen et al., 2017). For instance, suggestions for involuntary movements are already integrated in the field of motor control and agency, leading to fruitful cognitive models (e.g. Martin & Pacherie, 2019), and reciprocally agency is discussed integrating the unusual experience of hypnosis (Gallagher, 2013). Additionally, other non-hypnotic techniques have demonstrated reduction of agency using coaction (Wegner & Sparrow, 2007) and seem to rely on social factors. Analysing the similarities and interactions of different techniques leading to reduction of agency would be fruitful both for understanding agency, and for understanding the specific way hypnotism modulates this feeling. However, most hypnotic phenomena lack such a level of integration with their respective fields. While such a coupling-based program seems to leave aside the big questions raised by hypnosis, we will see in the next section that this is not the case. On the contrary, such an approach reframes the old issues of the field in current context.

4. OLD ISSUES IN CURRENT CONTEXT

Reviewing the history of the field makes the issues more self-evident as they tend to persist from one era to the other. From the historical perspective I proposed here, *two* questions are central to the domain of hypnosis, with other issues stemming from them:

(A) How can hypnotized individuals implement changes in their mind and body that are thought to be beyond voluntary control?

(B) How can they be so wrong about obvious states of the world?

Before unpacking these questions, let's address an issue relative to the frame of these questions.

4.1. *Levels of explanation*

Determining the correct level (or levels) of explanation for a phenomenon is vital to set a coherent scope and to select the correct tools for investigation. In the case of hypnosis, it has been argued that many disagreements are the result of conflicting levels of explanation (Jamieson, 2007; Kallio & Revonsuo, 2003). At least two levels have been conflicting since the origin of the discipline: the personal and the sub-personal level.

As it seems, the hypnotised subject is passive during hypnosis, only experiencing what is suggested. This has led theorists to mainly focus on sub-personal mechanisms explaining the experience and behaviour present at the personal level. This is particularly evident in cognitive theories of hypnosis following the seminal work of Hilgard (Barnier, Dienes, et al., 2008; Woody & Sadler, 2008). In these explanations, cognitive mechanisms are not something the hypnotised subject does, but rather something that the brain does. Ultimately, these theories seek to uncover the neural bases implementing the computational mechanisms hypothesised (e.g. Raz, 2005).

Conversely, other theorists observed that hypnotic subjects were far from being passive, and that passivity was overall the worst strategy to experience hypnosis (Sheehan & McConkey, 1982; Wagstaff, 2004). While experimentalists focusing on the sub-personal level tried to isolate a single mechanism (e.g. Lush et al., 2016; Terhune & Hedman, 2017), those interested in the personal level explored the variety of strategies and attitudes hypnotised participants endorsed (Gorassini, 1999; Sheehan & McConkey, 1982).

Incidentally, one level of inquiry is always in interaction with the levels immediately adjacent. The personal level needs to incorporate the mechanisms of the sub-personal level and the influences of the social level in its explanations; hence these approaches are often referred to as "socio-cognitive". Similarly, theories of hypnosis falling within the sub-personal level are bridging the personal level (e.g. the experience of automaticity) and biological implementation of cognitive functions at the neural level (e.g. Haggard, 2017). For example, in the case of hypnotic analgesia, a scientist interested in sub-personal explanations might identify mechanisms interfering with the activation of regions associated with the experience of pain (Rainville et al., 1999), where one interested in the personal level of explanation would rather identify strategies conducted by the participant (Fernandez & Turk, 1989; Peres & Lucchetti, 2010; Spanos, 1986). In this example, the two explanations could coincide with participants being reassured by the demeanour of the practitioner (social level), using imagery (personal level), therefore being distracted from the painful procedure (mechanistic level), and having only a partial activation of brain regions associated with pain perception (biological implementation level). It would be tempting to simply acknowledge that hypnosis spans several levels of explanations and cannot be confined to only one. However, there is always a cost to stretching the scope of inquiry, may it be experimental complexity or the difficulty to integrate theoretical accounts of various levels.

Alternatively, one can draw a distinction between implicit and explicit levels. The explicit level comprises what is considered "higher cognition", with awareness, deliberate planning and action control being the most salient features. Conversely, implicit mechanisms can operate outside of awareness and are automatic. While the personal vs. sub-personal distinction is hard to map, the explicit vs. implicit distinction covers much of the same ground, but it is experimentally tractable (i.e. it relies on discrepancies between self-reports and behavioural or physiological data). Therefore, a preliminary question to (A) and (B) would then be: (O) what is the best level of description of hypnosis? The way one answers this question determine the scope, approach and ultimately the kind of research outcome that ensue from enquiring into the questions we will now outline.

4.2. *Two types of outcomes*

The first issue (A) touches on d'Eslon question: "*if the medicine of the imagination is the most efficient, why do we not make use of it?*" (Pintar & Lynn, 2009, p. 85). Since its mesmeric origins, hypnosis demonstrated effects on phenomena that are generally considered uncontrollable: conscious perception and physiology. The most impressive examples of the first category can be found in so-called hypnotic hallucinations, both positive (e.g. hearing a music in a complete silence; Bowers, 1993) and negative (e.g. not feeling pain in response to the activation of nociceptors; Rainville et al., 1999); while for the second category, the most striking examples are hypnotic alleviation of allergies, asthma, dermatological problems, warts and gastrointestinal disorders (for a review: Benham & Younger, 2008). However, grouping these phenomena for the mere reason that they are usually uncontrollable is not informative and the first question can first be split in two sub-questions:

(A1) What are the mechanisms by which hypnosis changes conscious perception?

(A2) What are the mechanisms by which hypnosis regulates physiological processes?

Addressing these sub-questions will clearly require different research strategies and will integrate hypnosis with different fields: consciousness research for (A1) and psychosomatics (also called mind-body interaction) for (A2).

4.3. *Uncertainties regarding the antecedent(s) of hypnosis*

Both questions seek to understand the causal chain that ends in altering usually autonomous processes. At the beginning of this causal chain, many scientists assume that there is a certain cognitive state akin to belief or desire, from which regulation stems in a top-down manner (Terhune et al., 2017a). However, it is not clear what is the nature of this cognitive state. Some have proposed that expectancies is the principal determinant of the hypnotic response (Kirsch, 1997, 2000a; Lynn et al., 2008), while other contend that knowledge of the social role of "hypnotic subject" and desire to play this role are the necessary and sufficient antecedents of the hypnotic response (Barber, 1969; Sarbin & Allen, 1968; Sarbin, 1950). Expectancies and role knowledge could be mistaken with beliefs, but the authors behind the mentioned theories insist on key differences. Expectancies are implied to rest on low-level processes that are both rapid and efficient, as Kirsch states it: [expectancies] "*help us to disambiguate the world rapidly and effectively by preparing us to see it in particular ways*" (Kirsch, 2000a, p. 279). In the role-taking theory, Sarbin insists on the difference between role playing, which rests on "cold" high-level processes, and role-taking, which is "*is organismic, that is to say, it embraces the entire organism, not merely the voluntary reaction-systems*" (Sarbin, 1950, p. 260).

In that regard, Gendler (2008) offers a useful distinction within cognition, between what she calls *alief* and belief. While beliefs "track truth" and change in response to changes in evidence, aliefs are said to be automatic action-generating associations that are arational (neither rational or irrational) and more primitive than beliefs or desires. This distinction between high-level (beliefs) and low-level cognition (aliefs) is also used in other cases of delusion under the name double bookkeeping (Bortolotti, 2011). For instance: "*a patient can view doctors and nurses as poisoners (in delusional reality) but happily eats the food they give her (in everyday reality).*" (Gallagher, 2009, p. 260). The concept of alief is much closer to what theorists of hypnosis have proposed as antecedent of hypnosis: a relatively primitive cognitive representation (see also: Woody & Szechtman, 2007).

There is good evidence supporting the existence of such cognitive states. However, the nature of these states and how they relate to other states is still uncertain. Labelling them "aliefs" or "expectancies" does not explain hypnosis, rather they are placeholders, waiting for an answer to the question:

(A3) What is the nature of the cognitive state(s) responsible for hypnotic phenomena?

4.4. *Scope*

(A1), (A2) and (A3) are too broad to be answered readily. Instead of searching for mechanisms responsible for hypnotic phenomena, we would gain to first map their limits. Research has spent much effort comparing the relative difficulty of producing hypnotic phenomena, but not so much the parameters influencing the difficulty of a single phenomenon. For example, it is clear from experimental data that motor suggestions are easier to produce than negative visual hallucinations (e.g. Bowers, 1993; de Saldanha da Gama et al., 2012; Lush et al., 2018), but motor suggestions exclusively target movements that are under voluntary control and negative visual hallucination suggestions are exclusively tested in environments with perfect visibility (well lit, no distractors, no visual noise, etc.). In this context, knowing that negative visual hallucination is more difficult than motor suggestion is quite uninformative regarding the plausible mechanisms at play. Before searching for these mechanisms, it would be interesting to know if some parameter changes the difficulty of enacting these suggestions. For example, for motor suggestions, the time window allowed for the suggestion to take place (i.e. the speed of the automatic movement) could serve as a continuous parameter changing the difficulty (see Annex 1). Alternatively, targeting muscles that are not usually under voluntary control (e.g. moving vestigial muscles around the ears) or suggesting reflex movements (e.g. spasm, coughing, sneezing, etc.) would serve as a discrete change in difficulty. For hallucinations, the same could be done in the other direction (i.e. lowering difficulty) by adding visual noise to the scene. Understanding the borderline cases where suggestions fail would give important insights on the range of plausible mechanisms involved. For example, it is currently unknown if suggested effects are hindered by difficulty in a continuous manner or if the effect collapses at some point in a discrete manner. In other words, there is still much to do to locate the limits of hypnosis for various hypnotic phenomena, before moving to explore the mechanisms allowing control over the (usually) uncontrollable (A1 & A2). This can be summarised under the question:

(A4) What are the limits of hypnosis?

4.5. *Hypnosis and false belief*

The second issue (B) touches on an entirely different topic, namely the formation of inaccurate or plain false beliefs, and their maintenance despite counterevidence. At first glance, it seems that an individual responding to a motor suggestion is simply acting a normal movement while believing that he/she is not the author of the movement; an individual responding to a hallucination suggestion is simply imagining some sensory state while believing that it is perception; and an individual responding to an age regression suggestion is simply pretending to be a child while believing in the pretence. However, there are many questions raised by such a naïve approach.

4.6. *Genuine error or self-deception?*

One distinction can be made between genuine error, like believing you are seeing the flag of Indonesia when it is actually the flag of Poland, and self-deception, like believing that you will have a great day because you read it in the astrology section of the local newspaper though you *are aware* that astrology does not have predictive power. In that latter case, you have apparently contradictory beliefs, but you are motivated to accept one as true and not to question it despite what you know.

One might argue that the ambiguity of the hypnotic context (like the ambiguity between the Indonesian and Polish flags) could be suitable to generate errors. For instance, in the "hand lowering" suggestion (e.g. Bowers, 1993), participants hold their arm strait in front of them at shoulder height with the palm facing up. In that posture muscular fatigue comes rapidly and foster hand lowering. In the context of hypnosis, the relative ease to let the hand move down can lead to an attribution error (Barnier, Dienes, et al., 2008) which is experienced as making an involuntary movement. This type of reasoning can be duplicated for other suggestions, but it is often difficult to pinpoint the factors inducing ambiguity.

Conversely, the self-deception interpretation, which is endorsed by socio-cognitive theorists (Gorassini, 1999), stresses the active role of the hypnotised subject and hypnotist in forging evidence in favour of the suggested reality and in entertaining an erroneous interpretation of the situation. This type of process is similar to believing you are a soldier while playing a war game in the safety of your living room; or believing that Boromir (a fictional character) is dying when seeing a projection of Sean Bean (an actor) acting in a move set. In this view, motivation plays a key role to avoid disconfirming information or to critically assess the situation (for a discussion of motivation and information avoidance, see: Sharot & Sunstein, 2020). One strong objection against the self-deception interpretation is that the type of state endorsed by hypnotised participants can hardly be considered as a belief. Indeed, you might “believe” in some sense that you are a soldier when playing a war game, but you do not really fear to be shot dead and you do not experience crushing guilt for killing what you “believe” to be an enemy soldier. The type of cognitive state endorsed in that case might be closer to the concept of alief discussed earlier rather than belief. One important difference between the error and the self-deception interpretations is the type of factors allowing the suggested experience. In the first case, ambiguity in low-level processes such as fluency of action are responsible for an attribution error, whereas in the second case it is motivation and strategies that are maintaining the suggested reality. Regardless, the question remains:

(B1) Are hypnotic phenomena based on genuine cognitive errors, or akin to self-deception?

We do not imply a forced choice here, hypnotic phenomena could be based on both, some could be based on errors and others on self-deception, or maybe error and self-deception are irrelevant in the case of hypnotic phenomena.

4.7. *Error in belief or error in perception?*

There is another problem with the naïve approach of considering beliefs as constitutive of hypnotic phenomena. One could legitimately argue that false beliefs can be present in hypnotic phenomena, but are not necessary, their signature is rather altered *perception*. There are many instances in which beliefs and perceptual experiences can come apart, the most well-known example being visual illusions. In the Muller-Lyer illusion, despite knowing full well that the two lines are of the same length, you still visually experience them as being different. Similarly, it is actually quite common for someone responding to a motor suggestion to report that he/she *knows* that his/her muscles are executing the movement, but that it *feels* like something is acting upon the body to make it move. In so-called hypnotic hallucinations, most participants know that the suggested hallucination is not caused by something *in the world*. For instance, in the taste hallucination item of the WSGC (Bowers, 1993), participants experience a sweet or sour taste, but they do not endorse the belief that there is a candy or piece of lime that magically appeared in their mouth. And in hypnotic analgesia, participants are not believing that they are not in pain, they simply do not *feel* pain.

This raises fundamental issues about the relation between cognition and perception in hypnosis, and more generally about the phenomenon known as cognitive penetration (Pylyshyn, 1999). There is a general distinction between early perception, thought to be immune to cognitive contents and affected only by attention, and late perception which is *inferential* and can be shaped by cognitive contents. In the case of hypnosis, especially when it comes to hypnotic hallucinations, there is plenty of data suggesting that these later stages of perception are indeed recruited (Derbyshire et al., 2004; Kosslyn et al., 2000a; McGeown et al., 2012). However, it is not clear that these manifestations are the result of believing in the suggested reality. We can thus phrase the following sub-question:

(B2) What is the influence of beliefs and desires on the suggested perceptual experiences?

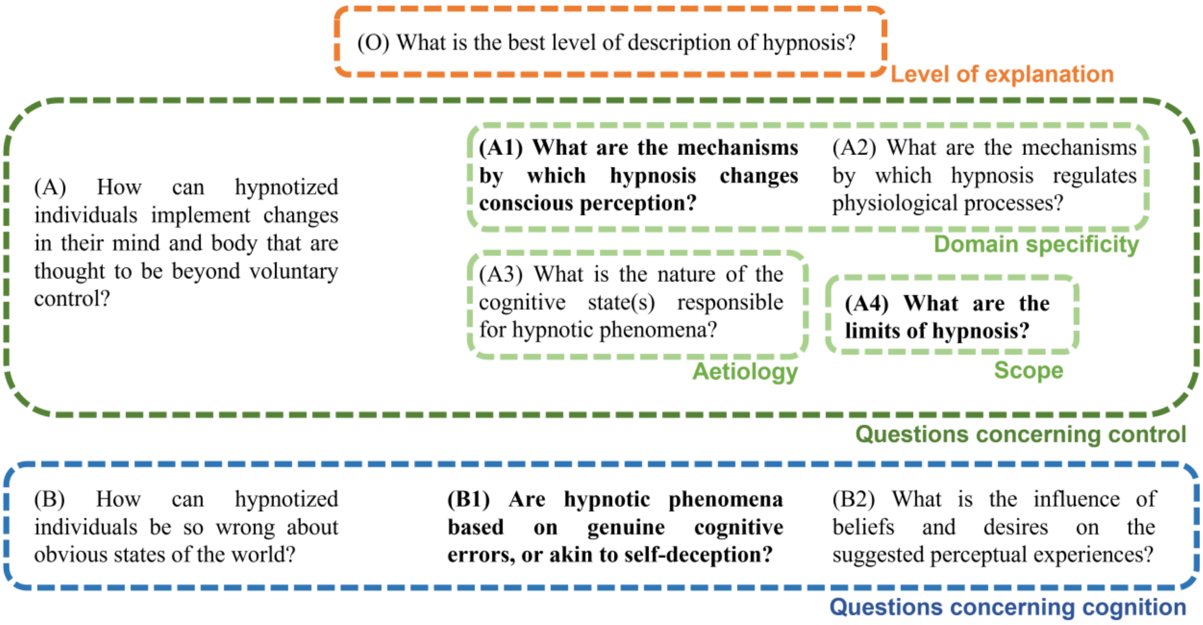

Figure 2: *Some questions raised by the unusual manifestations of hypnosis. Questions in bold (A1, A4 and B1) will be the main focus of this thesis.*

In this thesis, we will restrict our investigation to changes in conscious perception (A1), with a focus on the limits of this influence (A4). Our experiments will also provide insights into (B1), but it was not the central goal of this study.

Based on our coupling-based approach, we selected a pair consisting of a technique and a hypnotic phenomenon, namely hypnotic suggestion and finger-size modulation respectively. We will introduce elements of their theoretical background before presenting our experimental work.

5. WHAT IS HYPNOTIC SUGGESTION?

In the "preliminary distinctions" section, we highlighted induction and suggestion as the two elements that are consensually considered constitutive of hypnotism, i.e. the techniques used to produce hypnotic phenomena. There are a lot of variations in hypnotism as the historical review shows, so here we will narrow our focus to a single technique that will be used throughout this thesis.

Induction is generally composed of four components: "*(a) procedure identification: identifying the procedure as hypnosis and informing someone that they will enter a state of hypnosis; (b) receptive set: instructions and suggestions to put the participant in an appropriate or receptive experiential set; (c) relaxation: instructions, exercises, and suggestions intended to promote relaxation; and (d) absorption set: instructions and suggestions to promote absorption in the words and actions of the experimenter and the corresponding suggested or spontaneous inner experiences while diminishing attention to environmental stimuli and extraneous concerns*" (Terhune & Cardeña, 2016, p. 4-5). The role of the induction ritual is controversial (Terhune & Cardeña, 2016); some contend that it is of little use, only slightly raising expectancies, and consequently response to suggestion (Kirsch & Braffman, 2001). However, a study indicates that for some suggestions, induction can have a dramatic effect, achieving for instance an eightfold increase in response to suggested mirror-self misidentification (Connors et al., 2012). Exploring further the role of various inductions for different hypnotic phenomena would prove useful in uncovering the mechanisms of hypnosis. In particular, procedure identification has been shown to increase response to suggestions (Gandhi & Oakley, 2005), while relaxation has been shown to be completely unnecessary (Bányai, 2018). Receptive and absorption sets have little research to conclude in either direction (Brown et al., 2001), and do not correspond to well-defined techniques compared to the previous two elements.

An alternative definition would be to consider induction as an introduction to the procedure and the first suggestion (Barnier & Nash, 2008; Nash, 2005). The introduction identifies the procedure as being hypnosis and to provide information about what is going to happen during the procedure, what to expect and how to respond to upcoming suggestions. The first suggestion can target any hypnotic phenomenon, from supposedly going into a "hypnotic state" while the hypnotist is counting, to feeling one's head heavy and falling, or having one's eyes closing by themselves after fixation (Bowers, 1993; Shor & Orne, 1963b). In our experimental studies, the content of the induction varied substantially, mainly because we shortened the length of the induction from study to study. Nonetheless, the structure and key elements remained exactly the same: (a) identify the procedure as hypnosis; (b) raise confidence in hypnosis (the phenomenon has been studied for a century; everyone can be hypnotised; fears are unfounded and are inspired by myths); (c) condemn faking or compliance and ask for honesty; (d) recommend absorption in the suggested reality and reduced critical thinking; and finally (e) one motor suggestion (chosen because this is the easiest suggestion type, with around 70% success rate or more).

Now that we specified the "induction" part of the technique, let's take a closer look at the "suggestion" part. Suggestion can take many forms (De Pascalis et al., 2000), but usually modern-day research practice put the focus on *direct verbal suggestion*. This type of suggestion consists in simply verbally communicating in a non-deceptive manner (i.e. informing or requesting) to have an experience. These suggestions are also called imaginative suggestion (Braffman & Kirsch, 1999; Lynn et al., 2008), as they require the individual to imagine an alternative reality, either explicitly (e.g. "imagine you have something sweet tasting in your mouth, like a little sugar"; Weitzenhoffer & Hilgard, 1962), or implicitly (e.g. "I shall now count to five, and at the count of five, you will be back on a pleasant day in the fifth grade"; Bowers, 1993). However, we chose not to instruct participants to use imagery because the link between hypnosis and imagery is controversial (Terhune & Oakley, 2020) and prompting participants to use goal-directed imagery does not seem to improve responding, and might even decrease it (Comey

& Kirsch, 1999). Direct verbal suggestions are worded as a description of the suggested effect as already happening or about to happen. There is no intrinsic limit to the kind of experience that can be suggested, nevertheless, suggestions are known to differ in difficulty (i.e. proportion of participants being able to experience the suggestion).

Suggestions received after a hypnotic induction are said to be hypnotic suggestions. This is the technique that we chose to use throughout this thesis because it is the most iconic and uncontroversial form of hypnotism.

6. BODY METRICS

We chose to focus on modulating the perceived size of the finger to investigate the effect of hypnotic suggestion on perception. Before describing the advantages of studying this phenomenon, let's start by presenting how finger-size is represented.

Three sensory modalities are relevant to estimate body-size: vision which has a direct access, and touch and proprioception with only an indirect access. Vision does not require much explanation; you can see different body-parts and assess their relative size with one another and with other objects in the environment. By contrast, touch does not have a direct access to body-size. Indeed, passive touch on body parts can only inform about that body-part size as long as one already knows the extent of the contact. Indeed, tactile receptive fields are not equal in size and density across the skin, and they project onto the primary somatosensory cortex which represents body parts surface proportional to receptor density (Roux et al., 2018). This representation has been coined the homunculus, a distorted map of body surface with disproportionately large hands, head and feet as these areas are the most sensitive. As a result, to convert pairs of stimuli from the somatosensory map to visuospatial distances, one needs body-size information (Taylor-Clarke et al., 2004). This prior knowledge can only be derived from two sources: vision and proprioception.

Proprioception is the perception of the position and orientation of different body-parts relative to one another. For instance, eyes-closed, you can instantaneously know in which position your body is: seated or standing, legs crossed or not, and the position of your hands for only a few examples. Proprioception is based on various sensory signals coming from mechanosensory neurons located within muscles (muscle spindles), tendons (Golgi organs) and joints (joint receptors) (Tuthill & Azim, 2018). However, these signals can only give information about angles of the various joints, not the position of body-parts. Hence, proprioception relies both on these sensory signals and on a priori knowledge about the distance between the different joints (i.e. the size of the various body segments; Gandevia et al., 2002). Proprioception lies most often outside of conscious awareness, but it is nonetheless essential for action. For example in cases of extreme autoimmune response to a pathogen, nerves can be damaged and patients can be deprived of proprioceptive signals (Tuthill & Azim, 2018). This results in a complete inability to coordinate movements to perform any meaningful action such as standing, walking and basically, interacting with anything. This demonstrates the importance of proprioception for action.

The reliance of proprioception on body-size and its tight link with action has an interesting consequence: sensory consequences of action can become a source of information about body-parts size. This is evident when one walks in a crowded environment and eventually bumps into something or someone with one’s arm or shoulder. In this case, if we exclude inattention, motor planning failed as a consequence of body size underestimation. Most salient examples of body-size modulation come from sensorimotor adaptation to tool-use. Indeed, using a grabber (Cardinali et al., 2009) or stilts (Dominici et al., 2009) for a short duration updates body-size estimation, as-if the tool were incorporated. These examples show how body-size representation can be updated based on sensorimotor feedback.

Body-size representation results from integrating vision, touch and proprioception, exploiting redundancy and complementarity among sensory modalities. This kind of multisensory integration is not confined to this representation, but it is rather a common mechanism of bodily awareness (Blanke, 2012; Ehrsson, 2020; Ehrsson, 2012). In the case of body-size representation, tactile and proprioceptive signals are integrated in early somatosensory cortices (Delhaye et al., 2018), while vision is involved in later stages, likely in the cortices lining the postcentral sulcus and the cortex rostral to intraparietal cortex (cytoarchitectonic areas 2 and 5; Naito et al., 2016).

The cognitive and perceptual architecture has evolved to meet selective pressure of our ecological niche. It is therefore not surprising that non-ecological stimuli can lead to illusions. Indeed, research on multisensory integration in general, and on body representations in particular, have extensively used illusions to uncover mechanisms at play. Two illusions are widely used to alter body-size perception, one based on altering visual and tactile signals, the other on tactile and proprioceptive signals. The first illusion induces body-size modulation by manipulating visual inputs, using virtual reality (Anders et al., 2021; Kilteni et al., 2012a; Normand et al., 2011), a manipulated video capture of one's body (Newport et al., 2015), or a prop (Schaefer et al., 2007). In this illusion, synchronous tactile stimulations are performed on the real body-part, and on the visually distorted body-part. When these conditions are met, participants often report feeling a change in the target body-part size. Alternatively, the second illusion is performed in the absence of body-relevant visual inputs (often blindfolded), and consists in inducing a conflict between proprioception and touch (Lackner, 1988a). This illusion is induced by simultaneously vibrating the insertion site of the biceps brachii (or the triceps for opposite effect) and holding a body-part with the ipsilateral hand. The vibration of the tendon elicits an illusory motion of the arm by exciting proprioceptors located in the tendon and muscle. There is an incompatibility between the proprioceptive information (illusory motion), touch (holding a body-part) and the body-size representation. Hence, many individuals undergoing the Lackner illusion report a change in posture or body-size (Lackner, 1988, p. 285, Fig. 1). Alternatively, vibration can be replaced by transcutaneous electrical stimulation with similar effects (Rangwani & Park, 2021). Interestingly, in these illusion tactile perception is disrupted on the elongated body-part (D'Amour et al., 2015; Vignemont et al., 2005; Taylor-Clarke et al., 2004), with an overestimation of tactile distances. However, there is no underestimation of tactile distances in the other direction (Vignemont et al., 2005) and overall, perceived contraction of body-parts is less clear, and less frequent than extension (Lackner, 1988; but it works nonetheless: Ehrsson et al., 2005a). This is coherent with another study demonstrating that whole-body size modulation has an effect on the estimated reaching distance in the "taller" direction, but not in the "shorter" direction (D'Angelo et al., 2019). This can be interpreted as the effect of a developmental prior since our body has only grown and never shrunk in our entire life.

Indeed, there are suspicions that cognitive factors could participate in body-size perception, though it received scant attention. For germane representations such as body ownership, the impact of cognitive factors has been recently investigated. For instance, the famous rubber hand illusion (RHI; Botvinick & Cohen, 1998) can be elicited with larger, but not smaller fake hands (Giurgola et al., 2021) and that the effect was reduced for a mechanical looking hand compared to a biological (normal) looking hand (Bertamini & O'Sullivan, 2014). Moreover, effects of the RHI were shown to correlate with hypnotic suggestibility (Lush et al., 2020; Marotta et al., 2016; Walsh et al., 2015a), but these correlations are inconsistent, sometimes appearing with explicit or implicit measurements of the RHI, and disappearing when adequate controls are applied (Ehrsson et al., 2021). These results indicate that interindividual variation in bodily illusions strength might depend in part on cognitive factors, but hypotheses leaning in that direction are controversial. These cognitive effects on body ownership and the interesting debates they raised are inviting similar inquiry in the domain of body-size perception.

The results discussed so far on body-size perception are drawn from the experimental literature on healthy participants. However, pathological conditions (lesion studies and psychopathologies) can reveal unsuspected dissociations, giving insights into the possible mechanisms underlying body-size estimation. For instance, in micro/macro-somatognosia, patients experience their whole body or body-parts as smaller or bigger. This is most commonly observed in patients with epilepsy or migraine and are often part of Alice in Wonderland syndrome where the awareness of body mass, shape, size and position in space are distorted (Blom, 2016; Farooq & Fine, 2017). The duration of these symptoms is often short, from minutes to days, but can be highly incapacitating. Interestingly, some patients report feeling very tall, as if they were walking on stilts, yet they walk normally (Pitron & Vignemont, 2017). This dissociation between perception and action is not restricted to this disorder. Indeed, in autotopagnosia, patients are unable to locate their different body-parts, but they are able to use them normally. As a result, almost all taxonomies of body representations acknowledge functional distinctions between a sensory-motor representation of the body that are guiding action, and a visuospatial representation allowing location in space and perceptual identification of body-parts (Vignemont, 2010; Dijkerman & Haan, 2007; Gallagher, 2005; Paillard, 1999; Schwoebel & Coslett, 2005; Sirigu et al., 1991). The visuospatial representation is known as body image, while the representation guiding action has been referred to as body schema. Body image and body schema are supposed to be coupled in everyday life (Irvine et al., 2019; Pitron et al., 2018a), however illusions can selectively impact body image without having an effect on body schema (Aglioti et al., 1995; Kammers et al., 2006; Whitwell et al., 2018).

Body-size representations present opportunities for testing the effect of hypnotic suggestion. One interesting property of body-size perception (body image) is that its metric is stable from one individual to the other. Indeed, since we share common standards for measuring distance, two participants reporting the same finger-size distortion can be said to have similar subjective experience. Other subjectively reported parameters are much more difficult to interpret. For example, the subjective scoring of the mosquito hallucination item of the SWASH (Lush et al., 2018) is based on a Likert scale (0-5) following the question: "*On a scale from 0 to 5, how strongly did you feel the sensation of a mosquito being there, in either sound or touch, where 0 means you felt no sensation and 5 means you felt by any means as if there actually was a mosquito there?*". In this case, it is not warranted that one point on the scale for an individual represents the same change in subjective experience than another person. The dual nature of body metrics offers another interesting property for testing hypnotic suggestion. By suggesting alteration of finger-size (body image), no specific expectation is given concerning body schema, which circumvent some problems pertaining to demand characteristics (i.e. to behave in ways that are consistent with what is expected; Orne, 1962). There is also the possibility (in theory) to manipulate expectancies relative to the effect of body image modulation on body schema, allowing better control of consistency motivation (Council & Green, 2004). Also, comparing hypnotic suggestion to an illusion with similar effect on body image (i.e. similar perception), would allow to strictly test the effect of hypnotic suggestion on body schema. Indeed, in this case consistency motivation should remain constant given the same tasks, instructions and experience, and effect of illusions on body schema have been found to be negligeable (Aglioti et al., 1995; Kammers et al., 2006; Whitwell et al., 2018) or weak (Burin et al., 2019; Heed et al., 2011; Kammers et al., 2010; Newport et al., 2010; Newport & Preston, 2011; Zopf et al., 2011). All these features of body metrics make it suitable for tackling the issues raised in the "old issues in current context" section. We will now weave together the questions we will be pursuing in this thesis, the approach we chose and the theoretical background of hypnotic suggestion and body metrics, to introduce the experimental work we conducted.

7. INTRODUCTION TO EXPERIMENTAL WORK

The main focus of this thesis is to contribute to uncovering the mechanisms responsible for changes in perception occurring in hypnosis. To that end, we limit the scope of this inquiry to mapping some limits of these changes and restrict our approach to a single technique among hypnotism, namely hypnotic suggestion, and a well-defined hypnotic phenomenon: modulation of the perceived finger-size.

In a first experiment, we compared hypnotic suggestion for finger-size elongation to the classical Lackner illusion and to a sham version of this illusion. This experiment aimed at assessing the relative effect of these manipulations on body image and body schema. The effects of hypnotic suggestion compared to no manipulation gave a first glance at the effect of hypnotic suggestion on body-size perception. A more constrained comparison with the sham illusion allowed to parcel out some of the contextual effect brought by manipulation such as compliance and response expectancies. Also, by comparing the effect of a purely sensory-driven manipulation (Lackner illusion) with a purely cognitive manipulation (hypnotic suggestion), we hoped to reveal interesting contrasts hinting at plausible mechanisms at play.

The second experiment compared hypnotic suggestion for finger-size elongation to imagery instruction. This variation of technique was made to assess the relative importance of the standard decorum of the hypnotic technique (i.e. induction procedure and the wording of suggestion) and the underlying processes recruited. We also asked participants several questions relative to their experience during hypnotic suggestion or imagery instruction procedure to better isolate the components common to both manipulations.

In the third experiment, hypnotic finger-size modulation suggestion was confronted with sensory evidence against it. To that end, we asked participants to look at their finger during the whole procedure and to touch it before testing. The aim of this experiment was to assess the interference of sensory cues with mechanisms underlying hypnotic suggestion. We hoped that these limitations, and the interaction of both sensory cues would hint towards the most likely mechanisms supporting the effect.

CHAPTER 1: HYPNOTIC SUGGESTION VERSUS SENSORY MODULATION OF BODILY AWARENESS

C. APELIAN[1,2], D.B. TERHUNE[3], F. DE VIGNEMONT[1]

1- Institut Jean Nicod, Département d'études cognitives, ENS, EHESS, CNRS, PSL University, UMR 8129, 29 rue d'Ulm 75005 Paris, France.

2- A.R.C.H.E. Research Center, 27 rue de Fontarabie 75020 Paris, France.

3- Department of Psychology, Goldsmiths, University of London, 8 Lewisham Way London SE 14 6NW, UK

1. ABSTRACT

Bodily awareness arises from somatosensory, vestibular, and visual inputs but cannot be reduced to these incoming sensory signals. Cognitive factors are known to also impact bodily awareness, but their specific influence is poorly understood. Here we systematically compared the effects of sensory (bottom-up) and cognitive (top-down) manipulations on the perceived size of body parts. Toward this end, in a repeated-measures design, we sought to induce the illusion that the right index finger was elongating by vibrating the biceps tendon of the left arm whilst participants grasped the tip of their right index finger (Lackner illusion; bottom-up) and separately by hypnotic suggestion (top-down), with a sham version of the Lackner illusion as an active control condition. The effects of these manipulations were assessed with perceptual and motor tasks to capture different components of the representation of body size. We found that hypnotic suggestion significantly induced the illusion in both tasks relative to the sham condition. The magnitudes of these effects were stronger than those in the Lackner illusion condition which only produced a significantly stronger illusion than the sham condition in the perceptual task. We further observed that illusion magnitude significantly correlated across tasks and conditions, suggesting partly shared mechanisms. These results are in line with theories of separate but interacting representational processes for perception and action, and highlight the influence of cognitive factors on low-level body representations.

Keywords: Hypnosis, body representations, body image, body schema, suggestion, Lackner illusion

2. INTRODUCTION

The experience of the body may seem self-evident, coherent, and stable, to the point of being almost invisible. However, in some circumstances bodily awareness can be dramatically altered. Not only can one experience phantom sensations in long-lost amputated limbs (Makin & Flor, 2020), but one can also fail to locate one's body parts (autotopagnosia; Sirigu et al., 1991), or experience them as being elongated (macrosomatognosia; Blom, 2016), alien (somatoparaphrenia; Vallar & Ronchi, 2009), or as having a will of their own (anarchic hand syndrome; Albrecht et al., 2019). Critically, these distortions of bodily awareness are not restricted to psychiatric or neurological disorders and can be experimentally induced in neurotypical individuals through manipulation of sensory inputs (Botvinick & Cohen, 1998b; Kilteni et al., 2012b; Lackner, 1988a).

The present study focused on body metrics, namely the representation of the length of body parts. Body metrics comprise relatively basic properties, whose accurate representation is essential for action planning (Sposito et al., 2012). It is also relatively central to the way we perceive ourselves, as distortions of these metrics are known to contribute to disorders such as anorexia nervosa (Gadsby, 2017a, 2017c). Yet, it can be manipulated relatively easily. For instance, the vibration of the insertion site of the biceps brachii of the participant's arm can elicit the experience of illusory limb extension. If, at the same time, the participant holds one part of his/her body with the arm that they feel moving away, he/she can report feeling that the grasped body part is elongating in the direction of the illusory motion (Lackner illusion; Burrack & Brugger, 2005; D'Amour et al., 2015; Vignemont et al., 2005; Ehrsson et al., 2005; Kammers et al., 2006; Lackner, 1988; Naito et al., 1999). One can induce similar body part elongation by altering visual inputs, for example through virtual reality (Kilteni et al., 2012b).

It is generally assumed that bodily illusions depend on misleading sensory signals (Ehrsson, 2020; Longo et al., 2016). For example, in the Lackner illusion, perceived limb extension is caused by vibrating a tendon, which alters proprioceptive signals. By contrast, the extent to which these illusions are attributable to, or influenced by, top-down factors, has received only scant attention. In contrast to sensory-driven methods, a top-down approach aims to modify bodily awareness by inducing changes in the subject's beliefs, motivation, and expectations, with outcomes shaped by personal learning history, current social environment, and germane psychological traits (Laurence et al., 2008). Many experiments adopting this approach target mostly high-level representations of the body. For example, participants are exposed to photographs of thin fashion models, which has been shown to modify bodily satisfaction as indexed by psychometric measures (Yamamiya et al., 2005). A possibly more promising, albeit understudied, route for investigating the role of top-down mechanisms in the modulation of bodily awareness is provided by hypnotic suggestion (Oakley & Halligan, 2009; Terhune et al., 2017). A wealth of data has demonstrated how hypnotic suggestion can be used to impact processes long thought to be beyond social influence. For instance, it has been shown that hypnotic suggestion can reliably induce analgesia (Thompson et al., 2019), subjective blindness (Bryant & McConkey, 1989), and visual hallucinations (Kosslyn et al., 2000b; Landry et al., 2020; McGeown et al., 2012), and can reduce response conflict in cognitive control tasks (Raz et al., 2005a). Hypnotic suggestion has also been used to influence various dimensions of self-awareness, including the sense of agency (Deeley et al., 2013; Lush et al., 2017; Polito et al., 2018), mirror self-recognition (Barnier, Cox, et al., 2008a) and sex change delusion (Noble & McConkey, 1995a), and the sense of body ownership (Rahmanovic et al., 2012). Some of these studies specifically target bodily awareness (Röder et al., 2007; Terhune & Cardeña, 2009; Zeev-Wolf et al., 2016), but, to our knowledge hypnotic suggestion has not yet been systematically used to study the relatively low-level property of body metrics.

Bottom-up (distorted sensory signals) and top-down (hypnotic suggestion) modulations may be conceived as distinct modes by which bodily awareness can be manipulated but it remains an open question to what extent these different approaches are fully independent. For example, several studies have reported positive correlations between the magnitude of the rubber hand illusion (RHI; Botvinick & Cohen, 1998b), as well as other germane bodily illusions, and (hypnotic) suggestibility (Fiorio et al., 2020; Lush et al., 2019; Marotta et al., 2016; Stone et al., 2018; Walsh et al., 2015b). However, in contrast with claims made by some of these authors, a correlation between hypnotic suggestibility and a bodily illusion does *not* necessarily mean that an illusion is driven by suggestion and expectations; rather, it may indicate that highly suggestible individuals are merely more responsive to the illusion induction method via bottom-up mechanisms. Furthermore, demand characteristics – namely participant's explicit compliance, or unconscious changes in behaviour and experience in accordance, with implicit or explicit experimental aims (Orne, 1962b) – were recently debated as a potential contributing factor to the RHI (Lush, 2020a). Effects turned out to be weak and unsignificant when relevant controls were applied (Ehrsson et al., 2021), but the existence of these debates highlight the need for a better understanding of top-down influence on bodily awareness. In turn, this will allow us to critically examine current models of body representation and pave the way forward to better understand the diverse features that shape bodily awareness.

A now classic taxonomy distinguishes between visuospatial aspects of body representation, labelled body image, and sensorimotor aspects of body representation, often referred to under the label of body schema (Vignemont, 2018). Whereas body image is the body you perceive, body schema is the body you act with. Accordingly, bodily awareness can be selectively impaired specifically at one level (Anema et al., 2009). In Alice in Wonderland syndrome, for instance, some patients report feeling very tall, as if they were walking on stilts, yet they walk normally (Pitron & Vignemont, 2017). In this case, only body image is disturbed, and body schema remains intact. This dissociation can also be experimentally induced in healthy participants. In several instances, illusions impact perceptual responses considerably more than motor responses (Aglioti et al., 1995; Kammers et al., 2006; Whitwell et al., 2018). Illusory arm movement due to tendon vibration, for instance, does not seem to affect motor planning (Kammers et al., 2006). Nonetheless, it is believed that body image and body schema interact in most instances (Irvine et al., 2019; Pitron et al., 2018; Pitron & Vignemont, 2017) in part because the brain tends to avoid conflict whenever possible and favours unity and consistency. Consequently, in everyday life the body we perceive is the body that we act with.

The central aim of this study was to contrast bottom-up (Lackner illusion) and top-down (hypnotic suggestion) manipulations intended to induce the experience of finger elongation. We assessed body image by using a continuous version of body size estimation (Vignemont et al., 2005; Guardia et al., 2010; Mölbert et al., 2018), a widely-used perceptual task, whereas body schema was measured by a line reaching task where participants match the position of different lines with their fingertip hidden inside of a box (Baccarini et al., 2014; Kammers et al., 2006). First, we sought to determine whether hypnotic suggestion can effectively modulate body image and/or body schema. Secondly, we compared the magnitude of such effects against corresponding bottom-up influences on these representations. Since models of body image and body schema are mostly informed by bottom-up manipulations, our third aim was to assess the robustness of these models when cognitive factors are manipulated. More precisely, we wanted to clarify the interaction of body image and body schema, as reflected in correlations of their respective measurements under different sets of constraints, either sensory (Lackner illusion) or cognitive (hypnotic suggestion). Insofar as responsiveness to direct verbal suggestions varies considerably in the general population (Laurence et al., 2008), we measured hypnotic suggestibility and expected that it would predict the magnitude of the hypnotic suggestion effect.

3. MATERIAL AND METHODS

3.1. *Participants*

The sample size was estimated prior to data acquisition. We specified the *a priori* criterion that a mean effect compared to the sham condition below the test-retest reliability of our measurements would not be considered meaningful. A pilot study led us to estimate this minimal effect at 10mm, corresponding to an effect size of g=.53. Using a statistical power estimate (1-β) of 0.95 and an α-level of .05 with a two-tailed paired-samples t-test, a power analysis run using GPower 3.1 (Faul et al., 2009) yielded a minimum sample size of 49 participants. To account for potential outliers and/or attrition, we pre-specified a sample size of 52, allowing for around 5% of data loss. 51 participants (31 females, 20 males) completed the experiment (M_{age}=38.7; SD=13.2; range: 20-65 year-old). All but two were right-handed according to the Edinburgh Handedness Inventory (Oldfield, 1971). None reported psychiatric or neurologic disorders nor use of psychoactive drugs (medical or recreational) in the past six months. All participants had two valid, functional arms and were fluent French speakers. 27 participants had never experienced hypnosis, 11 reported having experienced hypnosis in the past at least once, and 13 were current hypnosis users (self-hypnosis, counselling, therapy).

3.2. Materials

Social desirability was indexed using the *Balanced Inventory of Desirable Responding* short form (BIDR-16; Hart et al., 2015). The BIDR-16 consists of sixteen items in which participants rate the extent to which different statements apply to them using a 7-point Likert scale. This scale includes two subscales: self-deceptive enhancement, corresponding to the tendency to give honest but positively-biased reports, and image management, corresponding to conscious dissimulation of responses in order to give a socially-favourable image of oneself. These subscales have good test-retest reliability and correlate modestly. In our sample, the self-deceptive enhancement subscale displayed acceptable internal consistency (Cronbach's α=0.74) whereas the image management subscale did not (α=0.52).

Hypnotic suggestibility was measured using the French version of the *Waterloo-Stanford Group Scale of Hypnotic Susceptibility: Form C* (WSGC; Bowers, 1998; Saldanha da Gama et al., 2012). This scale consists of a relaxation-based hypnotic induction followed by twelve suggestions for alterations in motor control, cognition, and perception. Following a de-induction, participants dichotomously self-rate their responsiveness to each of the suggestions. Hypnotic suggestibility is subsequently quantified as the total score (range: 0 to 12). The WSGC is a widely-used measure of hypnotic suggestibility that has previously been found to exhibit acceptable internal consistency (Bowers, 1993; Saldanha da Gama et al., 2012) although it was borderline in the present sample (α=0.61). In addition to hypnotic suggestibility, we asked participants to report their familiarity with hypnosis with the question "Report your familiarity with hypnosis (being hypnotized) or auto-hypnosis" using a Likert 5-point scale (1: "None" to 5: "Daily").

A *finger length perception task*, a continuous version of body size estimation (Vignemont et al., 2005; Guardia et al., 2010; Mölbert et al., 2018), was used to measure body image. The task was performed using a graphical user interface displaying a picture of the participant's right hand and a slider (Figure 1.1). The participant was instructed to adjust the slider until the picture of their index finger matched their perceived length of their finger. In each condition, perceived finger length was measured as the mean of two trials, one with the starting position of the slider at the maximum distortion (three times the normal size) and one starting at the minimum distortion (one third of the normal size). By comparing the reported finger size at rest to the actual finger size, we can derive an estimate of the validity of the measure. In this study, a mean bias of 9.6mm (*SD*=7.4) was found, indicating that participants overestimate the size of their index finger. This motivated us to use *perceptual error* as the dependent measure for this task, which was operationalized as the difference between the perceived finger length in each experimental condition relative to baseline perceived finger length, with negative and positive values denoting perceptual contraction and elongation, respectively.

A *line reaching task* was used to measure body schema, similar to classic reaching or matching tasks (Baccarini et al., 2014; Kammers et al., 2006). In this task, the participant's right arm was hidden in a box on a table before removing their blindfold. Three parallel lines {1,2,3} with an inter-line distance of 40mm were displayed in the field of view of the participant next to the box, with a number displayed next to each line (Figure 1.1). In each condition, participants completed seven trials in which they were asked to match the position of one of the three parallel lines with their right index fingertip {1,2,3,2,1,3,1}. The lines were only visible to the participants outside the box, so they could not see the position of their right hand. When comparing the difference of finger positions at rest relative to the target lines positions, the mean error was 6mm (*SD*=18.9mm), again indicating participants' tendency to overestimate their fingertip distance (resulting in undershooting). Hence, as in the finger perception task, we used the *pointing error* in our analyses, computed as the mean finger position in each experimental condition relative to the mean finger position at baseline.

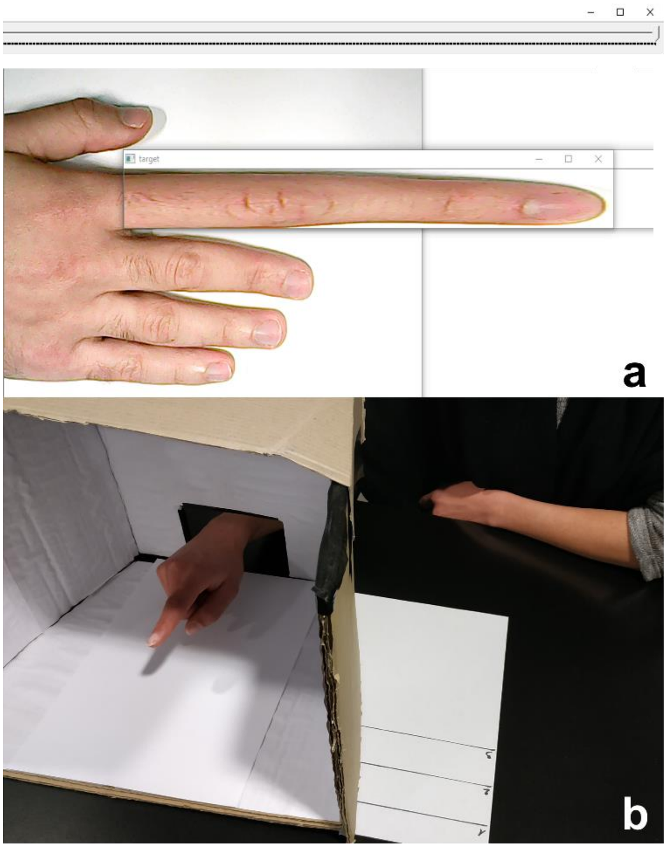

Figure 1.1: *Experimental apparatuses in the finger length perception task (a) and line reaching task (b). (a) Participants adjusted the slider so that the graphical representation matched their perceived finger length. As the slider is moved, the target window is resized to change the displayed length of the finger. The window is set to enclose only the index finger and no other element that could give away the true finger size. (b) Participants hovered above the estimated location of one of three parallel lines with their right index fingertip whilst their hand was hidden from view in a box.*

3.3. Lackner illusion

In the Lackner illusion condition we vibrated (80Hz ± 10Hz) the tendon at the insertion site of the left biceps brachii for 30s, whilst the participant held their right-hand index finger with their left hand in a pincer grip. This frequency and duration of stimulation has previously been shown to be optimal in the induction of the illusion (Naito et al., 1999). The vibrating device used in this study was a handheld wand massager (CE; Paloqueth). Participants were informed that they might feel their right index finger changing in size or not, but no reference was made regarding whether it might contract or elongate. Insofar as the Lackner illusion persists after vibration has stopped, the illusion was tested in the same way as other conditions, without vibration or index finger holding.

3.4. Sham

In the sham condition, all instructions were the same as the Lackner illusion, except the vibration was applied to the skin next to the tendon (~4cm distance) where no physiological effect should arise (Vignemont et al., 2005; Lackner, 1988).

3.5. Hypnotic suggestion

The hypnotic suggestion condition was conducted following a script developed for this experiment and contained an induction followed by a suggestion to experience the right index finger elongating. The induction consisted of focusing attention on the bodily sensations felt in the hands, reducing agency for hand motion (similar to the item "moving hands together"; Bowers, 1993), and in using imagery to change the sensation experienced in the hands, thus fostering a positive set of attitudes toward hypnosis and a passive response set. The hypnotic suggestion was phrased as "the finger is being pulled and elongated". This suggestion was repeated three times and participant was given 60s to experience the suggestion without further suggestions or cues. Afterwards, and before testing, participants were told that they would go through the measurement tasks, eyes open, while remaining hypnotized with their index finger keeping the elongated size for the whole duration of the measurements. When testing was done, a standard de-induction was performed (similar to Bowers, 1993) with an emphasis on the index finger returning to its normal size. Participants where then instructed to rub their hands and take a short break.

3.6. *Procedure*

Participants' involvement in this study consisted of two sessions separated by at least one day. The first session involved the administration of the French version of the WSGC in small groups (3-8) in a small, quiet classroom without windows or distractors. In the second session, participants completed the finger length perception task and the line reaching task four times: at rest without manipulation (baseline); after vibrating an irrelevant location near the participant's elbow (sham); after vibrating the insertion site of the biceps brachii (Lackner illusion); and after a hypnotic induction and a verbal suggestion for finger elongation (hypnotic suggestion). In all four conditions – except baseline – the participants held their right index finger with their left hand in a pincer grip whilst blindfolded. Baseline measurements were performed first, allowing the participant to develop familiarity with the tasks. The sham condition always preceded the Lackner illusion so that participants had no reference level concerning the real illusion. The order of the sham and Lackner illusion conditions and hypnotic suggestion condition were counterbalanced. Participants were told that the illusions were independent so that they might experience the first one only, the second one only, neither, or both. In each condition, the line reaching task always preceded the finger length perception task. At the end of the experiment, participants were debriefed regarding the sham condition and explained the motivation for this deception. A question-and-answer time was offered to dissipate any uneasy feelings that might arise due to the unusual experience of hypnosis. Participants were compensated 16€ for their time.

3.7. *Analyses*

In each task, we quantified finger elongation by subtracting the baseline score from the mean score in the respective condition. A single multivariate outlier ($>M+3$ *SD*s in 3 conditions) was identified and removed from the dataset. Data were analysed using linear mixed effects models, Bayesian paired *t*-tests, Pearson correlation, and correlation comparisons using *R* studio software (Version 1.2.5001, 2009-2019 RStudio, Inc.) with the lme4, car, BayesFactor, and cocor libraries (Bates et al., 2015; Diedenhofen & Musch, 2015), respectively. All t-tests were two-tailed. In the mixed effect models, condition was treated as a fixed effect, finger perception error and finger pointing error as the outcomes, with participant identification number as a random effect. All other analyses were performed using Python 3 and the scipy library. Data are publicly available on the Open Science Framework (https://osf.io/jxek3/).

4. RESULTS

4.1. Sample description

The distribution of hypnotic suggestibility in our sample, as indexed by the WSGC, M=5.65; SD=2.4; range: 0-11, was commensurate with the general francophone population (M=4.84; SD=2.15; range: 1-10; Saldanha da Gama et al., 2012). Our sample contained 8 low (score ≤ 3) and 8 high (score ≥ 9) suggestible participants. Body mass index (kg.m^{-2}), M_{BMI}=22; SD=3.3; range: [17.4-36.6], was comparable to the general French population, M_{BMI}=24.8; SD=5.4 (*Santé et itinéraire professionnel (Sip) - Ministère du Travail*, 2010). Social desirability, M_{SDE}=4.32; SD=0.97, M_{IM}=4.63; SD=0.78, was also commensurate with previously reported samples (Hart et al., 2015). No significant sex differences were observed for perceptual or pointing errors in all conditions. Condition order (sham/Lackner condition first or hypnotic suggestion first) had a significant effect on pointing error in the Lackner condition with the group receiving the hypnotic suggestion condition first displaying a larger error than the group receiving the hypnotic suggestion condition second, $t(48)=2.50$, $p=.02$, $g=0.59$. By contrast, condition order did not have a significant effect in the hypnotic suggestion condition, either on perceptual error, $t(48)=0.37$, $p=.72$, $g=0.11$, or pointing error, $t(48)=0.01$, $p=.99$, $g<0.01$, nor did we observe significant condition order effects in the sham condition on perceptual error, $t(48)=0.08$, $p=.94$, $g=0.02$, or pointing error, $t(48)=0.99$, $p=.33$, $g=0.28$, or in the Lackner illusion condition on perceptual error, $t(48)=0.62$, $p=.54$, $g=0.18$.

4.2. Condition differences on finger elongation

Our first analysis contrasted the magnitude of the condition manipulations on errors in the two tasks. As can be seen in Figure 1.2, linear mixed effects models revealed that, relative to the sham condition, hypnotic suggestion produced larger perceptual errors, $t(49)=7.26$, $p<.001$, $g=1.25$, and pointing errors, $t(49)=5.72$, $p<.001$, $g=0.90$. Hypnotic suggestion also had a significantly larger effect than the Lackner illusion on perceptual error, $t(49)=4.87$, $p<.001$, $g=0.66$, and pointing error, $t(49)=4.85$, $p<.001$, $g=0.74$. The Lackner illusion produced a larger perceptual error than the sham condition, $t(49)=2.39$, $p=.02$, $g=0.43$, but the two conditions did not significantly differ for pointing error, $t(49)=1.23$, $p=.22$, $g=0.25$. These results demonstrate that the Lackner illusion manipulation produced a moderate-sized illusion of finger elongation, when indexed with the perceptual error, whereas hypnotic suggestion yielded a substantially larger effect that is observed in both perceptual and pointing errors.

We next tested if there was evidence in favour of similar distributions (null hypothesis) for pointing error in the Lackner illusion and sham conditions using a Bayesian paired *t*-test. We performed the analysis separately for both condition orders (hypnotic suggestion before or after the sham and Lackner illusion) since there was a significant effect of Condition order on pointing error in the Lackner illusion condition. We obtained moderate evidence (BF_{01}= 0.207 or approximately 1:5 in favour of the null hypothesis) for similar distributions when sham and the Lackner illusion were completed first. However, the data were inconclusive when sham and the Lackner illusion were completed after the hypnotic suggestion condition (BF_{01}=1.60). Hence, at least when isolated from hypnotic suggestion, the effect of the Lackner illusion on pointing error is probably indistinguishable from the effect of the sham condition.

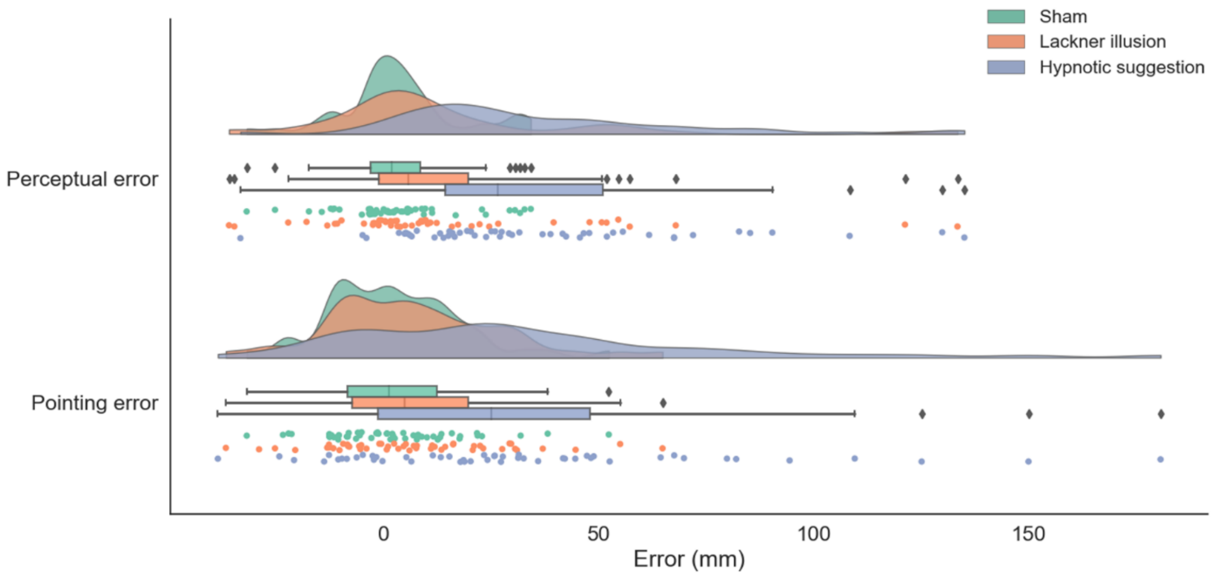

Figure 1.2: *Raincloud plots of perceptual and pointing errors (mm) as a function of Condition (N=50). Distributions reflect kernel density estimation plots and markers reflect individual measurements. Boxplot whiskers represent 1.5 interquartile range, diamonds represent individual values outside the whiskers.*

Additionally, we found that hypnotic suggestibility was significantly positively correlated with perceptual error in the hypnotic suggestion condition, r=.32, p=.02, but not pointing error, r=.22, p=.13. By contrast, hypnotic suggestibility did not significantly correlate with perceptual error in the Lackner illusion condition, r=.24, p=.10, or the sham condition, r=.22, p=.12, or pointing error in the Lackner illusion condition, r=.07, p=.61, or the sham condition, r=-.04, p=.76.

We next sought to assess the role of control variables: age, sex, condition order, BMI, hypnotic suggestibility (WSGC), social desirability (self-deceptive enhancement and image management), and familiarity with hypnosis. We did so by comparing with a χ^2 test the basic mixed linear model (perceptual error ~ condition / pointing error ~ condition) against a model where each control variable was sequentially included as a covariate. In the pointing error model, only the hypnotic suggestion condition was compared to the sham since the Lackner illusion had no significant effect on the pointing error. For the analysis of perceptual errors (Table 1.1), only hypnotic suggestibility significantly improved the model, $\chi^2(1,N=50)=5.99$, $p=.01$, although the model did not improve if we allowed for an interaction between hypnotic suggestibility and condition, $\chi^2(2,N=50)=3.28$, $p=.19$. For the analysis of pointing errors (Table 1.2), only self-reported familiarity with hypnosis significantly improved the model, $\chi^2(1,N=50)=5.32$, $p=.02$, and the model improved further with the inclusion of a hypnosis familiarity x hypnotic suggestion interaction term, $\chi^2(2,N=50)=43.55$, $p<.001$. In these models, we find again a significantly larger effect of hypnotic suggestion and Lackner illusion manipulations compared to the sham condition on perceptual error (see Table 1.1) and a significant effect of the hypnotic suggestion on pointing error compared to the sham condition (see Table 1.2). These results indicate that the hypnotic suggestion manipulation yielded the largest illusion on both errors and that this effect is independently fostered by hypnotic suggestibility for the perceptual error whereas the impact of the hypnotic suggestion was further modulated by familiarity with hypnosis for the pointing error. Interestingly, hypnotic suggestibility and familiarity with hypnosis were not significantly correlated $r=.24$, $p=.10$.

Table 1.1

Linear mixed effect model of perceptual error in the finger length task (N=50).

Model: Perceptual error ~ Condition + hypnotic suggestibility + (1|Subject)					
Effect	Estimate	*SE*	95% *CI*		*p*
			LL	UL	
Fixed effects					
Intercept (Sham)[a]	-14.17	8.08	-30.01	1.67	.08
Lackner illusion [a]	10.58	4.43	1.90	19.25	.02
Hypnotic suggestion [a]	32.12	4.43	23.44	40.79	<.001
Hypnotic suggestibility [b]	3.07	1.24	0.63	5.50	.01

Notes. CI = confidence interval; LL = lower limit; UL = upper limit. Within subject variance = 258.7; residual variance = 489.8. [a] = estimates in mm; [b] = estimates in mm/scale unit (0-12 scale).

Table 1.2

Linear mixed effect model of pointing error in the line reaching task (N=50).

Model: Pointing error ~ Condition * familiarity with hypnosis + (1|Subject)					
Effect	Estimate	*SE*	95% CI		*p*
			LL	UL	
Fixed effects					
Intercept (Sham)[a]	0.22	6.49	-12.49	12.94	.97
Hypnotic suggestion [a]	9.40	3.57	2.40	16.41	.01
Familiarity with hypnosis [b]	1.05	2.73	-4.30	6.39	.70
Hypnotic suggestion * familiarity [b]	10.07	1.50	7.12	13.02	<.001

Notes. CI = confidence interval; LL = lower limit; UL = upper limit. Within subject variance = 163.3 ; residual variance = 647.6. [a] *= estimates in mm;* [b] *= estimates in mm/scale unit (1-5 scale).*

4.3. Correlations

Our final set of analyses involved assessing the correlations between errors in the two tasks in the different conditions. As can be seen in Figure 1.3, perceptual and pointing errors were positively correlated in all conditions. This association was strong in the hypnotic suggestion condition but moderate in the Lackner illusion and sham conditions. Moreover, the correlation was significantly higher in the hypnotic suggestion condition (two-tailed) than in the sham condition, $z = 1.98$, $p = .048$, and Lackner illusion, $z = 1.98$, $p = .048$, but did not significantly differ between the latter two conditions, $z = 0.24$, $p = .81$. These results suggest a moderate to strong association between errors in the two tasks.

A further series of correlation analyses between errors in the different conditions provides further insights into individual differences in these effects. In particular, we observed significant positive correlations between perceptual errors in the sham, Lackner illusion, and hypnotic suggestion conditions, although this association was most pronounced between the latter two (Figure 1.3). Pointing errors in the Lackner illusion condition also significantly correlated with those in the sham and hypnotic suggestions conditions, although those between the latter two did not significantly correlate. Since the Lackner illusion and hypnotic suggestion conditions both had a significant impact on perceptual error, we compared the correlation of perceptual errors in these conditions to those between these conditions and the sham. The correlation of perceptual errors between hypnotic suggestion and Lackner illusion condition was not significantly different from the corresponding correlation with the sham condition, z=1.84, p=.066, a similar result was observed with the correlation for perceptual errors in the Lackner illusion and the sham, z=1.13, p=.26.

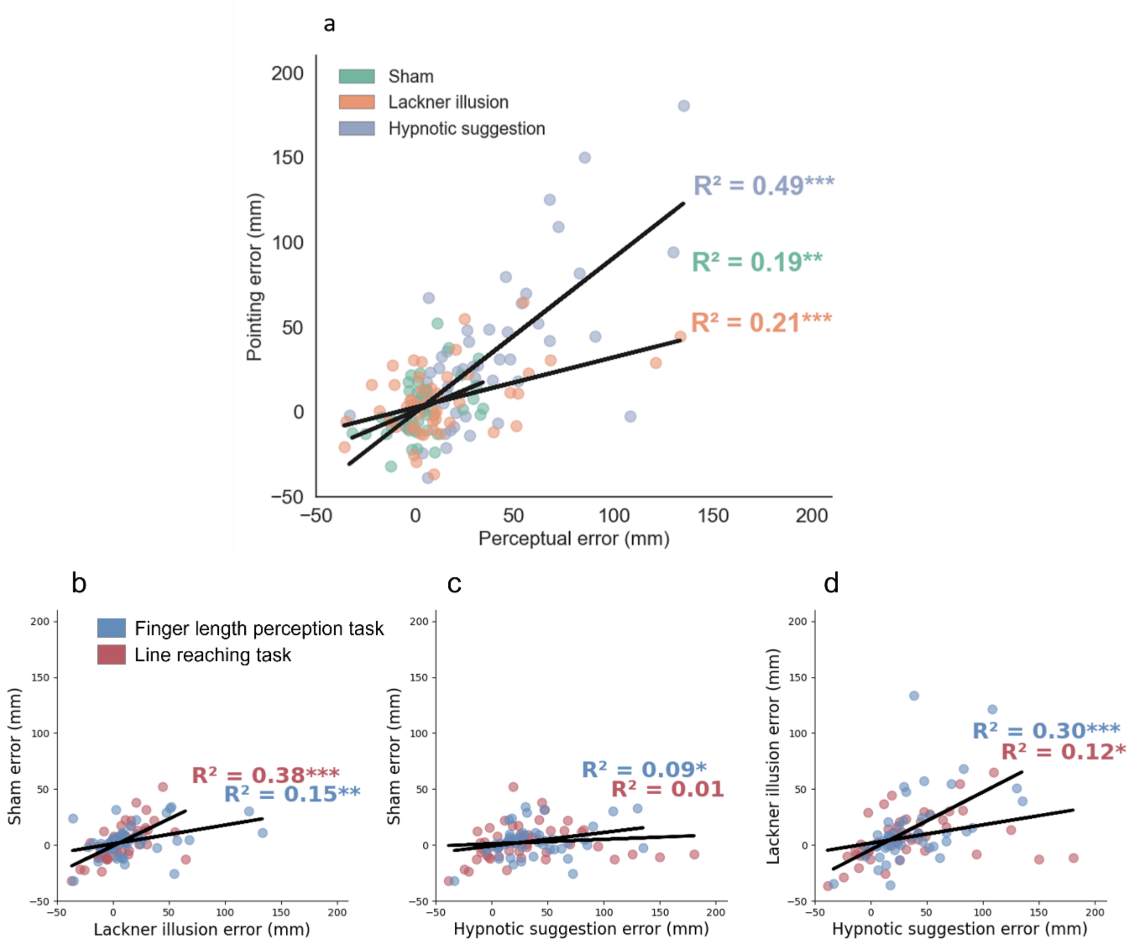

Figure 1.3. *Scatterplots depicting associations between measurement variables. (a) Associations between pointing error and perceptual error in the sham, Lackner illusion, and hypnotic suggestion conditions. (b, c, d) Scatterplots depicting associations for both errors between (b) sham and Lackner illusion conditions; (c) sham and hypnotic suggestion conditions; and (d) Lackner illusion and hypnotic suggestion conditions. Lines denote least squares regression slopes. * p<.05; ** p<.01; *** p<.001*

5. DISCUSSION

This study compared the effects of hypnotic suggestion and the Lackner illusion on the perceived size of participants' index finger (body image) and on the way they act with it (body schema). Body metrics comprise relatively low-level properties, which one might have expected to be immune to cognitive penetration. However, we found that not only did hypnotic suggestion induce illusory finger elongation both at the visuospatial and at the sensorimotor levels, but also that these effects were significantly stronger than the corresponding magnitude of the sensory-driven Lackner illusion. Furthermore, we report a pervasive correlation between our perceptual and motor measurements across all conditions, suggesting that body image and body schema interacted substantially. These results demonstrate that the hypnotic suggestion is an effective technique for transient modulations of body image and body schema.

5.1. Effects on body image

Body image was significantly altered by the hypnotic suggestion and the Lackner illusion. However, the mean effect of the hypnotic suggestion on body image was larger than the effect of the Lackner illusion. Although the mechanisms underlying the effects of hypnotic suggestion are still debated, it is widely accepted that they involve top-down regulation (Terhune et al., 2017). This indicates that when sensory evidence was minimized (participants were blindfolded and had no tactile inputs), body image favoured higher-order information, even if contrary to prior knowledge of finger size. By contrast, in the presence of misleading sensory signals induced by vibrations (with no systematic expectation), body image leant towards prior knowledge for most participants, resulting in a weaker influence of the illusion compared to the hypnotic suggestion. It can indeed be safer for a cognitive system to rely more on the learning history of the organism than to the noisy, and sometimes contradictory, sensory inputs. This is in line with other studies showing that participants' perception is shaped more strongly by prior information in context of high uncertainty (Cassidy et al., 2018). Beyond reliance on memory, executive control (selecting and maintaining behaviours in line with the participant's goals) is believed to play an important role in regulating the integration of sensory information and the expression of lower subsystems of control, thus allowing for behavioural flexibility, especially in contexts with multiple conflicting tasks and sources of information (Norman & Shallice, 1986; Spagna et al., 2015; Wu et al., 2020). Hence, there are multiple ways for the cognitive system to make an inference based on incongruent sensory signals. Indeed, participants report different experiences in the Lackner illusion, some feel elongation, while other feel their body-parts change in position to accommodate the conflict between different sensory modalities (Lackner, 1988a). In our experiment, one participant reported that the finger seemed to float in the air, separated from the hand. From that perspective, we can interpret the difference between the Lackner illusion and the hypnotic suggestion as a tendency to favour data derived from executive functions compared to sensory data for updating body metrics.

The effect of hypnotic suggestion on perceptual error significantly correlated with hypnotic suggestibility. This indicates that highly suggestible participants tended to display larger perceptual errors in response to the hypnotic suggestion for finger elongation. Similar, albeit weaker and non-significant, correlations were observed for perceptual error in the Lackner illusion and sham conditions and warrant greater attention in future studies with larger statistical power. These results are relevant to current debates concerning the role of hypnotic suggestibility in bodily illusions (Lush, 2020a). Our data do not exclude the possibility that hypnotic suggestibility accounts for variability in the Lackner illusion, although our sample size was not large enough to detect this association. Nevertheless, our results suggest that *if* this association is present, it is rather weak (for the RHI, it was shown that with adequate control, the association was insignificant: Ehrsson et al., 2021). Relatedly, if a role for top-down processing is present, it does not explain away the specific effect of the Lackner illusion as it survived the inclusion of hypnotic suggestibility as a covariate in our model of perceptual error. Furthermore, the sham condition probably controlled adequately for confounding cognitive effects given the identical instructions and apparent similarity between the sham and Lackner illusion conditions, and as evidenced by similar correlations with hypnotic suggestibility.

Our data further reveal a common sensitivity to bottom-up and top-down manipulations of body image. In particular, we found a positive correlation between perceptual errors in the hypnotic suggestion and Lackner illusion conditions. This sensitivity to alterations of bodily experience across bottom-up and top-down contexts is probably not reducible to hypnotic suggestibility since correlations with errors in the Lackner illusion were weak and non-significant. Nonetheless, high hypnotic suggestibility has been proposed to reflect a proneness toward liminal conscious experiences that may be observed in a variety of contexts (Cardeña & Terhune, 2014; Dell, 2021). Future studies would benefit from more rigorously assessing this possibility by investigating associations between low-level bodily illusions and top-down body-related suggestions.

5.2. Effects on body schema

The hypnotic suggestion also had a significant effect on body schema. This effect seems tightly linked to the effect on body image as the two errors were strongly correlated. Although the Lackner illusion did alter body image, we found that it did not significantly alter body schema. This dissociation aligns with similar results showing that action is often immune to sensory illusions (although not always; Kammers et al., 2010), including different bodily illusions (Kammers et al., 2006, 2009; Aglioti et al., 1995; Whitwell et al., 2018). However, some rare participants displayed large pointing error (maximum: 77mm) in the Lackner illusion condition compared to the sham. At closer inspection, the pointing error was significantly greater in the Lackner illusion when participants had previously been given the hypnotic suggestion. Accordingly, all six individuals exhibiting the largest pointing errors in the Lackner illusion condition underwent the hypnotic suggestion first. This suggests that participants might have been influenced by expectations generated during the hypnotic suggestion condition, particularly regarding the direction (elongation) of the finger length distortion. However, the effect of the Lackner illusion on the perceptual error was too weak to be significant in each subgroup, limiting the interpretation of the aforementioned order difference. Additionally, pointing error in the Lackner illusion moderately correlated with pointing error in the hypnotic suggestion condition whereas the former correlated strongly with pointing error in the sham condition. Considering these results, we might be suspicious of any effect of the Lackner illusion on pointing error. The Lackner illusion is known to dissipate rapidly after ceasing vibrations, it is therefore possible that we underestimated its effect on body schema.

Hypnotic suggestibility did not significantly correlate with pointing error in any condition, nor did it improve the pointing error model. Conversely, self-reported familiarity with hypnosis significantly improved the model, revealing that the effect of hypnotic suggestion on body schema is significantly influenced by previous exposure to hypnotic contexts. Somewhat unexpectedly, it did not significantly correlate with hypnotic suggestibility. Some correlation was expected, both because low-suggestible individuals were expected to avoid hypnotic context that might be boring to them, as there are not experiencing hypnotic effects, and because highly suggestible persons were expected to exploit their ability through exposure to hypnosis (self-hypnosis, counselling or therapy). Nevertheless, hypnotic suggestion still had a significant effect when familiarity was included in the model. Generally, experimental hypnosis research does not account for familiarity with hypnosis, either leaving its results open to potential confound or selecting participants with no prior experience with hypnosis. Hence, this result warrants that familiarity with hypnosis, as well as beliefs about hypnosis, be afforded greater attention in experimental hypnosis research. Indeed, while common in germane fields such as mindfulness research (Bartlett et al., 2019), training participants to experience hypnotic phenomena is quite rare. Modification studies in hypnosis (Gorassini, 2004) are relatively brief (around one hour) yet are the source of controversies (for a review, see Lynn, 2004). As evidenced by our results, being frequently exposed to hypnotic contexts might not have a significant effect on the primary target of suggestion (perceptual elongation in our case) but rather on ancillary consequences of the suggestion. Nevertheless, the cognitive locus of this effect remains unclear as familiarity may reflect attitudinal effects (e.g., expectancies, beliefs, role knowledge, etc.) or dispositional factors (e.g., traits or skills) and either a cause (i.e., exposure to hypnosis modulates attitudes or dispositions) or a consequence (i.e., attitudes/dispositions motivate individuals to try hypnosis). Familiarity with hypnosis was found to covary with the magnitude of some effects dramatically; for example, the mean effect of the hypnotic suggestion on pointing error at the highest familiarity level was three times greater than that at the lowest familiarity level. Future studies would therefore benefit from both incorporating this variable into statistical analyses and decomposing its elements.

5.3. Mutual influence of body image and body schema

Research on body image and body schema has revealed many cases of dissociations thus motivating the position that they reflect separate representations (Vignemont, 2010). In our experiment, the effect of the Lackner illusion is consistent with this view of body image and body schema as separate. However, it has also been argued that in most cases these representations interact and shape each other (Irvine et al., 2019; Pitron et al., 2018; Pitron & Vignemont, 2017). This is supported here by the correlation between perceptual and pointing errors in all conditions. Evidence in favour of a coupling of these representations is further provided by the hypnotic suggestion manipulation. The hypnotic suggestion influenced both body image and body schema compared to the sham condition, but the fixed order of measurements prohibited the computation of path analysis models. Such models would help understand whether hypnotic suggestion has a direct effect on both representations, or if the effect on one of them is mediated by the other. Ideally, to provide an answer to that question, one should be able to independently (or at least differentially) influence body image and body schema. Regardless, evidence leans towards a mutual influence of body image and body schema.

5.4. Theoretical accounts of the effect of hypnotic suggestion

The strong effect of the hypnotic suggestion on body schema compared to the Lackner illusion, which corresponded to a relatively weak effect, can be interpreted at least in two different ways. Since the hypnotic suggestion explicitly revealed the intended purpose of the experiment, it is possible that participants enacted what they interpreted to be the “correct” hypnotic behaviour. This interpretation aligns with some sociocognitive accounts of hypnosis (Lynn et al., 2008; Wagstaff, 2004), which conceptualize hypnotic behaviour and experience as a culturally devised role and an active process. In this framework, the hypnotic suggestions did not directly alter body representations; rather, participants changed their behaviour and experience according to their expectations. This interpretation explains nicely the strong correlation between errors in the finger length perception and line reaching tasks. Indeed, if participants retain correct proprioception, they might index their pointing error on their perceptual error – i.e., the bias in the line reaching task is *intentionally* planned and enacted by the participant. According to this interpretation, participants imagine having a longer finger, wilfully suspend their disbelief and critical appraisal, report this experience in the finger length perception task, and then use it in conjunction with correct proprioception in the line reaching task. Though intentional, participants are not necessarily aware of wilfully biasing their responses according to this view, as proposed by metacognitive theories of hypnosis (Dienes & Perner, 2007; Kirsch & Lynn, 1998). One version of this orientation (Dienes & Perner, 2007) maintains that intentions are preserved during hypnosis whereas high-order thoughts representing these first order intentions are inaccessible, thus resulting in a lack of awareness of one's own intention (for supporting evidence, see Lush et al., 2016; Terhune & Hedman, 2017).

An alternative interpretation of these results relies on inferential accounts of perception. In this account, representations are updated on the basis of their prior probability distribution and new available evidence (Clark, 2015; Hohwy, 2013; Jamieson, 2021; Martin & Pacherie, 2019). In our case, the size of the index finger is usually inferred from prior knowledge stored in memory, and (new) sensory evidence. In the Lackner illusion condition, body image is computed based on wrongly integrating information from illusory proprioceptive signals (arm extension caused by vibrations) and touch. These sensory signals are inconsistent with a normal finger length prior, or in other terms, the probability of having a normal sized finger given the sensory evidence is low. Hence, the corresponding finger representation shifts for some participants to an elongated finger on the basis of (misleading) sensory evidence. By contrast, in the case of the hypnotic suggestion, no direct sensory evidence is present; rather, the normal finger prior retrieved from memory and the elongated finger expectation derived from the suggestion compete based on their relative probabilities. This process may explain why participants responded on a continuum rather than having a clear bimodal distribution. In turn, body image will be shaped by the weighted average of the two priors. When the suggested expectancies are unlikely for the participant, as is supposed to be the case for low suggestible participants, the memory prior will exert greater influence, yielding a small effect and *vice versa* if the suggestion prior is heavily weighted. More broadly, beyond the setting of this experiment, the suggested prior could be supported by imagery and selective attention to seemingly confirming evidence while downplaying disconfirming evidence.

These two accounts cannot be distinguished on the basis of our data. Nonetheless, differential predictions can be derived from them with alternative manipulations. In particular, when the hypnotic suggestion is antagonistic with the interaction of body image and body schema, the sociocognitive account would predict that suggestion effects will dominate, whereas the inferential account would predict that the influence of suggestion would be small. For example, if participants are led to believe that the effect of experiencing one's finger as longer is to point past the lines in the line reaching task (i.e., overshooting rather than undershooting), then a sociocognitive account would predict a quasi-reversal of the association between perceptual and pointing errors in individuals who form this expectation. By contrast, an inferential account would only predict a small reduction of the effect of the hypnotic suggestion due to marginal compliance effects, but overall the same positive association between errors (See Annex 2 for a test of this hypothesis).

5.5. Limitations of the study

Despite the advances afforded by the present work, we acknowledge some limitations of this study. Firstly, we did not perform a non-hypnotic suggestion condition, nor an induction without suggestion. These would serve as potentially valuable controls for the hypnotic suggestion manipulation as they would have allowed us to better dissociate effects attributable to the induction and the suggestion. These factors were not varied because these questions were outside the scope of the present work and because we do not expect an induction to produce spontaneous finger elongation. Moreover, insofar as non-hypnotic direct verbal suggestibility is a reliable correlate of hypnotic suggestibility (Braffman &

Kirsch, 1999; Wieder & Terhune, 2019), we expect that the present results would generalize to applications involving direct verbal suggestions without a formal induction procedure. Secondly, we did not measure participants' expectancies for finger elongation. This would have allowed us to clarify whether and to what extent the observed effects were mediated by this variable. We did not index response expectancies because doing so may provide participants with explicit indicators of how they are expected to respond. Relatedly, indexing response expectancies may introduce a confound wherein participants feel compelled to respond congruently with their expectations (consistency motivation; Council & Green, 2004), thereby artificially biasing response patterns towards expectations. Thirdly, we included all participants regardless of their responsiveness to the Lackner illusion. This was intentional, as we wanted to assess the general effect of this illusion compared to the impact of hypnotic suggestion on perceived finger elongation and the effect of the illusion was significant on body image. Nonetheless, we observed relatively few participants who *unequivocally* responded to this illusion and as a result we could not perform analyses on this subgroup alone. A comparison of hypnotic suggestion and Lackner illusion manipulations in a homogeneous group displaying both effects would prove more informative regarding the interplay of bottom-up and top-down effects on body metrics. Fourth, the hypnotic suggestibility scale we used (Saldanha da Gama et al., 2012) displayed internal consistency that is marginally acceptable and it suffers from many problems that plague classical hypnotic suggestibility scales (Acunzo & Terhune, 2021). However, this scale is one of the most widely used scales in contemporary experimental hypnosis research (Barnier & McConkey, 2004; Bowers, 1998) and was deemed to the most optimal among French-adapted scales.

Finally, our conclusion that body image and body schema were altered by the Lackner illusion and hypnotic suggestion are based on inverse inference. Caution is advised in interpreting results of behavioural tests as indicators of latent unobservable variables (Bach et al., 2018). Nonetheless, our claim that these behavioural tests are credible proxies of body image and body schema rests on current practices of the community (Vignemont et al., 2005; Guardia et al., 2010; Mölbert et al., 2018; Baccarini et al., 2014; Kammers et al., 2006). It follows that this inverse inference problem is rather a trivial limitation, meaning that the association between our behavioural indicators and body metrics is provisional and will depend on future development of the field.

5.6. *Clinical significance*

The results presented here pave the way to future clinical research. Bodily awareness is believed to be disturbed in eating disorders, such as anorexia nervosa (Gadsby, 2017a, 2017c; Guardia et al., 2010; Mölbert et al., 2018), and body image flexibility seems to be a valuable predictor of several psychopathological conditions (Linardon et al., 2021; Rogers et al., 2018). Hypnosis demonstrated efficacy as an adjunct to traditional treatments (Lynn & Kirsch, 2006; Milling et al., 2018; Ramondo et al., 2021b; Valentine et al., 2019), in particular in the treatment of psychosomatic disorders (Bernardy et al., 2011; Schaefert et al., 2014; Zech et al., 2017). However, greater understanding of hypnotic pathways to modulate bodily awareness could delineate more clearly the areas where hypnosis could help and where it should be avoided. In particular, future research is necessary to elucidate the roles of hypnotic suggestibility and body representation flexibility as possible risk or protective factors in psychopathologies involving body awareness.

6. Conclusion

Our objective was to compare sensory and cognitive contributions to bodily awareness. For the first time, we showed a strong effect of hypnotic suggestion on body metrics at both sensorimotor and visuospatial levels. This effect was larger than the Lackner illusion on both levels, although the Lackner illusion still exerted a reliable effect on perceptual error independent of hypnotic suggestibility. These presumed bottom-up (Lackner illusion) and top-down (hypnotic suggestion) effects were correlated, suggesting that they both partly index a latent sensitivity of body metrics to modulation. The claim, however, is not that hypnotic suggestion engages the same basic perceptual processes as Lackner illusion. Instead, we discussed two interpretations of the effect, either low-level in terms of cognitive penetration, or high-level in terms of compliance without awareness.

CHAPTER 2: COMPARATIVE EFFECTS OF HYPNOTIC SUGGESTION AND IMAGERY ON BODILY AWARENESS

C. APELIAN[1,2], F. DE VIGNEMONT[1], D.B. TERHUNE[3]

1- Institut Jean Nicod, Département d'études cognitives, ENS, EHESS, CNRS, PSL University, UMR 8129, 29 rue d'Ulm 75005 Paris, France.

2- A.R.C.H.E. Research Center, 27 rue de Fontarabie 75020 Paris, France.

3- Department of Psychology, Goldsmiths, University of London

1. ABSTRACT

Bodily awareness is informed by both sensory data and prior knowledge. Although misleading sensory signals have been repeatedly shown to affect bodily awareness, only scant attention has been given to the influence of cognitive variables. Hypnotic suggestion has recently been shown to have a strong impact on visuospatial and sensorimotor representations of body-part size although the mechanisms subserving this effect are yet to be identified. Mental imagery is likely to play a role in this effect, as it has been shown to influence body awareness in previous studies and it is prevalent in hypnotic experiences. Nonetheless, current views of hypnosis ascribe only an epiphenomenal role to imagery in the implementation of hypnotic suggestions. The current study compared the effect of hypnotic suggestion and imagery for influencing body image and body schema, respectively the visuospatial and sensorimotor aspects of body-size representation. Both manipulations produced a significant effect compared to baseline, although hypnotic suggestion yielded a significantly larger effect. Furthermore, the two effects were highly correlated, suggesting overlapping mechanisms. Participants' self-reports suggest that the use of voluntary imagery is not an important factor driving this phenomenon. Rather, top-down effects on body representations seems to be partly driven by hypnotic suggestibility in both conditions. These results are in line with current theories of suggestion and hint at new fundamental questions regarding the mechanisms driving the influence of cognition on body representations.

Keywords: Hypnosis, imagery, body representations, body image, body schema, suggestion

2. INTRODUCTION

Although considerable attention has been devoted to the sensory contributions to bodily awareness (Blanke, 2012; Blanke et al., 2015; Vignemont, 2018; Ehrsson, 2020; Salomon et al., 2017), cognitive factors are also known to play a role. For example, hypnotic suggestion (Oakley & Halligan, 2009; Terhune et al., 2017) has been shown to modify various dimensions of self-awareness, including the sense of agency (Deeley et al., 2013; Lush et al., 2017; Polito et al., 2018), the sense of body ownership (Rahmanovic et al., 2012), and mirror self-recognition (Barnier, Cox, et al., 2008a). Specific hypnotic suggestions can also be used to induce sex change delusion (Noble & McConkey, 1995a), and alterations in body-part size estimation (Apelian et al., Chapter 1), amongst others (Röder et al., 2007; Terhune & Cardeña, 2009; Zeev-Wolf et al., 2016). Understanding the mechanisms underlying these phenomena is key to uncovering the determinants of healthy and pathological bodily experiences and offers hope of better prevention and treatments (Oakley & Halligan, 2011; Woody & Szechtman, 2011). Although hypnosis may seem to represent a singular case of cognitive influence on bodily awareness, it recruits multiple components, some of which are widely recognized as mundane psychological processes (Barnier et al., 2020; Lynn et al., 2008; Wagstaff, 2004; Woody et al., 2005; Woody & Barnier, 2008). These processes are also thought to play an important role in alterations of conscious experience in everyday life, outside the context of hypnosis (Cardeña & Terhune, 2014).

One of the components that seem to be recruited by hypnotic suggestion is mental imagery, as it is often featured in the phenomenological response to hypnotic inductions (Pekala & Kumar, 2007). Mental imagery can be defined as quasi-perceptual mental states in the absence of the corresponding sensory stimuli (Thomas, 2014). It has been found to activate modality-specific and cross-modal networks (Daselaar et al., 2010; Spence & Deroy, 2013). In particular visual mental imagery engages fronto-parietal networks and a well delimited region in the left fusiform gyrus (Spagna et al., 2021) and it shares mechanisms with sensory perception (Dijkstra et al., 2019) . It should not be confused with cognitive imagination, or supposition, which involves entertaining a counterfactual thought. Mental imagery encompasses all sensory modalities and their multisensory integration, such as imagining lifting a cup of coffee, while smelling its aroma and feeling the warmth of the brew.

However, it is not clear whether imagery is a crucial feature of responsiveness to hypnotic suggestion (Sheehan & Robertson, 1996) or only a mere epiphenomenon (Terhune & Oakley, 2020). It has been argued that imagery and hypnosis are orthogonal processes. One study compared conditions in which the use of counter-pain imagery was either prescribed or proscribed during hypnotic analgesia and found that they were essentially identical (Hargadon et al., 1995). Another study analysed participants' goal-directed imagery reports and found that voluntary use of imagery was not associated with better responsiveness to the hypnotic procedure (Comey & Kirsch, 1999). However, these results obtained for hypnotic analgesia might not generalize to all hypnotic suggestions, as different hypnotic suggestions might recruit different mechanisms (e.g. Barnier et al., 2020; Woody et al., 2005). Furthermore, one major hurdle to elucidate how hypnotic suggestion relates to imagery is the multidimensionality of both constructs. One dimension of imagery (e.g. vividness) might play a role for some dimension of hypnotic experience (e.g. verisimilitude) for some goal (e.g. motor suggestion), but not for other combinations. For instance, involuntary imagery (intrusive images) has been associated with response to suggestion in studies demonstrating the ineffectiveness of voluntary imagery (Comey & Kirsch, 1999; Hargadon et al., 1995). Therefore, in this study, we asked participants to rate their imaginative experience in both conditions (hypnotic suggestion and imagery instruction) regarding the intensity of voluntary and/or spontaneous imagery.

Here we focused on the representation of body-part size, assessed at both sensorimotor level and visuospatial levels (Apelian et al., Chapter 1). The visuospatial component, the body that one perceives, is usually referred to as "body image", whereas the sensorimotor component, the body one acts with, is generally labelled "body schema" (Vignemont, 2010). Hypnotic suggestion has been shown to be effective at modulating both body image and body schema compared to an active placebo, and a classic illusion (Apelian et al., Chapter 1), but no direct comparison with imagery has been made. Modulation of body metrics using imagery has received scant attention, which is at odds with the pervasive use of motor imagery for assessing and altering body schema in patients (Purcell et al., 2018; Schwoebel et al., 2001, 2002; Schwoebel & Coslett, 2005) and in healthy participants (Baccarini et al., 2014; Naito, 1994; Oikawa et al., 2017). One study revealed that imagining using a tool had similar effects on movement kinematics as physically using it, showing the incorporation of the tool into body schema (Baccarini et al., 2014; Cardinali et al., 2009). By contrast, to our knowledge, only few studies have used imagery to alter body image and those doing so use the term "body image" for a semantic and affective representation of the body akin to body satisfaction (e.g. Esplen et al., 2018). There is no direct evidence of the modulation of the body image by imagery.

In this study, we contrasted the effect of imagery instruction and hypnotic suggestion on body metrics. Both manipulations targeted the perceived size of the left index finger, such that participants were alternately given the suggestion that their finger was growing longer or instructed to imagine their finger growing longer. As in our previous study (Apelian et al., Chapter 1), responsiveness to the manipulations was assessed with an estimation of finger size to measure body image, and a line reaching task to index body schema. The central aim of this study was to test to what extent mental imagery modulates body image and body schema and how the magnitude of this effect compares to that of hypnotic suggestion. We also assessed expectancies prior to each manipulation and whether participants used imagery voluntarily or experienced spontaneous imagery. We further evaluated whether hypnotic suggestibility and familiarity with hypnosis covaried with these effects as they were both previously found to relate to the effects of hypnotic suggestion on body image and body schema, respectively (Apelian et al., Chapter1).

3. MATERIAL AND METHODS

3.1. Participants

The sample size was estimated prior to data acquisition. We expected the difference between hypnotic suggestion and imagery instruction to be relatively small given that the wording of suggestion evokes imagery. Hence, we prespecified an effect size similar to the differential effect of hypnotic and non-hypnotic suggestions (i.e. with or without induction). This effect size was estimated around 0.28 based on previous experiments (Braffman & Kirsch, 1999) Using a statistical power estimate (1-β) of .8 and an α-level of .05 with a one-tailed paired-samples t-test and an effect size of 0.28, a power analysis run using GPower 3.1 (Faul et al., 2009) yielded a minimum sample size of 81 participants. A total of 82 participants (60 females, 22 males) completed the experiment (M_{age}=38.4; SD=11.6; range: 22-64 year-old). All were right-handed or ambidextrous according to the Edinburgh Handedness Inventory (Oldfield, 1971). None reported psychiatric or neurologic disorders nor current use of psychoactive drugs (medical or recreational). All participants had two valid, functional arms and were fluent French speakers.

3.2. Materials

Hypnotic suggestibility was measured using a French translation of the online version of the Sussex-Waterloo Group Scale of Hypnotizability (SWASH) (Lush et al., 2018; Palfi et al., 2019; Apelian, Annex 1). This scale consists of a relaxation-based hypnotic induction followed by ten suggestions for alterations in motor control, cognition, and perception. Following a de-induction, participants self-rated their behavioural and subjective responsiveness to each of the suggestions, respectively with dichotomous and 6-point (0-5) Likert scales. The SWASH was selected because of its similarity to the widely-used Stanford Hypnotic Susceptibility Scale: Form C (Weitzenhoffer & Hilgard, 1962). The SWASH usually has good internal consistency for the subjective scale, and this is confirmed in our sample, Cronbach's α=.85. However, the internal consistency of the behavioural measurement is not optimal) (Lush et al., 2018; Palfi et al., 2019; Apelian, Annex 3). Correcting for compliance helps raise internal consistency to an acceptable level (Apelian, Annex 3) by counting as failed any suggestion with a subjective score of 0 or 1 (indicating compliance). In our sample, the corrected behavioural measurement is indeed acceptable, α=.7 (for the uncorrected behavioural scale, α=.62). In this study, "hypnotic suggestibility" refers to the corrected behavioural ratings. In addition to hypnotic suggestibility, we asked participants to report their familiarity with hypnosis with the question "Report your familiarity with hypnosis (being hypnotized) or self-hypnosis" using a Likert scale (0-5) from (0) "I never experienced hypnosis" to (5) "I am acquainted with the experience of hypnosis". Only 56 participants completed the online SWASH scale.

The finger length perception task, identical to our previous study (Apelian et al., Chapter 1), was used to measure body image. The task was performed using a graphical user interface displaying a picture of the participant's left hand and a slider. The participant was instructed to adjust the slider until the picture of their finger matched their perceived length of their finger. In each condition, perceived finger length was measured as the mean of two trials, one with the starting position of the slider at the maximum distortion (three times the normal size) and one starting at the minimum distortion (one third of the normal size). Perceptual error was computed as the mean difference of measurements in each condition relative to baseline.

The line reaching task, similar to our previous study (Apelian et al., Chapter 1), was used to measure body schema. In this task, the participant's left arm was hidden in a box on a table (Figure 2.1). Four parallel lines {1,2,3,4} with an inter-line distance of 30mm were displayed in the field of view of the participant next to the box, with a number displayed next to each line. In each condition, participants completed nine trials in which they were asked to match their right index fingertip with the position of one of the lines {1,2,3,4,3,2,1,4,1}. The lines were only visible to the participants outside the box, so they could not see the position of their left hand. Pointing error was computed as the mean difference between measurements in each condition relative to baseline.

Figure 2.1: *Experimental apparatus in the line reaching task. Participants pushed or pulled the platform so that their fingertip match the position of the line specified by the experimenter. Contrary to the picture, participants could not see the inside of the box, as a lid covered the apparatus.*

3.3. Hypnotic suggestion

The hypnotic suggestion condition was conducted following a script developed for this experiment and contained a short induction, focussed on breathing and being absorbed in bodily sensations, followed by a suggestion to experience the left index finger elongating: "the finger is growing like a branch and extends until it is 10cm longer". Participants were given 60s to experience the suggestion without further suggestions or cues. Afterwards, and before testing, participants were told that they would go through the measurement tasks, eyes open, while remaining hypnotized with their index finger keeping the same size for the whole duration of the measurements. When testing was done, a standard de-induction was performed (similar to Bowers, 1993) with an emphasis on the index finger returning to its normal size. Participants were then instructed to rub their hands and take a short break.

3.4. Imagery instruction

The imagery instruction procedure consisted of a simple instruction matching the suggestion wording without prior induction procedure: "imagine that the finger is growing like a branch and extends until it is 10cm longer". Then participants were left to implement the instruction for 60s (matching the length of the hypnotic suggestion process). When one minute elapsed, participants were asked *to stop whatever they were doing* contrary to the suggestion condition where the effect is presupposed to continue during measurements.

3.5. Expectancies and voluntary vs. spontaneous imagery reports

Participants rated three statements with Likert scales (1-5) from "strongly disagree" to "strongly agree" in the context of each condition. Prior to each condition, participants rated their response expectancy: "I think I will experience my index finger growing longer". After each condition, they rated their voluntary use of imagery: "I voluntarily used imagery"; and their experience of spontaneous imagery: "Imagery happened spontaneously".

3.6. Procedure

Participants' involvement consisted of two sessions separated by at least one day. The first session involved the administration of a French translation of the online SWASH (Apelian, Annex 3). In the second session, participants completed the finger length perception and line reaching tasks first at baseline and then in the imagery instruction and hypnotic suggestion conditions in randomized counterbalanced order. In each condition, the finger length perception task always preceded the line reaching task. At the end of the experiment, a question-and-answer time was offered to dissipate any uneasy feelings that might arise due to the unusual experience of hypnosis. Participants were compensated 10€ for their time.

3.7. Analyses

No multivariate outliers (>M+3 SDs in 2 conditions) were identified in the dataset. Data were analysed using linear mixed effects models, paired t-tests (frequentist and Bayesian) and correlation comparisons using R studio software (Version 1.2.5001, 2009-2019 RStudio, Inc.) with the lme4, car and cocor libraries (Bates et al., 2015; Diedenhofen & Musch, 2015), respectively. All other analyses were performed using Python 3 and the scipy library. All data are publicly available on the Open Science Framework (https://osf.io/gy7u9/).

4. RESULTS

4.1. Sample description

The distribution of hypnotic suggestibility in our sample, as indexed by the SWASH, behavioural corrected: M=3.6, SD=2.2 (range: 0-9) was commensurate with the previous French study (Apelian, Annex 3). There were no significant gender differences for perceptual error in the hypnotic suggestion condition, $t(80)=0.45$, $p=.66$, Hedge's $g=0.08$, or in the imagery instruction condition, $t(80)=-0.13$, $p=.90$, $g=-0.02$. The same holds for pointing error, $t(80)=0.49$, $p=.63$, $g=0.09$, $t(80)= 0.54$, $p=.59$, $g=0.10$, respectively. Therefore, we pooled both gender samples for subsequent analyses. Similarly, there was no effect of condition order (imagery instruction first or second) on perceptual error, either in the hypnotic suggestion condition, $t(80)=1.52$, $p=.13$, $g=0.24$, or the imagery condition, $t(80)=0.58$, $p=.56$, $g=0.09$. The same held for pointing error $t(80)=1.71$, $p=.09$, $g=0.27$, $t(80)=0.81$, $p=.42$, $g=0.13$, respectively. Therefore, we did not consider condition order in our subsequent analyses.

4.2. Hypnotic suggestion vs. imagery instruction on finger elongation

Our first analysis contrasted the magnitude of the condition manipulations on perceptual and pointing errors. Figure 2.2 presents the effect of the two conditions (relative to baseline) on perceptual and pointing errors as well as their difference. Relative to baseline, hypnotic suggestion produced larger perceptual errors, t(81)=11.84, p<.001, g=1.50, and pointing errors, t(81)=8.19, p<.001, g=1.10. The same was observed for imagery instruction on perceptual errors, t(81)=8.77, p<.001, g=1.25, and pointing errors, t(81)=5.45, p<.001, g=0.73. Furthermore, the effect of hypnotic suggestion was significantly larger than the effect of imagery on perceptual errors, t(81)=3.41, p=.001, g=0.32, and pointing errors, t(81)=3.60, p<.001, g=0.31. These results demonstrate that both manipulations produced significant perceptual changes on the finger length perception and line reaching tasks compared to baseline, and that the effect of the hypnotic suggestion is higher than the effect of imagery on both measurements, although this difference is small in magnitude.

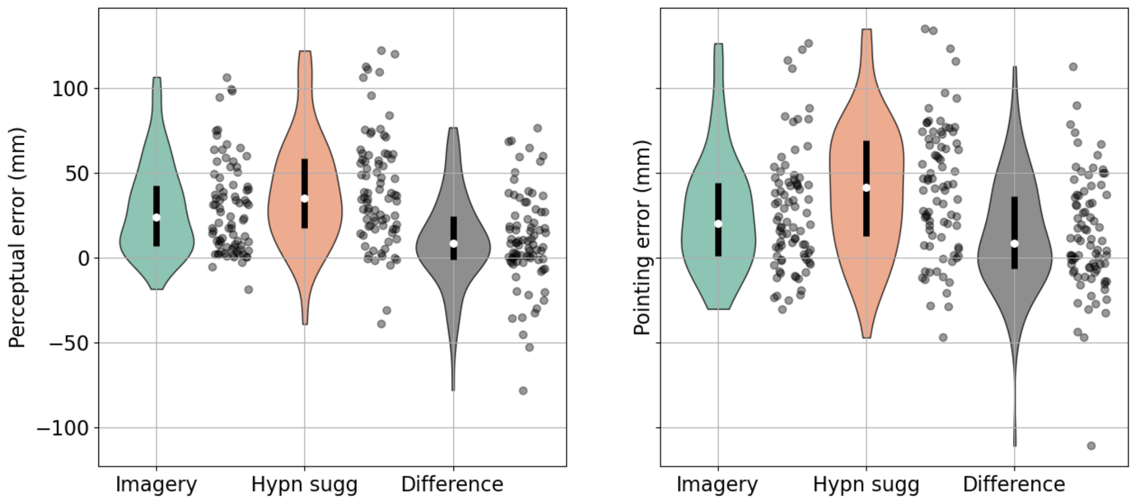

Figure 2.2: *Violin (kernel density estimation) plots and individual mean measurements of perceptual and pointing errors (mm) as a function of Condition (N=82). Central black lines represent the interquartile range and the white dots represent the median error in each condition. Difference= hypnotic suggestion - imagery instruction.*

4.3. Relation with hypnotic suggestibility

Our next analyses considered the extent to which the condition effects on finger length representation were related to hypnotic suggestibility. We found that perceptual error in the hypnotic suggestion condition was moderately (positively) correlated with hypnotic suggestibility, r=.37, 95% CI=[.58; .12],

$p=.005$. Similar positive correlations were observed in the hypnotic suggestion condition between pointing error and hypnotic suggestibility, $r=.43$, 95% CI=[.63; .19], $p<.001$. However, in the imagery condition perceptual error was only correlated at a trend level and non-significantly with hypnotic suggestibility, $r=.18$, 95% CI=[.43; -.09], $p=.19$. Hypnotic suggestibility was also significantly positively correlated with pointing error in the imagery condition, $r=.34$, 95% CI=[.55; .08], $p=.012$. These results indicate that the effect of both imagery instruction and hypnotic suggestion seem to be positively associated with hypnotic suggestibility, with a stronger association of the effect of hypnotic suggestion with hypnotic suggestibility.

In order to incorporate these different effects, hypnotic suggestibility was included in a mixed-effect model alongside the effect of the different conditions with participants as random effect (global intercept only). Model relevance was assessed with a χ^2 test comparing the basic mixed linear model (perceptual error ~ condition / pointing error ~ condition) against a model where hypnotic suggestibility was included as a covariate. We also allowed for an interaction between hypnotic suggestibility and the different conditions. In the perceptual model, hypnotic suggestibility improved the model, $\chi^2(1,n=56)=9.10$, $p=.002$, with further improvement when the condition x hypnotic suggestibility interaction is included, $\chi^2(1,n=56)=6.10$, $p=.014$. The pointing error model improved when we added hypnotic suggestibility, $\chi^2(1,n=56)=11.1$, $p<.001$. But it did not improve by allowing for interaction between condition and hypnotic suggestibility, $\chi^2(1,n=56)=1.8$, $p=.18$. Insofar as familiarity with hypnosis predicted pointing error in our previous experiment (Apelian et al., Chapter 1), we also included it as a covariate, which did not improve the perceptual model, $\chi^2(1,n=56)=2.3$, $p=.13$, but did improve the pointing error model, $\chi^2(1,n=56)=4.38$, $p=.036$. The model further improved with the inclusion of the “Condition x Familiarity” interaction, $\chi^2(1,n=56)=7.46$, $p=.006$, but no improvement occurred when allowing interaction between familiarity and hypnotic suggestibility, $\chi^2(1,n=56)=3.27$, $p=.35$. A summary of the best models is presented in Table 2.1 and Table 2.2. Taken together, these results suggest that most of the effect of hypnotic suggestion and imagery instruction are mediated by hypnotic suggestibility in both tasks. In a similar fashion to our previous study (Apelian et al., Chapter 1), familiarity with hypnosis predicted a significant amount of variance in the pointing task in the hypnotic suggestion condition but interestingly no significant effect was found in the imagery condition. The effect of hypnotic suggestibility was still significant after including familiarity with hypnosis. Indeed, the two variables are weakly and non-significantly correlated, r=.15, 95% CI=[.40; -.12], p=.26.

Table 2.1

Best linear mixed effect model of perceptual error (n=56)

	Perceptual error ~ Condition * hypnotic suggestibility + (1|Pariticipant)				
Fixed effects	Estimate	*SE*	95% *CI*		*p*
			LL	UL	
Intercept (Imagery instruction)[a]	**17.77**	**6.97**	**4.10**	**31.44**	**.011**
Hypnotic suggestion [a]	-1.17	5.89	-12.72	10.38	.84
Hypnotic suggestibility [b]	2.91	1.67	-0.37	6.19	.082
Hypnotic suggestion x hypnotic suggestibility [b]	**3.51**	**1.41**	**0.74**	**6.28**	**0.013**

Notes. CI = confidence interval; LL = lower limit; UL = upper limit. Within subject variance = 492.58; residual variance = 273.43. [a] = estimates in mm; [b] = estimates in mm/scale unit (0-10 scale).

Table 2.2

Best linear mixed effect model of pointing error (n=56)

	Pointing error ~ Condition * familiarity with hypnosis + hypnotic suggestibility + (1|Pariticipant)				
Fixed effects	Estimate	*SE*	95% *CI*		*p*
			LL	UL	
Intercept (Imagery instruction)[a]	-3.62	11.29	-25.74	18.50	.75
Hypnotic suggestion [a]	2.86	5.59	-8.10	13.82	.61
Hypnotic suggestibility [b]	**7.51**	**2.38**	**2.85**	**12.17**	**.002**
Familiarity with hypnosis [c]	1.90	2.68	-3.36	7.16	.48
Hypnotic suggestion x familiarity with hypnosis [c]	**4.78**	**1.72**	**1.40**	**8.16**	**.006**

Notes. CI = confidence interval; LL = lower limit; UL = upper limit. Within subject variance = 1325.9; residual variance = 356.2. [a] = estimates in mm; [b] = estimates in mm/scale unit (0-10 scale); [c] = estimates in mm/scale unit (0-5 scale).

4.4. Correlations

Figure 2.3 presents the correlations between perceptual and pointing errors in hypnotic suggestion and imagery instruction conditions, as well as the correlations of errors across conditions. We found that the two task errors were highly correlated in the hypnotic suggestion condition, and a similar (yet non-significantly weaker) association in the imagery condition z=-1.45, p=.15. We also report strong positive correlations between errors in the hypnotic suggestion and imagery conditions for both tasks. Taken together with other results reported above, these correlations highlight the similarities between imagery and hypnotic suggestion in this experiment.

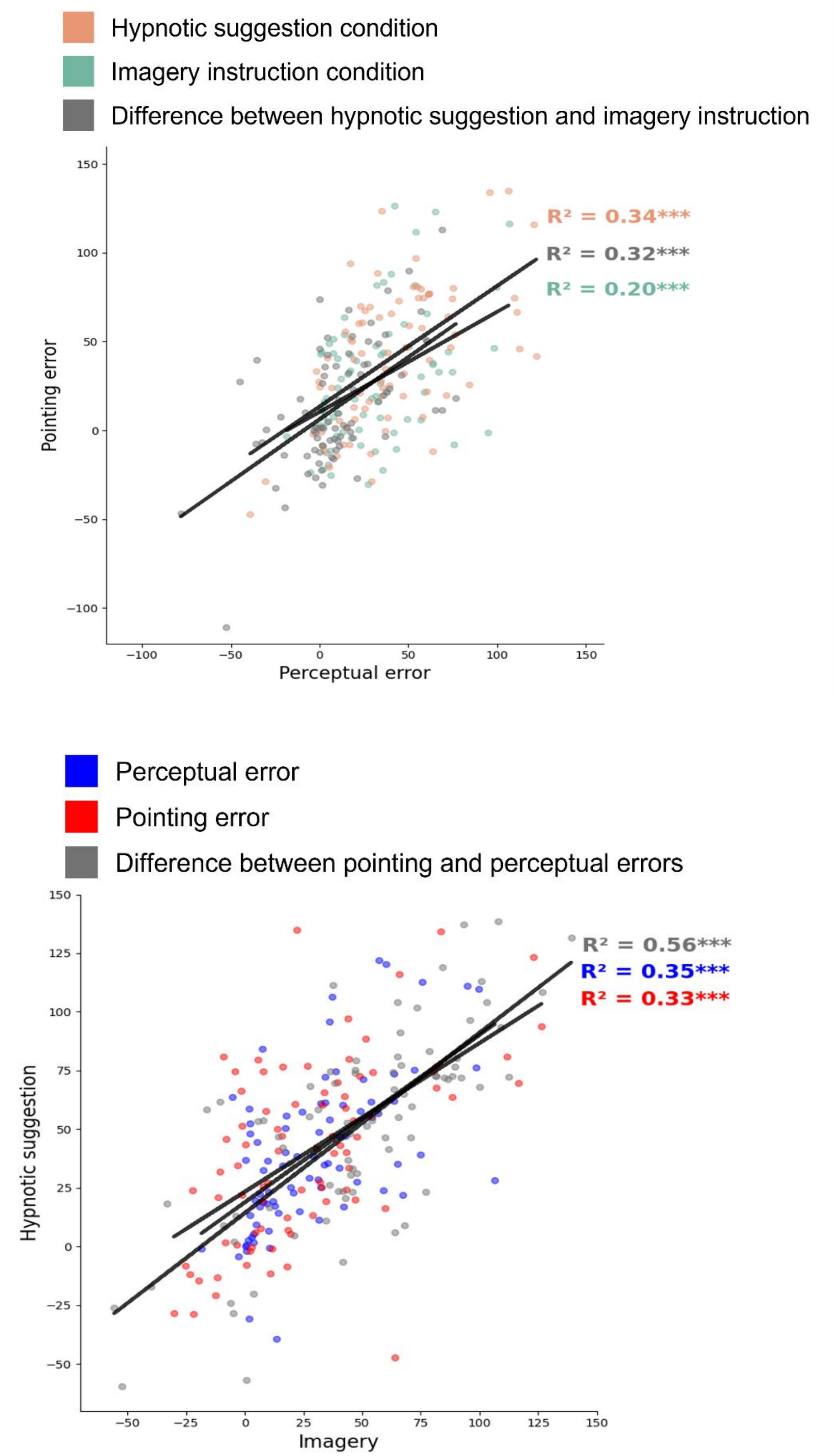

Figure 2.3: *Scatterplots depicting associations between pointing and perceptual errors as a function of condition (top), and associations of each error across conditions (bottom). (N=82)*

**** p<.001*

4.5. *Effect of expectancies*

We next considered the role of expectancies in the modulation of body representation by hypnotic suggestion and imagery instruction. Surprisingly, participants had similar expectancies in the hypnotic suggestion, and imagery conditions, B_{01}=0.32 (or odds 3.14:1 in favour of the null hypothesis of no condition difference). Expectancy self-report correlated with the magnitude of the perceptual error in both the hypnotic suggestion condition, r=0.39, p=.003, and imagery instruction condition, r=0.43, p<.001; and with the magnitude pointing error in both hypnotic suggestion condition, r=0.33, p=.01, and imagery condition, r=0.34, p=.009. We also computed a linear model of perceptual error including expectancies and hypnotic suggestibility as covariates. Both were significant predictors in the hypnotic suggestion condition with respectively (standardised β) β=.378, p=.013 for expectancies, and β=.373, p=.014 for hypnotic suggestibility. In the imagery instruction condition hypnotic suggestibility failed to reach significance β=.246, p=.126, but expectancies remained a significant predictor of perceptual error when it was present, β=.366, p=.025. This means that the predictive power of expectancies is not reducible to hypnotic suggestibility and *vice versa* (in the hypnotic suggestion condition at least).

4.6. *Effect of voluntary vs. spontaneous imagery during conditions*

Participants also reported having similar levels of spontaneous imagery in the two condition, B_{01}=3 (odd ratio of 3:1 in favour of the independence (null) hypothesis), but superior *voluntary* imagery in the imagery instruction compared to the hypnotic suggestion condition, B_{10}=29458 (odd ratio in favour of the hypothesis of different means). Notably, we found no evidence of a correlation between voluntary and spontaneous imagery ratings, r=.06, 95% CI=[.24; -.12], BF_{01}=7.03, which suggests that spontaneous and voluntary generation of imagery coexist and are not mutually exclusive. To assess the relations between these reports and perceptual and pointing errors, we performed linear mixed models with condition, voluntary and spontaneous imagery reports as covariates and participants as a random effect. For perceptual error, spontaneous imagery predicted a significant part of the variance, β=5.46 (mm per scale unit; 1-5 Likert scale), 95% CI=[1.96; 8.96], p=.002, but not voluntary imagery, β=1.91, 95% CI=[-2.07; 5.89], p=.35. For pointing error, the same pattern appears with β=5.46, 95% CI=[1.96; 8.96], p=.002, and β=1.91, 95% CI=[-2.07; 5.89], p=.35 respectively. Allowing for interaction between spontaneous imagery and condition did not improve the perceptual error model, $\chi^2(1, n=56)=0.44$, $p=.50$, nor the pointing error model, $\chi^2(1, n=56)=0.16$, $p=.69$. These results coherently indicate that spontaneous imagery explains variations in both errors and conditions, but voluntary imagery does not.

We further controlled for expectancies and hypnotic suggestibility by including these variables in the model described above (perceptual/pointing error ~ spontaneous imagery + (1|Participant)). Spontaneous imagery remained a significant predictor of perceptual error when expectancies were controlled for, β=4.74, 95% CI=[1.22; 8.25], p=.008, and when hypnotic suggestibility was controlled, β=4.16, 95% CI=[0.50; 7.81], p=.026. However, for pointing error, spontaneous imagery failed to reach significance when expectancies were included in the model, β=4.31, 95% CI=[-0.36; 8.98], p=.07, or when hypnotic suggestibility was controlled, β=3.12, 95% CI=[-1.92; 8.16], p=.225.

Additionally, we tested if the sub-group of $n=18$ participants reporting no spontaneous imagery had a significant effect of the manipulation. It was indeed the case for both perceptual error, $t(17)=4.47$, $g=1.05$, $p<.001$ and pointing error, $t(17)=3.90$, $g=0.92$, $p=.001$. This suggests that spontaneous imagery is not a necessary condition for the effect of imagery instruction or hypnotic suggestion on body-size representations.

5. DISCUSSION

This study compared the effect of imagery instruction and hypnotic suggestion on body image and body schema. We report a significant effect of both manipulations on both types of body representation, with a slight, albeit significantly, larger effect of hypnotic suggestion compared to imagery instruction. In addition, we found strong correlations between perceptual and pointing errors, which is consistent with our previous study (Apelian et al., Chapter 1) and aligns with models proposing an interaction between body image and body schema (Pitron et al., 2018a; Pitron & Vignemont, 2017). We also found strong correlations between the effects of hypnotic suggestion and imagery on both perceptual and pointing errors, suggesting overlapping abilities enabling response to both manipulations. Our results further suggest that hypnotic suggestibility predicts a sizable part of the variance in both conditions. Moreover, self-reports indicate that imagery *per se* does not directly cause the effect on body representations in any condition. This conclusion is in line with evidence drawn from the literature regarding other suggested phenomena (Terhune & Oakley, 2020). We explain these effects in terms of task-relevant expectancies and suggestibility and propose that mental imagery might play a facilitating role in modulating body image and body schema.

5.1. Similar effect of hypnotic suggestion and imagery instruction

Imagery instruction and hypnotic suggestion significantly altered body image and body schema in this experiment with a significantly larger influence of the latter. However, the difference between these effects was small and they were strongly correlated, suggesting an overlapping set of abilities underlying responsiveness to these manipulations. One likely candidate is hypnotic suggestibility, defined as responsiveness to direct verbal suggestions in the context of hypnosis (Laurence et al., 2008). Indeed, this trait predicts a sizable amount of the variance in both perceptual and pointing errors in both conditions. Additionally, we found that familiarity with hypnosis covaried with the effect of conditions on body schema. This might indicate a subset of attitudes or traits that are recruited only by the hypnotic suggestion to alter the sensorimotor representation. However, it is possible that participants acquainted with hypnosis refrained from using their abilities in the imagery condition. Relatively little is known about the extent to which familiarity with hypnosis modulates responsiveness to hypnotic suggestions, but this result is consistent with previous work (Apelian et al., Chapter 1).

5.2. Theoretical models for the effect of hypnotic suggestion and imagery instruction

Regardless of the condition, perceptual and pointing errors were highly correlated. These correlations can be interpreted as a similar effect (and maybe similar mechanisms) of hypnotic suggestion and imagery on body image and body schema. In what follows, we will consider plausible mechanisms underlying alteration of body representations leaving aside the distinction between body image and body schema since they are similarly impacted in both conditions. We propose two models explaining the effect of hypnotic suggestion and imagery instruction in our experiment. The first one, which we shall call the Epiphenomenal Imagery Model (EIM), views imagery as a by-product of other processes involved during the experiment, with no causal role in modulating body representations. The Facilitative Imagery Model (FIM) challenges this idea by slightly altering EIM and allowing imagery to play a causal role. In the following we will first describe the base model (EIM), highlight some limits and suggest that FIM accounts for the evidence in a way that is theoretically parsimonious.

5.3. Bayesian integration

The first model (EIM) ascribes an epiphenomenal role to imagery in this experiment. It supposes a simple Bayesian integration of different sensory signals and prior expectancies. In our experiment, sensory data are mostly uninformative since participants cannot see their finger and do not have tactile inputs. The only sensory input relative to the target finger is its own weight accessible through muscle spindles, Golgi tendon organs and joint receptors (Tuthill & Azim, 2018). Hence, the size representations mostly depend on the ratio of credence between prior knowledge about the finger length and task relevant expectancy, coherent with predictive processing theories of hypnosis (Jamieson, 2016; Martin & Pacherie, 2019). In this view, hypnotic suggestibility could either shift the ratio of credence in favour of task relevant expectancy or decrease the reliance on prior knowledge. This would explain why hypnotic suggestibility accounts for most of the variation produced by imagery and hypnotic suggestion. It would also explain the difference between hypnotic suggestion and imagery, the former resulting in stronger expectancies. Indeed, previous studies have shown that the induction ritual and labelling the procedure "hypnosis" increase response to suggestions, plausibly in part through the cultivation of stronger expectancies (Gandhi & Oakley, 2005; Kirsch & Braffman, 2001; Scacchia & De Pascalis, 2020; Terhune & Cardeña, 2016). Unfortunately, the measurement of expectancy realised in this experiment is inadequate to check this assumption as it was done *before* the hypnotic induction and consequently, we found no significant difference between self-reported expectancies between conditions. If the foregoing Bayesian model is correct, we would expect an interaction between expectancies and hypnotic suggestibility in predicting variations in body representations. One piece of evidence in this direction is the significant interaction of hypnotic suggestibility and hypnotic suggestion condition in the mixed model of perceptual error (Table 2.1). If the difference between condition is indeed a matter of expectancies, then this interaction is supporting this hypothetical Bayesian integration mechanism.

5.4. An epiphenomenal view of imagery

Imagery is considered in EIM to be a by-product of task expectancies with no causal influence over body representations. This epiphenomenal view of imagery is largely supported by the literature on hypnosis (Comey & Kirsch, 1999; Hargadon et al., 1995; Kirsch et al., 1987; Terhune & Oakley, 2020), with studies showing no meaningful correlation between goal-directed imagery and the effect of suggestion. Moreover, highly suggestible individuals are more likely to experience spontaneous imagery in their daily lives (Cardeña & Terhune, 2014), which could explain why spontaneous imagery reports predict part of the effect produced by the hypnotic suggestion and imagery conditions. Additionally, hypnotic inductions generally increases spontaneous imagery (Cardeña et al., 2013; Pekala & Kumar, 2007), which might be a direct consequence of cultural expectancies about this phenomenon. However, this model does not easily explain the difference between voluntary and spontaneous imagery. According to EIM, both should be the consequence of task expectancies (explicit or implicit instructions), but they seem to play distinct roles, with voluntary imagery having basically no predictive power, while spontaneous imagery predicts an important part of the variance. Hence, we propose some adjustments to EIM in order to account for this evidence.

5.5. Source monitoring as a modulator?

FIM is built on the same foundation as EIM, with body representations being derived from prior knowledge, task relevant expectancies and sensory data. The main difference is that FIM reverses the relation between expectancies and imagery. While EIM supposes that expectancies lead to imagery, FIM assumes that imagery can increase expectancies under some conditions. An individual being suggested that his/her finger is elongating can correctly *perceive* that it is not, which is rapidly lowering the expectancy that the procedure is efficient. In this scenario, if he/she imagine the finger growing, expectancies would remain the same, as imagery does not provide evidence in favour of a successful implementation of the finger elongation suggestion. However, if imagery is mistaken for perception, expectancies would raise in response to the (false) positive feedback. In this case imagery mistaken for perception bootstraps expectancies, leading to higher modulation of body representations.

Mental imagery does not come pre-stamped, rather, when needed source monitoring tries to discriminate imagery from perception. Different factors might foster misclassifications such as imagery vividness and intentionality (among other). We did not assess imagery vividness in this study, but it is a credible factor for confusing imagery and perception. Indeed, there is a significant overlap between neural network underlying perceptual and imaginal processes (Dijkstra et al., 2019) and higher vividness of imagery is correlated to higher activation of areas common with perception (Dijkstra et al., 2017); and it has been associated with response to suggestion (Glisky et al., 1995; Marucci & Meo, 2000; Spanos, Stenstrom, et al., 1988; Srzich et al., 2016). Intentionality may also be an important additional source of confusion between imagery and perception although it has less support (Fazekas, 2021). If it is the case, it would explain why voluntary imagery reports do not predict the magnitude of the effect of manipulations, but spontaneous imagery does.

5.6. Differences between competing theoretical models

FIM differs fundamentally from EIM in that imagery plays a causal but indirect role. More importantly, it changes from a linear model where initial expectancies and hypnotic suggestibility completely determine the response, to a model including a positive feedback loop. This difference leads the two models to make different predictions.

First, progressive strategies, with suggested effects that are expected (by participants) to *gradually* increase, should be more effective than effects that are expected to happen directly according to FIM but not EIM. This is a consequence of the positive feedback loop of FIM, implying that initially small fluctuations of body representations will lead to spontaneous imagery that reinforces expectancies. In turn, these heighten expectancies shift body representations further, until they converge to the expected goal, or to the maximum sustainable difference with prior knowledge given sensory data.

Second, important deficits in imagery abilities should have no consequence on the modulation of body representations by hypnotic suggestion according to EIM. Conversely, FIM would predict a significant, though not total, reduction in the magnitude of the effect. To this end, future studies might benefit from testing participants with aphantasia. Aphantasia is a condition in which individuals are unable to use imagery (Keogh & Pearson, 2018). Recent studies suggest that aphantasia is truly a deficit of imagery and not simply a lack of awareness of mental imagery; hence spontaneous imagery is unlikely to be elicited from aphantasic individuals (Dawes et al., 2020; Wicken et al., 2021). Therefore, according to EIM these individuals should be able to experience the suggested finger elongation with no significant difference with non-aphantasic control, but FIM would predict lesser effect.

Overall, these models are in line with current understanding of hypnosis as driven (in part) by expectancies (Benham et al., 2006; Kirsch, 2001a) and hypnotic suggestibility (Woody & Barnier, 2008), with FIM borrowing from metacognitive theories of hypnosis (Barnier, Dienes, et al., 2008; Dienes & Perner, 2007; Kirsch & Lynn, 1998). Counterintuitively, instructing individuals to imagine their finger longer is unlikely to influenced body representations through voluntary imagery.

5.7. Limitations of the study

We acknowledge some limitations of this study despite the advances discussed above. Expectancies were measured only before manipulations and only reflect imperfectly the attitude participants have during manipulations. In particular, the induction process in the hypnotic suggestion condition may raise expectancies, but our measurement was done before, therefore potentially explaining why self-reported expectancies were similar between the hypnotic suggestion and imagery instruction conditions. However, more invasive measurements of expectancies could have introduced a confound wherein participants feel compelled to respond congruently with their expectations (consistency motivation; Council & Green, 2004), thereby artificially biasing response patterns towards expectations. Additionally, controlling for participants' imagery ability may help to clarify whether reported effects intersect with heterogeneity in high hypnotic suggestibility. For example, although highly suggestible participants do not tend to reliably display superior imagery, as indexed by self-reported measures or behavioural tasks, than medium suggestible participants (Sheehan, 1996; Terhune & Oakley, 2020), a subset of highly suggestible individuals have been reported to have superior imagery (Terhune et al., 2011). Nonetheless, it remains a difficult construct to assess as it is understood as composed of multiple components (Cumming & Eaves, 2018; Mizuguchi et al., 2019; Williams et al., 2015). Additionally, contextual effects are expected and should be handled by measuring imagery abilities and administering hypnotic suggestions in two unrelated contexts (Council et al., 1986; Council & Kirsch, 1996). These precautions are necessary to draw meaningful conclusions but are time consuming, therefore we did not measure imagery ability in this study.

6. Conclusion

Our results show that both hypnotic suggestion and imagery instruction were effective to modulate representations of finger-size (body image and body schema) with only a slightly larger effect of hypnotic suggestion. Moreover, both manipulation effects were highly correlated regardless of the task, suggesting overlapping mechanisms. Indeed, self-reported expectancies, spontaneous imagery reports, and hypnotic suggestibility were significant predictors of both manipulation effects. Coherently with the literature, hypnotic suggestion effects were not associated with voluntary imagery. More surprising, the effect of imagery instruction is also unlikely to be supported by voluntary imagery as self-reports suggest. Hence, this study reveals that the mode of presentation of the manipulation, instruction or suggestion, and the presence or absence of induction procedure has only minimal effect on body representations. The main determinants of body metrics modulation are to be found in the traits, attitudes and abilities of the individual. Nonetheless, the role of spontaneous imagery remains unknown. It could play either a facilitative role, or only an epiphenomenal one. Experimenting with aphantasic participants would allow to discriminate amongst these hypotheses.

CHAPTER 3: HYPNOTIC SUGGESTION FOR ALTERING PERCEIVED BODY SIZE RESISTS CONFRONTATION WITH THE SENSES AND PRIOR KNOWLEDGE

C. APELIAN[1,2], D.B. TERHUNE[3], F. DE VIGNEMONT[1]

1- Institut Jean Nicod, Département d'études cognitives, ENS, EHESS, CNRS, PSL University, UMR 8129, 29 rue d'Ulm 75005 Paris, France.

2- A.R.C.H.E. Research Center, 27 rue de Fontarabie 75020 Paris, France.

3- Department of Psychology, Goldsmiths, University of London

1. ABSTRACT

Body representations are thought to rely mainly on multisensory integration to flexibly adapt to the environment. Cognitive factors were also shown to have a significant role. In particular, hypnotic suggestion, a cognitive manipulation, can induce important modulation of perceived body-size and the way we act with it. However, there is considerable uncertainty regarding the interaction of cognitive and sensory factors when they contradict each other. The objective of this study was to assess the respective weight of cognitive and sensory factors for informing body-size representation. To that end, we delivered hypnotic suggestion for modulating body-size perception with or without visual and/or sensorimotor cues contradicting the suggestion. Cues did decrease the effect of hypnotic suggestion, but an important part of the effect remained, suggesting that the effect of hypnotic suggestion is robust to contradiction by the senses. Hypnotic suggestibility was a driving factor of the suggested effect, but it did not act as a protection factor against sensory cues. Additionally, vision and touch did not interact in any meaningful way, suggesting that mechanisms managing these disconfirming sensory cues were likely orthogonal. These results indicate that in some contexts, body representation can be more responsive to cognitive factors than sensory cues.

Keywords: Hypnosis, multisensory integration, body representations, body image, body schema, suggestion

2. INTRODUCTION

Once adulthood is reached, body metrics largely stays the same. Regardless, the representation of body size is not bound to the biological body boundaries, but rather adapts to available data. At the perceptual level, proprioceptive-tactile (Lackner, 1988) and visuo-tactile illusions (Kilteni et al., 2012a) can induce the feeling that one's body part has elongated. At the sensorimotor level, tool-use leads to the incorporation of the tool, which affects the estimated size of the limb (Cardinali et al., 2009). More generally, low-level afferent and efferent information suffices to induce plasticity of body representations. Indeed, illusions are standard tools to induce changes in body representations (e.g. Anders et al., 2021; de Vignemont et al., 2005; Kilteni et al., 2012; Naito et al., 2016), and their use in the last decades yielded major improvement in our understanding. These illusions can arise from *incorrect sensory signals*, as in the vibration induced illusion of limb movement (Lackner & Taublieb, 1984) where vibrating specific tendons produces incorrect proprioceptive signals and result in feeling one's limb moving. Alternatively, they can appear as the result of an *erroneous integration* of sensory signals. For instance, in the classical rubber hand illusion (RHI; Botvinick & Cohen, 1998), a fake hand is placed next to the participant's hidden hand; and he/she can feel sensations located one the fake hand if it is stroke in synchrony with the hidden (real) hand. In both cases, the strength of these illusions is influenced by relevant sensory cues that are available. For example, the vibration induced illusion of limb movement is weaker when seeing the limb (Lackner & Taublieb, 1984) and the RHI is elicited only when the visuo-tactile stimulation is synchronous (Botvinick & Cohen, 1998; but see: Samad et al., 2015).

However, body representations are not solely informed by the senses, but also by cognitive factors. It has recently been shown that mental imagery and hypnotic suggestion can modulate body size representations (Baccarini et al., 2014; Apelian et al., Chapter 1 & 2). Coherently, abovementioned illusions can also be influenced by cognitive factors. For instance, it seems that body-size representations can be extended, but not so easily contracted in the Lackner illusion (Bernardi et al., 2013; Vignemont et al., 2005). Also, in the RHI, bigger hands can be incorporated, but not smaller ones (Pavani & Zampini, 2007) and the strength of the illusion depends on the appearance of the fake hand (more or less human-like; Bertamini & O'Sullivan, 2014; Tsakiris et al., 2010). Size-asymmetry coincides with the ontogenetic development of the human body, which might provide a cognitive constraint on the malleability of body representations (Vignemont, 2018).

There is considerable evidence showing that illusions are shaped by both sensory data and cognitive factors. Although cognitive factors have been shown to moderate the magnitude of these illusions, sensory evidence can alter body representations even when change is highly unplausible (e.g. limb changing size). This suggests a strong influence of sensory data compared to cognitive variables. Conversely, cognitive manipulations have been shown to modulate body representations only in the absence of relevant sensory cues and without interference with other cognitive constraint. Hence, there is considerable uncertainty regarding the interaction of cognitive factors and sensory data when they are in conflict. In particular, we focused here on manipulating body-size representation using hypnotic suggestion (a cognitive manipulation used in previous studies; Apelian et al., Chapter 1 & 2) and assessed the influence of sensory data (visual and/or tactile) and cognitive constraint (size-modulation asymmetry) contradicting the suggestion.

Hypnotic suggestion (Oakley & Halligan, 2009; Terhune et al., 2017) has been used to modify several aspects of bodily awareness, most notably pain experiences (Jensen & Patterson, 2008), but also self-awareness (Rahmanovic et al., 2012). More generally, highly suggestible individuals can experience drastic changes in their perceptual experience (e.g. Bryant & McConkey, 1989; Kosslyn et al., 2000; Landry et al., 2020; McGeown et al., 2012) and beliefs (Barnier, Cox, et al., 2008b; Connors, 2015; Noble & McConkey, 1995b). Interestingly, they can sometimes produce and sustain these effects despite disconfirming sensory evidence and prior knowledge. For example, in one experiment, participants were suggested that they were of the opposite sex. Some participants successfully adopted the suggested belief, but only extremely suggestible individuals maintained it when they were shown a video of themselves (Noble & McConkey, 1995). Less suggestible individuals revised their beliefs, even those that are usually considered highly suggestible. This raises the question of whether hypnotic suggestibility plays a moderating role regarding sensory evidence, thereby shielding the target representation from counterevidence.

In this experiment, we contrasted the effect of hypnotic suggestion for finger-size modulation (extension/contraction) with and without visual and tactile factual cues (i.e. in contradiction with suggestions). Suggestions were administered in the same way as previous studies (Apelian et al., Chapter 1 & 2), with the same suggested size change for elongation and contraction (5cm). Insofar as body-size properties have been shown to be encoded in two distinct formats, visuospatial (body image) and sensorimotor (body schema), participants had to complete two tasks after each manipulation to assess each aspect. These representations are thought to coincide most of the time, but they can be dissociated (Pitron et al., 2018a). Suggestions were administered either with participant's arm hidden in a box (no vision condition) or after removing the lid and asking the participant to look at his/her hand during the process (vision condition). After each non-touch trial, either with or without vision, participants were asked to perform a self-touch motion with their left hand intended to provide tactile feedback on the actual length of the target finger (the left index finger). This move was demonstrated by the experimenter and consisted in repeatedly joining and separating the middle finger and index finger in a scissor-like motion. Hypnotic suggestibility was assessed online before the experiment (Apelian, Annex 3).

We expected an effect of elongation suggestion in the conditions without vision nor touch, replicating our previous results (Apelian et al., Chapter 1 & 2), with an effect size between 0.75 and 1.50. We also had strong expectations that visual and tactile cues would *decrease* the suggestion effect regardless of the suggestion direction. However, it was not clear which cue would reduce the effect the most. Based on the literature on bodily illusions, vision was presumed to give away the correct size of the finger, disrupting the suggestion effect. Conversely, based on discussion with participants following the previous experiments, touch seemed to better disrupt the suggested experience. Hence, no specific prediction relative to the magnitude of these effect was made. Also, given the nature of the task assessing body schema (line reaching task), participants had all the needed information for performing perfectly in the vision conditions. Therefore, we expected that effects on this task in the vision conditions would be small. Finally, hypnotic suggestibility was expected to predict a significant part of the suggested effect based on our previous studies, and we also suspected that it would act as a protection factor against factual sensory cues. In other words, that vision and/or touch would have a lesser impact for individuals with higher hypnotic suggestibility.

3. MATERIAL AND METHODS

3.1. Participants

The sample size was estimated prior to data acquisition. A pilot study revealed that the effect of sensory cues was stronger than the difference between elongation and contraction suggestions. Therefore, we based our estimation of the sample size on the smallest meaningful difference between the effect of these suggestions. This value was set at the test-retest value for the finger length perception task, at approximately 6mm, resulting in an estimated minimal effect size of 0.4. Using a statistical power estimate (1-β) of .9 and an α-level of .05 with a two-tailed paired t-test and an effect size of 0.4, we found a minimum sample size of 68 participants. Due to attrition, a total of 66 participants (43 females, 23 males) completed the experiment (M_{age}=37.2; *SD*=11.1; range: 20-64), with an actual power (1- β) of .89. All except three were right-handed or ambidextrous according to the Edinburgh Handedness Inventory (Oldfield, 1971). None reported psychiatric or neurologic disorders nor current use of psychoactive drugs (medical or recreational). All participants had two valid, functional arms and were fluent French speakers.

3.2. Materials

Hypnotic suggestibility was measured using a French translation of the online version of the *Sussex-Waterloo Group Scale of Hypnotizability* (SWASH; Lush et al., 2018; Palfi et al., 2019; Apelian, Annex 3). This scale consists of a relaxation-based hypnotic induction followed by ten suggestions for alterations in motor control, cognition, and perception. Following a de-induction, participants self-rated their behavioural and subjective responsiveness to each of the suggestions, respectively with dichotomous and 6-point (0-5) Likert scales. The SWASH was selected for its similarity to the *Stanford Hypnotic Susceptibility Scale: Form C* (Weitzenhoffer & Hilgard, 1962), a widely-used measure of hypnotic suggestibility. The SWASH usually has good internal consistency for the subjective scale, and this is confirmed in our sample, with Cronbach's α=.80. However, the internal consistency of the behavioural measurement is often bellow acceptable, necessitating correction for compliance (Apelian, Annex 3). Correction corresponds to counting a test suggestion as failed if the corresponding subjective rating is 0 or 1 (on a Likert 6 point scale 0-5). In our sample, the corrected behavioural measurement is indeed acceptable, α=.65 (for the uncorrected behavioural scale, α=.50). Consequently, hypnotic suggestibility was indexed by the corrected behavioural score in this study. In addition to hypnotic suggestibility, we asked participants to report their familiarity with hypnosis with the question "Report your familiarity with hypnosis (being hypnotized) or self-hypnosis" using a Likert scale (0-5) from (0) "I never experienced hypnosis" to (5) "I am acquainted with the experience of hypnosis".

A *finger length perception task,* similar to our previous studies (Apelian et al., Chapter 1 & 2), was used to measure body image. The task was performed using a graphical user interface displaying a silhouette of the participant's left hand and a slider. The participant was instructed to adjust the slider until the silhouette of their finger matched their perceived finger length. Perceived finger length was measured with two trials, one with the starting position of the slider at the maximum distortion (three times the normal size) and one starting at the minimum distortion (no finger). In each trial, eight measurements were performed. *Perceptual error* is the difference of measurements in a condition and baseline.

A *line reaching task,* similar to our previous studies (Apelian et al., Chapter 1 & 2), was used to measure body schema. In this task, participant's left arm was hidden in a box on a table, rested on a moving platform. Three parallel lines {1,2,3} with an inter-line distance of 30mm were displayed in the field of view of the participant next to the box at platform height, with a number displayed next to each line. In each condition, participants completed eighteen trials in which they were asked to match the position of one of the three parallel lines with their left index fingertip. Lines were called in the following order: {1,2,3}, {3,2,1} repeated three times. The position of the sliding platform was reset before each trial set (sets are {1,2,3} and {3,2,1}). The lines were only visible to the participants outside the box, so they could not see the position of their left hand when the lid was on. However, when the lid was removed, participants had full vision over their hand inside the box. *Pointing error* is the mean difference between measurements in a given condition and baseline.

3.3. Hypnotic suggestion

The hypnotic suggestion condition was conducted following a script developed for this experiment and contained a short induction, consisting mainly of the head falling suggestion of the HGHS:A (Shor & Orne, 1963b), followed by either a suggestion to experience the left index finger elongating until 5cm longer or shrinking until 5cm shorter. The hypnotic suggestion was phrased as "the finger is growing/shrinking until 5cm longer/shorter". Participants were given 60s to experience the suggestion without further suggestions or cues. Participants were asked to keep their eyes open during the whole procedure and to fix a point (on the box hiding their left hand or on their left index finger depending on the conditions). Afterwards, and before testing, participants were told that they would go through the measurement tasks, while remaining hypnotized and with the effect remaining for the whole duration of the measurements. When testing was done, a standard de-induction was performed (similar to Bowers, 1993) with an emphasis on the index finger returning to its normal size. Participants where then instructed to rub their hands and take a short break.

3.4. Sensory cues

In half of the conditions, the lid of the box hiding the left hand was removed to allow participants to see their hand. Furthermore, they were instructed to look at their left index finger during the hypnotic procedure and told during measurements that they can look at their finger as much as they want. After each non-touch condition, participants were asked to touch their left index finger with their left middle finger in a scissor-like motion three times with a contact duration of about one second. Every time the experimenter demonstrated the movement and asked the participant to mimic at the same time. All participants successfully complied.

3.5. Procedure

Participants' involvement in this study consisted of two sessions separated by at least one day. The first session involved the administration of a French translation of the online SWASH. In the second session, participants completed the finger length perception task and the line reaching task in ten conditions: without manipulation (baseline), with and without seeing their finger; after a hypnotic induction and suggestion for finger elongation, with and without vision and/or touch; and after hypnotic induction and suggestion for finger contraction, with and without vision and/or touch. All no-vision (hand hidden in the box) and vision (lid open) trials were performed in the same bloc. Baseline conditions were performed before hypnotic conditions. Touch trials were realised directly after each non-touch trials. The order of vision/no vision and elongation/contraction trials were counterbalanced and randomized. In each condition, the finger length perception task was interlaced with the line reaching task, with two measurements of the finger length perception followed by six trials (two sets) of the line reaching task, repeated three times. At the end of the experiment, a question-and-answer time was offered to dissipate any uneasy feelings that might arise due to the unusual experience of hypnosis. Participants were compensated 20€ for their time.

3.6. Analyses

No multivariate outlier (>*M*+3 *SD*s in 2 conditions) was identified in the dataset. Data were analysed using linear mixed effects models with the lme4 and car (Bates et al., 2015) using *R* studio software (Version 4.0.3, 2020 RStudio, Inc.), and paired *t*-tests (frequentist and Bayesian) using JASP (Version 0.14.1; Love et al., 2019). All other analyses were performed using Python 3 and the scipy library. Data are publicly available on the Open Science Framework (https://osf.io/ygzsv/).

4. RESULTS

4.1. Descriptive statistics

The distribution of hypnotic suggestibility in our sample, as indexed by the SWASH, *M*=4.1; *SD*=2.1; range: 0-9, was commensurate with the French population (Apelian, Annex 3). General statistics for each condition are presented in Figure 3.1 and Table 3.1.

First, we tested whether suggestions had a significant effect compared to baseline in each condition. To that end, we performed frequentist one sample one-tailed t-test since computations are realised on errors (deviations from baseline). All conditions had highly significant effects, p<.001, effect sizes are reported in Table 3.1.

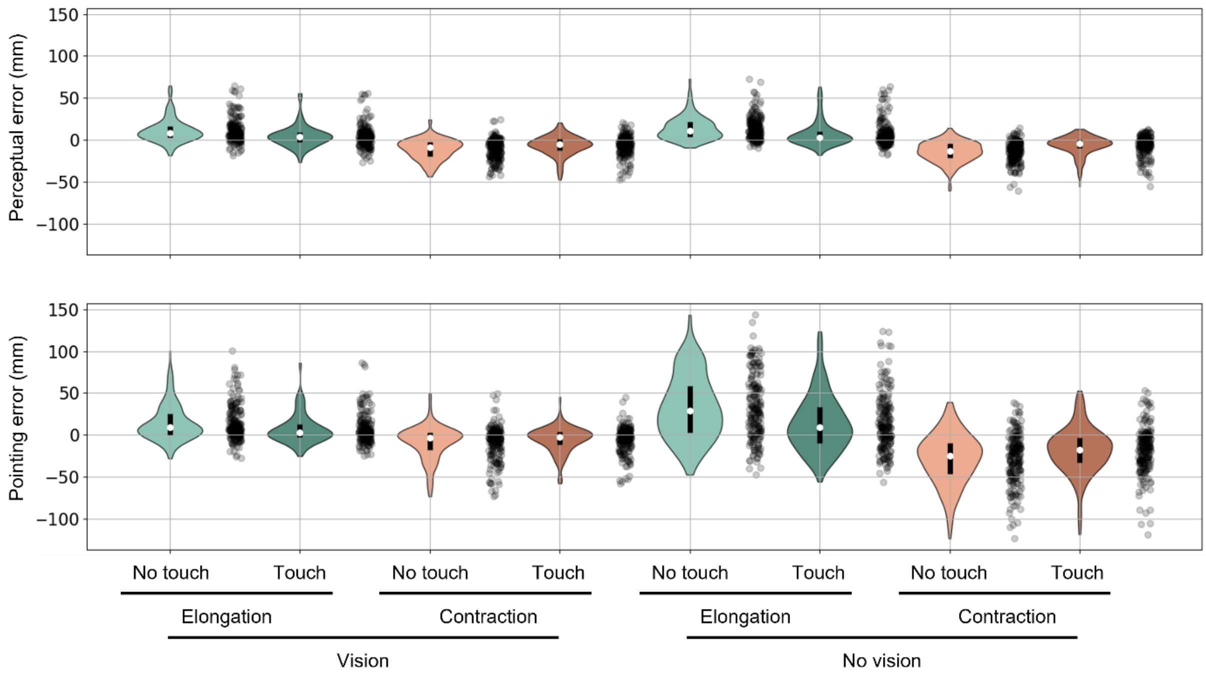

Figure 3.1: *Violin plots of perceptual and pointing errors (mm) as a function of Condition (N=66). Distributions reflect kernel density estimation plots and markers reflect individual measurements. Central black lines represent the interquartile range and the white dots the median error in each condition.*

Table 3.1

Descriptive statistics for each condition (N=66)

Condition	Mean (*SD*) / effect size perceptual error	Mean (*SD*) / effect size pointing error
Elongation; vision; no touch	11.6 (15.5) / 0.75	14.6 (22.6) / 0.65
Elongation; vision; touch	4.6 (14.2) / 0.32	7.6 (19.1) / 0.38
Contraction; vision; no touch	-10.8 (13.2) / -0.82	-8.8 (21.5) / -0.41
Contraction; vision; touch	-6.4 (12.8) / -0.50	-5.2 (16.8) / -0.31
Elongation; no vision; no touch	14.4 (15.5) / 0.93	32.7 (40.2) / 0.81
Elongation; no vision; touch	7.3 (16.5) / 0.45	14.0 (35.8) / 0.39
Contraction; no vision; no touch	-14.2 (13.6) / -1.039	-28.5 (32.4) / -0.88
Contraction; no vision; touch	-6.6 (12.8) / -0.51	-18.4 (30.2) / -0.61

*Notes. Mean effects in mm, effect sizes are Cohen's d, all differences are highly significant (p<.001). Degrees of freedom for perceptual error df=527 (66*8-1); and df=1187 (66*18-1) for pointing error.*

4.2. Hypnotic suggestion for finger elongation versus contraction

Our second set of analyses aimed at comparing the two antithetical hypnotic suggestions used in this study. To that end, we compared elongation and contraction suggestions in each condition (no vision/vision x no touch/touch) with Bayesian paired sample t-tests. We reversed contraction errors (multiplying by negative one) to be able to compare the magnitude of suggestions, as if they were in the same direction. We also took the mean of measurements taken in each condition for each participant. This was mandatory to respect assumptions of independence between measurements. In all conditions (except one with inconclusive result) the perceptual and pointing errors were similar for elongation and contraction suggestion. In the condition without vision nor touch, perceptual errors were similar, $B_{01}=7.4$, $g=0.035$, as well as pointing errors, $B_{01}=4.86$, $g=0.09$; the same conclusion was reached in the condition without vision but with touch for perceptual, $B_{01}=6.92$, $g=0.04$, or pointing error, $B_{01}=5.23$, $g=-0.085$; in the condition with vision but no touch for perceptual error, $B_{01}=7.27$, $g=0.04$, yet results were inconclusive for pointing error, B_{01}=1.47, *g*=0.195; and finally in the vision and touch condition elongation and contraction suggestion effects were similar both for perceptual, B_{01}=4.39, *g*=-0.09, and pointing errors, B_{01}=5.31, *g*=0.08. These results indicate overall a clear symmetrical effect of elongation and contraction suggestions for perceptual and pointing errors regardless of the condition.

4.3. Correlations

We then undertook to analyse correlations between perceptual and pointing errors and similarly to previous results (Apelian et al., Chapter 1 & 2), we found a strong positive correlation between them, either in the vision condition *r*=.75, 95% CI=[.70; .79], *p*<.001 or without vision, *r*=.77, 95% CI=[.73; .81], *p*<.001. Interestingly, in the vision conditions, perceptual and pointing errors had a 1:1 relation with a slope of 1.03 for the best linear fit, compared to a slope of 1.82 for the best linear fit of data in the no vision conditions (Figure 3.2). The elongation and contraction suggestions were modestly but significantly correlated, both for perceptual error, r=-.33, 95% CI=[-.41; -.24], p<.001, and pointing error, r=-.31, 95% CI=[-.39; -.21], p<.001. Furthermore, the effect of suggestions (either elongation or contraction) in the vision condition was highly correlated with its counterpart in the no vision condition, both for perceptual error, r=.76, 95% CI=[0.71; 0.80], p<.001, and pointing errors, r=.57, 95% CI=[0.50; 0.64], p<.001. Finally, we checked the correlation of the visual and tactile cues effect (i.e. the amount of reduction in the suggestion effect). Visual and tactile disruption effects were moderately correlated, r=.39, 95% CI=[.31; .47], p<.001. These results indicate that pointing error tend to be closely associated to the perceptual report, especially in the vision condition, but also indicate that the effect of one suggestion (elongation or contraction) is stable, as it was highly correlated across conditions. However, the link between elongation suggestion and contraction suggestion is weaker, with only a modest correlation between the two.

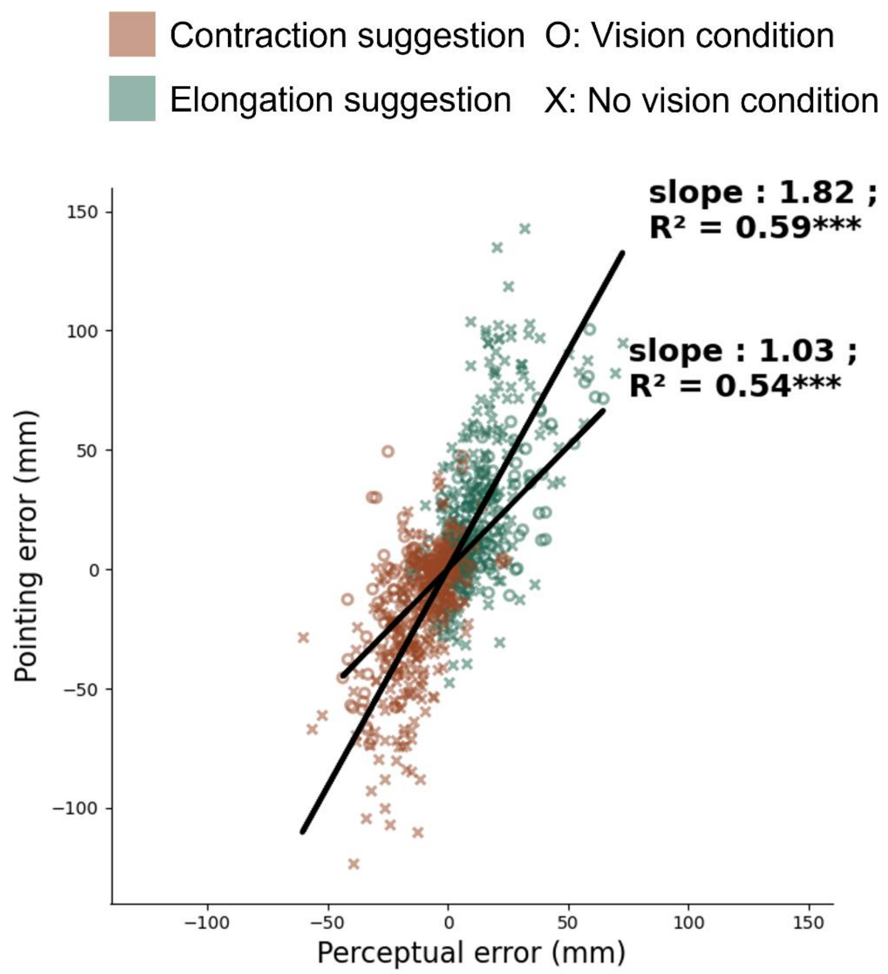

Figure 3.2: *Linear regression between perceptual and pointing error in the vision or no vision condition.*

4.4. Effect of vision and touch on the perceived finger-size modulation

In order to assess the effect of vision and touch on the finger-size modulation effect on perceptual error, we performed mixed linear models with full interaction between elongation/contraction, vision/blind, and touch/no touch conditions and progressively removed non-significant interactions. Perceptual errors for the contraction conditions were reversed to compare the effect of vision and touch on both suggestions simultaneously. Best model is presented in Table 3.2 and reveals that vision and touch reduced the effect of suggestions. To further test if the positive interaction term between vision and touch was caused by weak suggestion effects being nullified by either vision or touch, we computed the mixed model for the top quartile of the sample (participants with an overall mean perceptual error larger than 13.568 mm). In this subgroup with the largest effects, no significant interaction was detected, β= -0.38, 95% CI=[-4.02;-3.27], *p*=.84. These results are suggesting that, when the effects are large enough, vision and touch are independently taxing the perceptual error following suggestion, but in the case of weak effects one of the sensory cues is enough to nullify the effect of suggestions.

Table 3.2

Linear mixed effect model of perceptual error (N=66)

	Perceptual error ~ Direction of modulation + vision x touch + (1|Participant)				
Fixed effects	Estimate	*SE*	95% *CI*		*p*
			LL	UL	
Intercept (elongation)	**14.26**	**1.09**	**12.13**	**16.40**	**<.001**
Contraction [a]	0.01	0.36	-0.70	0.72	.99
Vision	**-3.10**	**0.51**	**-4.10**	**-2.09**	**<.001**
Touch	**-7.32**	**0.51**	**-8.32**	**-6.32**	**<.001**
Vision x touch	**1.64**	**0.72**	**0.22**	**3.06**	**.02**
			Within subject variance		67.75
			Residual variance		138.26

Notes. All estimates are in mm. [a] *contraction errors are reversed (multiplied by negative one) to be directly comparable with elongation effects. CI = confidence interval; LL = lower limit; UL = upper limit.*

To further control for confounding variables, we sequentially added control variables to the mixed model presented in Table 3.2 (age, gender, condition order, and chronological order of measurements). Age did not improve the perceptual error model, $\chi^2(1,N=66)=0.38$, $p=.54$, nor did gender $\chi^2(1,N=66)=2.71$, $p=.10$, the order of passing elongation/contraction $\chi^2(1,N=66)=2.06$, $p=.15$, or the order of vision/no vision conditions $\chi^2(1,N=66)=0.98$, $p=.32$. To assess the role of participants tiredness during the experiment, we tried to add the chronological order of measurements, but it did not significantly improved the model, $\chi^2(1,N=66)=1.79$, $p=.18$. Hence results drawn from Table 3.2 are not confounded by these variables.

4.5. Modulation of the suggestion effects on the line reaching task by vision and touch

The modulation of the suggestion effect on pointing error by vision and touch was assessed through mixed linear model in the same way as perceptual error, with results presented in Table 3.3. These results are similar to those found for perceptual error, with some notable differences. First, contraction had a significantly lower effect than elongation for pointing error contrary to perceptual error where it was non-significant. Second, vision and touch effects were similar in magnitude for pointing error, while for perceptual error, touch had more than twice the effect size of vision. Third, contraction interacted with touch, with a lesser reduction of the suggestion effect by touch in the contraction condition.

As for perceptual error, age did not improve the pointing error model, $\chi^2(1,N=66)=0.06$, $p=.81$, nor did gender $\chi^2(1,N=66)=2.71$, $p=.10$, the order of vision/no vision conditions $\chi^2(1,N=66)=0.34$, $p=.56$, or duration of the experiment (chronological order of measurements to assess tiredness) $\chi^2(1,N=66)=1.16$, $p=.28$. However, the order of passing elongation/contraction condition significantly improved the model, $\chi^2(1,N=66)=5.88$, $p=.015$, with participants undergoing the contraction block first having overall weaker suggestion effects, $\beta= -8.97$, 95% CI=[-16.16; -1.77], $p=.015$. Nonetheless, results drawn from Table 3.3 are maintained when this variable was included.

Table 3.3

Linear mixed effect model of pointing error (N=66)

	Pointing error ~ Direction of modulation x vision x touch + (1|Participant)				
Fixed effects	Estimate	*SE*	95% *CI*		*p*
			LL	UL	
Intercept (elongation)	**32.73**	**2.01**	**28.79**	**36.68**	**<.001**
Contraction [a]	**-4.28**	**0.99**	**-6.21**	**-2.35**	**<.001**
Vision	**-18.16**	**0.99**	**-20.10**	**-16.23**	**<.001**
Touch	**-18.73**	**0.99**	**-20.67**	**-16.80**	**<.001**
Contraction x vision	-1.50	1.39	-4.24	1.23	.28
Contraction x touch	**8.65**	**1.39**	**5.92**	**11.38**	**<.001**
Vision x touch	**11.42**	**1.39**	**8.69**	**14.16**	**<.001**
Contraction x vision x touch	**-4.94**	**1.97**	**-8.80**	**-1.07**	**0.012**
			Within subject variance		235.22
			Residual variance		577.58

Notes. All estimates are in mm. [a] *contraction errors are reversed (multiplied by negative one) to be directly comparable with elongation effects. CI = confidence interval; LL = lower limit; UL = upper limit.*

4.6. Role of hypnotic suggestibility and familiarity in the finger-size modulation effect

We examined the role of hypnotic suggestibility in the finger-size modulation effect. To that end, we included hypnotic suggestibility in mixed effect models (Table 3.2, Table 3.3). It improved both the perceptual and pointing error models with higher hypnotic suggestibility predicting higher error as expected, β= 1.29, 95% CI=[0.24; 2.34], p=.016 and β= 3.03, 95% CI=[1.20; 4.87], p=.001 respectively.

To further assess if hypnotic suggestibility acted as a protection factor against sensory cues, we estimated the proportion of suggested effect lost for groups of similar level of hypnotic suggestibility. Results are presented in Figure 3.3 and suggest that hypnotic suggestibility did not protect against sensory cues. To better assess how much hypnotic suggestibility interacted with these cues (vision and touch), we added these interactions in the previous mixed models. In both models the trend was significantly downwards, with β= -0.51, 95% CI=[-0.88; -0.14], p=.007 and β= -0.76, 95% CI=[-1.13; -0.39], p<.001 for the interaction of hypnotic suggestibility with vision and touch respectively in the perceptual error model, and β= -2.16, 95% CI=[-2.65; -1.66], p<.001 and β= -2.36, 95% CI=[-2.86; -1.87], p<.001 in the pointing error model. These results indicate that the higher hypnotic suggestibility, the higher the suggested effect (elongation or contraction), and the higher the impact of sensory cues.

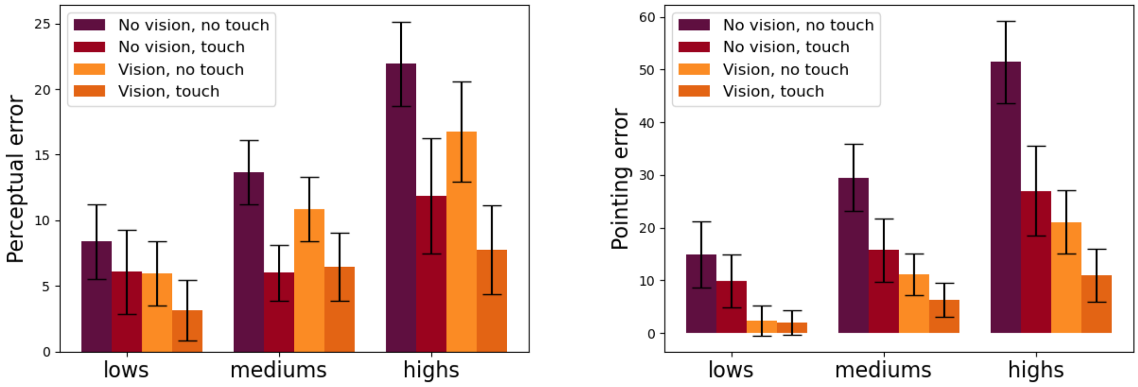

Figure 3.3: *Bar plots of perceptual and pointing errors in the different conditions relative to baseline, segregated by hypnotic suggestibility level. With n=13 lows (score < 3), n=29 mediums (score ∈ [3;5]) and n=16 highs (score >5).*

Previous studies reported that familiarity with hypnosis had an effect on pointing error but not on perceptual error (Apelian et al., Chapter 1 & 2). Hence, we tried to add familiarity with hypnosis ratings to mixed effect models alongside hypnotic suggestibility. Familiarity with hypnosis did not improve the perceptual error model, yet it was tangential, $\chi^2(1,N=66)=3.50$, p=.06, nor the pointing error model surprisingly, $\chi^2(1,N=66)=1.45$, p=.23.

Taken together, these results indicate that hypnotic suggestibility is a significant predictor of the finger-size modulation effect but did not protect this effect from sensory cues, and that familiarity with hypnosis was probably not a relevant variable in this study, contrary to previous research.

5. DISCUSSION

In this study we assessed the impact of disconfirming sensory cues and cognitive constraints on the effect of hypnotics suggestion for body-size modulation. Our results show that elongation and contraction suggestions have a symmetrical effect. As expected, the suggested effect was reduced by sensory cues. Nonetheless, vision, touch, or both combined failed to fully supress the suggested effect, and this was found both at the visuo-spatial and at the sensorimotor levels, with respectively 38% and 27% of the effect remaining when both sensory cues were present. In addition, we found that no constructive interference (synergy) was found between the different types of sensory cues, suggesting independence between sensory effects. Hypnotic suggestibility accounted for a significant amount of suggestion effects. However, it did not act as a protective factor against sensory cues. Taken together, these results are in line with previous studies showing that body representations are informed by both sensory and cognitive factors. Nonetheless, the relative strength of cognitive factors compared to sensory cues might have been underestimated.

5.1. Symmetrical effects for elongation and contraction suggestion

One seemingly innocuous result in this study is the symmetry between the effect of elongation and contraction suggestions. Indeed, the body tends to expand rather than to shrink, whether one is growing up or for tool use. Accordingly, the malleability of bodily representations is primarily concerned by body elongation (Bernardi et al., 2013; Cardinali et al., 2009; Vignemont et al., 2005b; Pavani & Zampini, 2007). Even if after dropping a tool, the estimated size of the bodily effector needs to diminish, it only shrinks back to the original size, like a rubber band (Vignemont & Farnè, 2010; Vignemont, 2018). Amputated patients describe that their phantom limbs can become shorter than their amputated limb, but this telescoping phenomenon corresponds more to a segment of the limb disappearing than shrinking in size. It is only in rare cases of microsomatognosia that patients experience their body as smaller. Yet we succeeded here in inducing a significant contraction effect for one of the first times in healthy participants. Furthermore, this effect was as strong as for elongation. This result implies that the elongation-contraction asymmetry found in other contexts is not a general functional constraint of the malleability of body representations, but seems rather to be a cognitive prior.

Interestingly, elongation and contraction suggestion effects are only moderately correlated. In other words, knowing the effect of one suggestion (elongation or contraction) does not give much information about the effect of the other one for a given participant. This is at odds with our understanding of suggestion, especially derived from suggestibility scales, showing that response to a suggestion is generally associated to responding to other suggestions (Laurence et al., 2008).

However, one can wonder whether closely related suggestions have necessarily highly correlated effects. For example quasi-identical suggestions such as the fly hallucination of the Harvard group scale and the mosquito hallucination of the Stanford scale present different loading patterns on factor analysis (Woody et al., 2005). Similarly, factor analyses of multiple suggestibility test have failed to provide a coherent grouping of similar suggestions (Tasso & Perez, 2008). Here, we interpret the moderate correlation between elongation and contraction suggestions as the result of a confound. Indeed, during post-experimental discussions, some participants revealed that one alteration (elongation or contraction) was easier than the other, with often negative valence associated with the difficult alteration. Thus, it seems that motivation during the different suggestions was not constant, which is known to play a role in responding to suggestions (Spanos et al., 1987).

Overall, our data contrasting elongation and contraction suggestion demonstrate a remarkable symmetry in the light of previous asymmetric results. This symmetrical effect at the group level does not generalise at the individual level, probably because of negative affects/expectancies randomly associated with one of the suggestions. Since the effect of elongation and contraction can be considered equivalent at the group level, we will keep this distinction aside for discussing the effect of vision and touch on the magnitude of the suggested effect.

5.2. *Effect of vision and touch*

Visual and tactile feedback reduced the magnitude of the suggested effect, but did not extinguish it, as it remained significant. Touch led to a larger reduction of the perceived elongation/contraction than vision, with more than twice the effect. This means that some formats could be weighted more than others to compute body metrics. This is especially striking considering that vision is known to have a strong effect on illusions (e.g. Lackner & Taublieb, 1984) and that the time of exposure to visual feedback was longer than for touch: participants could see their finger during the whole condition (hypnotic induction, suggestion and measurements), while touch was restricted to three repetitions during only one second. We propose that this difference comes mainly from participants' expectancies. Indeed, no participant expected their finger to *physically* change size according to post-experimental discussions. Most likely, participants interpreted the suggestion as *feeling* one's finger elongated/contracted (rather than visually *seeing* it longer). Therefore, vision did not directly contradict with suggestions. In addition, touch has been conceived as having an epistemic privilege compared to other modalities (James, 1890; Vignemont & Massin, 2013). By feeling the resistance of the object on our skin, we experience it as being independent from us. By contrast, people have a critical distance with their visual experience: movies, advertisement, false recognition, optical illusions, etc. Therefore, touch is likely given more weight than vision to counter the body-size modulation suggestion.

Not only was vision less powerful in reducing the suggested effect than touch, but it also changed the relation between body image and body schema. In conditions where the target hand is hidden, sensorimotor effects are roughly two times larger than perceptual effects. However, in the vision condition, variations in body schema are indexed on body image (1:1 relation). This can be explained by the crucial role played by vision for action guidance. In one study, for instance, participants could see the line that they were drawing but a spatial bias was introduced so that it did not match with their actual drawing. Yet, they used the visual information to guide their subsequent action (Fourneret & Jeannerod, 1998). Indeed, proprioception is far less precise (far noisier) than vision, as supported by our data. Hence, when vision is available, it combines its strength with proprioception for action guidance.

Two possibilities can explain the residual effect of suggestion on the line reaching task in the vision condition. It is possible that some participants *visually experienced* a longer/shorter index finger, even in the vision condition, explaining why given all necessary information to perfectly execute the task, they still present a bias consistent with the suggestion. However, this is unlikely to capture the whole phenomenon as hypnotic visual hallucination is generally accessible to a tenth of the general population (Anlló & Sackur, 2017; de Saldanha da Gama et al., 2012a). Alternatively, we can speculate that participants chose to index their response on the distorted body image much like believed-in imagination. This "make-believe" attitude would entail that participants played a "serious game" where they neither simply complied with the suggestion, nor entirely complied with the task instruction. Indeed, if participants complied with the suggestion, the majority of the sample would have presented responses centred around the target elongation/contraction (5cm), which was not the case. Conversely, if participants complied with the task instruction "*match the position of line {1,2,3} with your left index fingertip the best you can*", they should present *no bias* in the vision conditions, which was not the case. Hence, in this second option, participants reinterpreted the situation to respond in a way that satisfied to both conflicting requests (akin to the constructive mode described in Sheehan & McConkey, 2015, p. 90-93). These two hypotheses are not incompatible and explain why body schema is indexed on body image in vision conditions. Consequently, the effect of vision on body schema presented in Table 3.3 is likely inflated by the correction that participants applied while indexing their response on body image.

Many aspects of bodily awareness are thought to rely on multisensory integration (Ehrsson, 2020; Kilteni et al., 2015; Longo et al., 2016). Hence, we expected convergent sensory evidence (vision and touch) to interact in such a way such that the combined effect would be greater than each individual effect. However, our data suggest otherwise. Even in participants with the highest response to suggestions, we could not find signs of a constructive interaction. This may be explained by one major difference between vision and touch conditions. Vision conditions started with participants looking at their finger at the beginning of the induction process and visual cues were available *throughout measurements*. By contrast, in touch conditions participants had *short* (about three seconds) self-generated motor-tactile evidence. Therefore, participants might have used different mechanisms to manage these two events. For vision, a long-term strategy needs to account for uninterrupted visual disconfirmation of the suggested effect, whereas in the touch conditions participants can power through the disconfirming evidence. Our results indicate that the effects of vision and touch were not interacting. This suggests that, if strategies were employed to mitigate the effect of these cues, they were likely orthogonal. This interpretation rests on active strategy use, but it raises the question about the passive influence of personal traits such as hypnotic suggestibility.

5.3. The role of hypnotic suggestibility

In line with previous studies, hypnotic suggestibility did predict a significant part of the magnitude of the elongation/contraction suggestion (Apelian et al., Chapter 1 & 2). However, it accounted for only about a third of the effect. Nonetheless, this number needs to be considered in the context of hypnotic scales (Acunzo & Terhune, 2019). Most notably, the item-total correlation of the online SWASH used in this study (Apelian, Annex 3) is at most r=.45. Also, in this study, the correlation between elongation and contraction suggestion effects was modest (r=.33). Hence, it is unlikely that general hypnotic suggestibility would be more strongly associated with the general effect of these suggestions than these suggestions are correlated among themselves.

One could have expected that the negative effect of vision and touch would be mitigated by hypnotic suggestibility. However, our results suggest otherwise. If any effect is present, there is even a tendency for highly suggestible individuals to have greater reduction of the suggested effect. This relative independence of the effect of hypnotic suggestibility and disconfirming sensory cues suggests that the role of hypnotic suggestibility is restricted to the cognitive level in this experiment. While there is research arguing for a role of attentional abilities in hypnosis (Cojan et al., 2015; Crawford et al., 1993;

Raz, 2005; though not always, e.g. Varga et al., 2011), in this experiment, there was no evidence that hypnotic suggestibility exerted its influence through modulations of attention. Otherwise, a protective factor against sensory cues would be expected. Overall, these results indicate that hypnotic suggestibility is a relevant predictor of the suggested response, but it did not prevent the decrease in magnitude brought by sensory cues.

5.4. Clinical relevance

The preponderance of cognitive factors on body-size representations opens concerning questions for body image research, especially in relation to psychopathology. If cognitive factors are an important force driving low-level body representations, sometimes *despite* disconfirming sensory evidence, then what are the consequences of poor body cognition? For instance, what are the effects of body dissatisfaction on self-suggestions? In a previous study, we draw parallels between the effect of imagery and hypnosis (Apelian et al, Chapter 2), highlighting that suggestion-like effects could be present in the seemingly innocuous activity of "simply imagining". Considering the role of distorted body representations in some pathologies such as anorexia nervosa (Gadsby, 2017b, 2017d; Guardia et al., 2010; Longo, 2021; Mölbert et al., 2018), hypnotic suggestibility could represent a potential risk factor. On a more optimistic note, it also opens new avenues for preventing and treating such pathologies. Indeed, if hypnotic suggestibility is potentializing expectancies, then reappraising dysfunctional expectancies would be especially important in highly suggestible individuals. Yet, more research needs to be done to answer these questions.

5.5. Limitations

We acknowledge several limitations of this study. First, we did not perform non-hypnotic suggestions to assess the specific effect of the induction process. This was not done because non-hypnotic direct verbal suggestibility is a reliable correlate of hypnotic suggestibility (Braffman & Kirsch, 1999; Wieder

& Terhune, 2019). Thus, we expected similar yet slightly lower results in a hypothetical non-hypnotic suggestion group, and we preferred to allocate resources to more central issues. Second, no expectancy measurement was done. This would have been an important addition, especially to test the hypothesis that expectancies are confounding the low correlation between elongation and contraction suggestion effects. It would also have helped to have expectancies relative to the expected loss/gain caused by sensory cues. This could reveal some discrepancies, with participants expecting reduction following sensory cues experiencing higher reduction, and a possible interaction with hypnotic suggestibility. However, we did not measure response expectancies because doing so may provide participants with explicit indicators of how they are expected to respond, introducing demand characteristics (Orne, 1962a). Relatedly, indexing response expectancies may introduce a confound wherein participants feel compelled to respond congruently with their expectations (consistency motivation; Council & Green, 2004), thereby artificially biasing response patterns towards expectations. Third, touch conditions always followed other conditions. This could be an important confound if there was a significant drop in the effect throughout measurements. Hopefully, it was not the case in this experiment. This optimisation was made to shorten the experimental time, halving the number of induction/suggestion blocs. This was considered preferable to listening to eight times the same script, as it was expected to introduce more problems such as boredom.

6. Conclusion

The main result of this study is that hypnotic suggestion is quite robust. Not only can it last several minutes without significant decrease (duration of measurements), but it kept most of its effect (78%) when participants looked at their finger and almost half (49%) its effect when participants touched it. In contrast to another study (Noble & McConkey, 1995b) demonstrating that virtuosos (most suggestible individuals) could conserve a suggested delusion but not highly suggestible participants, our result suggest that body-size modulation can resist disconfirming sensory evidence for most participants. This study is also congruent with our previous study (Apelian et al., Chapter 1) demonstrating a superior effect of hypnotic suggestion compared to the Lackner illusion (Lackner, 1988b), a sensory-driven alteration of body-part size. These results suggest that body-size representations can be more responsive to cognitive factors than sensory cues in the right context. Our results also show that elongation and contraction suggestions have a symmetrical effect, which means that previously observed asymmetries in the effect of illusions are caused by factors that are not relevant in the context of hypnotic suggestion. Hypnotic suggestibility was a driving factor of the suggested effect, but it did not act as a protection factor against sensory cues as we expected. Additionally, vision and touch did not interact in any meaningful way, suggesting that mechanisms managing these disconfirming sensory cues were likely orthogonal. Given the preponderance and stability of cognitive variables in such non-ecological situation, we advocate for further inquiry into the benefits and risks of hypnotic suggestibility and autosuggestions for disorders of body representations.

GENERAL DISCUSSION

Our experimental work detailed in the previous chapters (see also Annex 1 and 2) investigated the effect of hypnotic suggestion on body-part size representations. Our main focus was on laying preliminary work to uncover the mechanisms by which hypnosis alters perception. I shall first briefly summarise our contribution to the field of bodily awareness. Then I will discuss and compare key experimental results relative to hypnosis. Finally, we will describe a theoretical account of body-size modulation suggestion based on most prominent models of hypnosis.

1. CONTRIBUTION TO BODY AWARENESS RESEARCH

The primary objective of this thesis was to explore the mechanisms underlying hypnosis. But to do so in a fruitful way, we decided to focus on a specific hypnotic phenomenon, namely, modulation of body awareness, and to target a relatively low-level property, body metrics (by contrast with studies on higher level phenomena related to self-awareness). This allowed us raising a number of questions about body awareness specifically, questions that have become timely these last few years with the recent controversies surrounding the RHI (see: Ehrsson et al., 2021; Lush, 2020). In brief, we were interested in the interplay of sensory and cognitive factors upon body representations. We shall not go into the details here, but we can highlight the following key results that we found.

First, we demonstrated an effect of hypnosis and imagery on the perceived size of the body. Moreover, the influence of these manipulations was not limited to body image, but they also shaped body schema, which is thought to be more primitive and less sensitive to cognitive factors (but see: Baccarini et al., 2014).

Secondly, our results provide empirical support for models where body image and body schema interact substantially (Pitron et al., 2018a). Indeed, hypnotic suggestion targeted only body image but strong correlations were observed between measurements of body image and body schema throughout our studies.

Thirdly, hypnotic suggestion had the same effect on body representations with elongation and contraction being suggested. This contrasts with previously reported asymmetries in the effect of illusions (Bernardi et al., 2013; Bertamini & O'Sullivan, 2014; Vignemont et al., 2005b; Pavani & Zampini, 2007; Tsakiris et al., 2010). This means that asymmetry in illusion is probably not caused by a functional constraint of body-size representation as previously hypothesised, but rather by other cognitive factors that are inoperant in our experiment.

Finally, our results suggest that cognitive factors, under certain circumstances can play a major and robust role in modulating body-size representations, since the effect of hypnotic suggestion was much stronger than the sensory-driven Lackner illusion (Lackner, 1988; Chapter 1), and contradicting sensory cues did not dissipate the effect of suggestion in many cases (Chapter 3).

Each of these findings would require more discussions but from now on we shall focus on hypnosis, our primary interest, and ponder the question raised at the beginning of this thesis: What are the mechanisms by which hypnosis changes perception?

2. KEY EXPERIMENTAL RESULTS

Experiments conducted on finger-size modulation with hypnotic suggestion show remarkable stability of the phenomenon. Let's summarise the results that were replicated across all experiments before diving into the specific contribution of each study.

2.1. General effect

The suggested elongation (without any relevant perceptual cue) was equal (10cm) in experiment 1, 2 and for the experiment described in Annex 2, however it was halved (5cm) for experiment 3. To assess the difficulty of this hypnotic suggestion, we report in Figure D.1 the pass rate for different elongation thresholds (i.e. the proportion of participants reporting elongations larger than the threshold). It is readily apparent that for the same target elongation (10cm), the general effect of the suggestion is similar from one experiment to the other, suggesting that the effect was reliable. This is particularly noteworthy knowing that measurements evolved from experiment 1 to experiment 3, even if the basic idea remained the same. Furthermore, perceptual error pass-rate curves have an inflection point around two thirds of the suggested elongation, and the slope of the curve corresponding to experiment 3 is steeper than the others. This demonstrates that the suggested target does not act as a *cut-off* point, limiting the potential perceptual alteration, rather it seems to *scale down* responses. This means paradoxically that someone experiencing an elongation of 5cm when suggested 10cm would likely experience a lesser elongation when suggested a 5cm elongation. Conversely, we found no influence of the target elongation suggested on pointing errors.

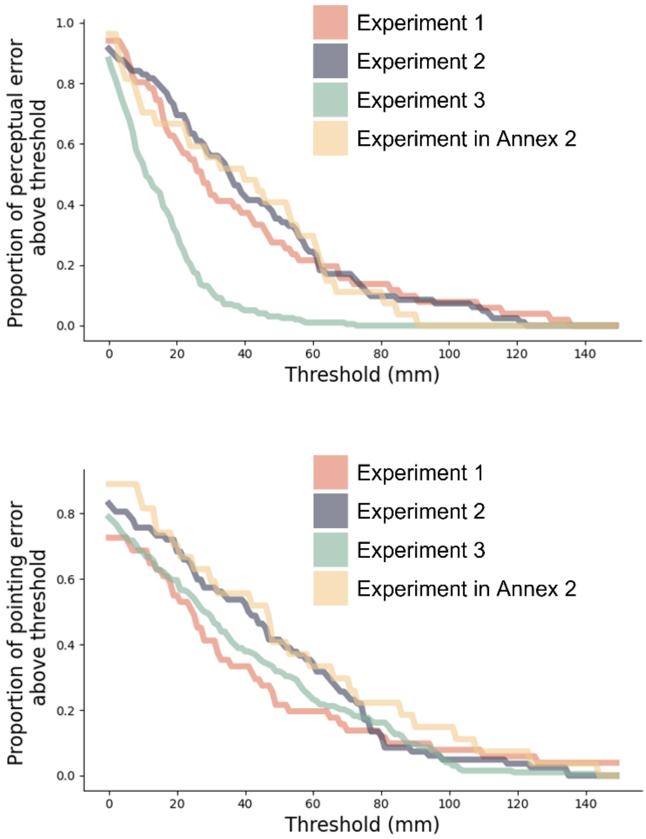

Figure D.1: *Pass rate curves for the elongated finger hypnotic suggestion.*

Additionally, distributions of perceptual errors in all experiments were similar to a bi-gaussian distributions (sum of two gaussian distributions, see Figure D.2). This might be the result of two modes of response to hypnotic suggestion for perceived finger elongation, but we could not identify a factor that clearly separates the two posited distributions (spontaneous imagery or expectancies). It could also be that the second gaussian distribution corresponds to the subgroup of participants having the ability to go beyond the suggested elongation but controlled the amount of distortion to achieve the desired result.

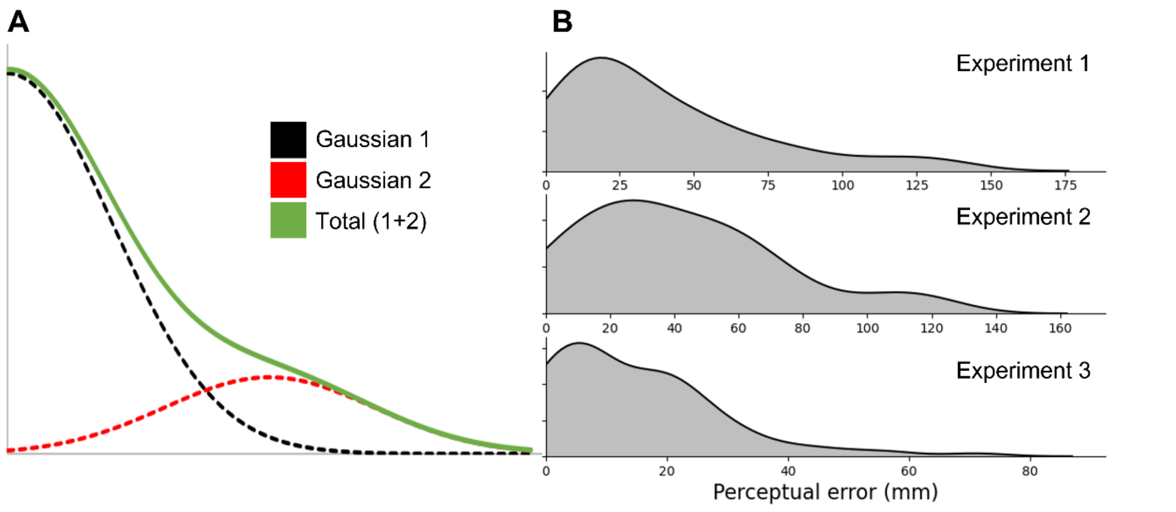

Figure D.2: *Distribution of perceptual errors can be approximated by two gaussian distributions. (A) simulation of the combination of two gaussian distributions. (B) Distribution of perceptual errors in each experiment.*

Overall, these results are demonstrating a strong stability of the effect of the finger elongation suggestion across experiment, with seemingly an independence of pointing error responses to the suggested target elongation. The variation of responses with different suggested targets warrants attention alongside the seemingly bimodal nature of the response distribution.

2.2. Hypnotic suggestibility

Hypnotic suggestibility is considered as the trait-like ability to respond to hypnotic suggestions (Laurence et al., 2008) and it is measured as the number of suggestion one responds to in a standardised test (e.g. Bowers, 1993; Shor & Orne, 1963). In every study we reported correlation between perceptual error and hypnotic suggestibility: r=.32, 95% CI=[.05; .55], p=.02; r=.37, 95% CI=[.12; .58], p=.005; r=.30, 95% CI=[.22; .38], p<.001, in experiment 1, 2 and 3 respectively. Correlations between pointing error and hypnotic suggestibility were: r=.22, 95% CI=[-.07; .47], p=.13; r=.43, 95% CI=[.19; .63], p<.001; r=.37, 95% CI=[.32; .42], p<.001, in experiment 1, 2 and 3 respectively. While the WSGC (Bowers, 1993; de Saldanha da Gama et al., 2012) was used in experiment 1, the online SWASH was used in experiment 2 and 3 (Apelian, Annex 3; Lush et al., 2018; Palfi et al., 2019) and it was corrected for compliance using subjective ratings (see Annex 3). This explains the discrepancy between correlations obtained in the first experiment and the other two. Apart from these variations, we can conclude that hypnotic suggestibility robustly correlated with the effect of the finger-elongation suggestion. This result empirically supports the claim that the finger-elongation hypnotic suggestion can be considered a "*classic suggestion effect [that is, a genuine hypnotic effect]*" (Bowers, 1982, p. 6; Woody & Barnier, 2008).

2.3. The finger-elongation suggestion effect is not mere compliance

The question of whether hypnosis is simply due to compliance, lying and faking is considered a long solved issue in the field of hypnosis (McConkey, 2008). Nonetheless, when investigating a new hypnotic phenomenon, one should provide evidence against a "mere compliance" interpretation. In experiment 1, the effect of hypnotic suggestion was weakly and non-significantly correlated with the effect of the sham illusion. Moreover, these effects were systematically weaker than the correlation of the sham illusion with the Lackner illusion. The results of the experiment described in Annex 2 are also indicating that participants do not comply to the experimenter's communicated expectancies. Also, in all experiments, we found no trace of a *categorical responses* where some participants comply with the suggested target elongation, and other do not; rather we found a continuum of responses. Together, these results indicate that participants had genuine perceptual alterations following hypnotic suggestion.

2.4. Imagery instruction replicates suggested effects

Imagery instruction replicated all effects of hypnotic suggestion for finger-elongation with only a slightly smaller effect. This indicates that participants can autonomously generate perceptual alteration of body-size perception using imagery without an induction ritual or reliance on the hypnotist. However, voluntary use of imagery did not significantly predict the amount of perceptual elongation reported, contrary to spontaneous imagery use. Interestingly, this was the case in both the hypnotic suggestion and the imagery instructions conditions. This suggests that both conditions might share a common mechanism recruiting spontaneous imagery. This is further supported by the strong correlation between hypnotic suggestion and imagery instruction effects on both tasks. Overall, these results suggest that modulation of perceived body-size can be achieved with or without hypnotic context, in autonomy, and that it likely involves spontaneous imagery rather than voluntary imagery use.

We will now provide a general view of the plausible mechanism at play in hypnotic suggestion for modulating body-size perception.

3. THEORETICAL ACCOUNT OF HYPNOTIC SUGGESTION FOR ALTERING BODY-SIZE PERCEPTION

In this section, I will attempt to bring together the insights we gathered in the previous chapters with the literature on hypnotic hallucinations to provide a plausible picture of the mechanisms underlying hypnotic suggestion for altering body-size perception. This tentative model is meant to provide testable hypotheses for future studies and to spell out general intuitions about this phenomenon. This section is organised as a progression through the various levels of explanation, from the social to the physiological.

3.1. The socio-cultural level

The practice of hypnotism rests on the social interaction between two individuals, one assuming the role of the hypnotist and the other the role of the hypnotised subject. Hence, a theory of any hypnotic phenomenon should address the weight of social factors and how they shape its expression. We can first highlight one experimental result drawn from experiment 2: self-generated alteration of body-size perception (non-social) was almost as efficient as the experimenter-hypnotist driven procedure (social). It means that the actual interaction between the hypnotist and the participant is not a necessary condition for this hypnotic phenomenon. This is old news, as hypnotic phenomena can be produced in autonomy, a practice called autohypnosis or self-hypnosis, well-documented for a long time (Barber, 1957; Ruch, 1975; Salter, 1941). Nonetheless, this does not mean that social factors are marginal even if they are often put aside (Cardeña & Krippner, 2010; Champigny & Raz, 2015).

In particular, the word "hypnosis" is culturally loaded, and defining the procedure as "hypnosis" sets the attitude of the hypnotised individual. Broadly, the representation of hypnosis in a given culture has a certain valence and credibility associated to it, setting respectively motivational factors and expectancies.

In addition, culture also dictates privileged modes (norms) of responding. This is illustrated by hypnotised individuals closing their eyes and lowering muscular tonus in a *simulacrum* of slumber, despite being told that hypnosis is different from sleep. Hypnotised individuals are not only responding to the suggestions of the hypnotist, but foremost to the cultural norms of hypnosis as stressed by sociocognitive theorists (Lynn et al., 2008; Wagstaff, 2004).

How does it relate to hypnotic alteration of body-size perception specifically? Values, beliefs and norms about the body, and how the experience of the body can or cannot be changed are likely to have a significant impact on how participants respond to hypnotic suggestion for altering body-size perception. This might also be true if one changes the target of suggestion from the finger, selected in our studies to be value-neutral, to value-loaded body-parts such as the belly. Nonetheless, we can only suppose these effects as they were not investigated in our work.

3.2. The explicit level: cognitive-behavioural strategies

Inquiry into the experience of hypnotised subjects revealed that often, despite appearance, they are not passive. Rather, they actively try to bring about the suggested experience. Doing so leads to higher hypnotic responsiveness indexed by standard scales (for a review: Gorassini, 2004). While some authors described general pathways to implement suggestions (Gorassini, 1999; Spanos, 1986), and others controlled for unwanted strategies in their studies (Raz et al., 2003), research on cognitive-behavioural strategies for enacting specific suggestions is scarce. Nonetheless, initiatives such as the one proposed in Annex 1 (see also: Galea et al., 2010) highlight the importance of better studying what successful hypnotised participants *do*. Indeed, the highest gains in responding have been obtained through cognitive-behavioural training such as the Carleton Skill Training Programme (CSTP; Gorassini, 2004; Gorassini & Spanos, 1999) which is based on changing explicit actions.

In this thesis we did not examine systematically the strategies used by participants. Nonetheless, experiment 2 gives some insights on that matter. Participants instructed to imagine their finger growing longer for 60 seconds had a significant perceptual and pointing errors similar to hypnotic suggestion (although lower in magnitude). Imaginative strategies thus seem at first glance to be efficient in producing alterations in body-size perception. However, self-reported use of *voluntary* imagery did not predict perceptual error, but *spontaneous* imagery did. This is in line with results obtained on other hypnotic phenomena (Comey & Kirsch, 1999; Hargadon et al., 1995; for a review: Terhune & Oakley, 2020). Therefore, voluntary imagery use *per se* does not seem to be a relevant strategy for altering body-size perception. Participants might be using strategies for eliciting spontaneous imagery, but this was not investigated in our work.

In addition to strategies aiming at perceiving a distorted body-part size, participants likely used strategies to mitigate the effect of sensory and cognitive factors. Indeed, it is likely that participants adopted an attitude where correct perception is less valued than perceiving what is suggested. Otherwise, we could expect them to rely more heavily on prior knowledge for correcting their perceptual reports. Moreover, in the vision conditions of experiment 3 participants had all the information needed to perform perfectly in the line reaching task (if we exclude rare potential cases of visual hallucination). Nevertheless, they still displayed a significant pointing error. This means that they refrained from using available evidence. This attitude can be compared to the attitude one has when immersed in a movie or video game, where cognitions and sensory cues that are "spoiling the fun" are set aside, such as thinking that the character is actually an actor, or paying attention to your neighbour eating popcorn. This is akin to a strategies of "not questioning" (Gorassini, 1999) or "reduced critical thinking" (Brown et al., 2001) that were shown to improve response to suggestion (although the evidence is tentative). In other words, if participants' concerns where to change, for instance if a reward was offered for correct perception, it is likely that the magnitude of the perceptual error would be greatly reduced or suppressed entirely.

Nonetheless, explicit strategies used cannot explain everything. Indeed, to continue our comparison, one can endorse an attitude *facilitating* immersion in a movie, but implicit factors ultimately determine if we are hooked or not (e.g. the salience of distractors).

3.3. The implicit level: a mechanistic view

This thesis was focused mainly on implicit mechanisms, in line with most recent theories of hypnosis (Barnier, Dienes, et al., 2008; Jamieson, 2016; Martin & Pacherie, 2019). Our theoretical model posits that hypnotic alteration of body-size perception rests on several key elements: motivation, epistemic attitude, expectancies, imagery, and source monitoring. Motivation and epistemic attitude (introduced in the last section) are necessary but not sufficient conditions. Indeed, previous studies have shown that the absence of motivation prevents response to suggestion, but high motivation does not guarantee high responsiveness (Barber, 1969; Hawkins & Bartsch, 2000; Spanos et al., 1987). Epistemic attitude is an understudied aspect of hypnosis, despite being present in the theoretical landscape for more than half a century (Sarbin & Allen, 1968; Sarbin, 1950). Beyond these two enabling conditions, let's turn to constitutive elements of the mechanism.

3.3.1. Expectancies

Expectancies have been proposed to be the main determinant of hypnotic responding, explaining both responsiveness to suggestion and the marginal increase offered by hypnotic induction according to Kirsch's theory (Kirsch, 1985, 1991, 1997, 2000b, 2001b; Lynn et al., 2008). Experimental literature confirms part of the theory (Braffman & Kirsch, 1999), but it tempers the strong claim that expectancies is the main determinant (Benham et al., 2006). Indeed, in Benham et al. (2006) study, participants were asked to report expectancies after several groups of suggestions. What was found is that expectancies remained stable throughout the experiment, receiving a small contribution from success/failure of the previous group of suggestions (standardised β around 7-8%). Moreover, responsiveness to each group of suggestion was only moderately predicted by prior expectancies (β~10-13%) and more strongly predicted by a general factor representing hypnotic ability (β~around 39-68%). One could be worried that expectancies measured in these studies are inducing biases. Indeed, it has been shown that participants tend to be sensitive to the hypothesis being tested (Council et al., 1986; Holman et al., 2015; Orne, 1962b). For example, Council et al. (1986) showed that previously reported correlation between absorption and hypnotic suggestibility vanished when they were measured in independent contexts. Modification studies have tried to increase expectancies with verbal, experiential and placebo manipulations (Benham et al., 1998; Glass & Barber, 1961; Spanos et al., 1990; Wickless & Kirsch, 1989), but results are inconsistent, with some studies showing tremendous improvement in hypnotic responding and other no significant effect. Taken together, these studies indicate that expectancies are likely to play a role in hypnotic responding, but the extent of this influence might depend on uncontrolled variable and cannot explain single-handedly response to hypnotic suggestion.

Beyond response to suggestion, expectancies have been demonstrated to largely *shape* the outcome of suggestions. For instance Cardeña & terhune, (2019) showed that, following neutral hypnosis procedure (i.e. without explicitly suggesting a specific experience), the content of experience was partly determined by prior expectancies (see also Henry, 1985 cited in Lynn et al., 2008). In the same vein, Spanos and colleagues (Spanos et al., 1983; Spanos, Flynn, et al., 1988; Spanos & Hewitt, 1980) demonstrated that they could manipulate hidden observer phenomena (discussed in the introduction, p.22) making the "dissociated part" respond in ways that participants were led to expect.

In our second experiment (Chapter 2), self-reported expectancies correlated with the magnitude of the perceptual error (in the range of r=.4), interestingly expectancies remained a significant predictor of perceptual error when correcting for hypnotic suggestibility (accounting for about the same proportion of variance). However, the experiment presented in Annex 2 shows that expectancy manipulation was unable to influence the link between measurements in our tasks contrary to hidden observer manipulation experiments. This means that if expectancies are the *steering wheel* of suggestion, body image was the primary target and body schema followed mechanically without further influence of expectancies. The role of expectancies on body image can be described using the concept of perceptual inference.

3.3.2. Perceptual inference as a framework for expectancy effect

Perceptual inference is a concept that can be traced back to the work of Helmholtz (1867) who proposed the idea that perception is a form of unconscious inference. In this view body image is a perceptual hypothesis tested against sensory data. This hypothesis is derived from prior knowledge (i.e. general statistical regularities acquired from the history of the organism) and from contextual expectancies (i.e. exception to the general pattern that are anticipated). The hypothesis is adapted to minimise discrepancy with sensory data. Different models of perceptual inference exist, but those based on Bayesian inference (Colombo & Seriès, 2012; Kersten et al., 2004; Knill & Richards, 1996; Maloney & Mamassian, 2009), and more specifically on predictive coding (Clark, 2015; Friston & Kiebel, 2009; Hohwy, 2013; Rao & Ballard, 1999) have been particularly influential on theoretical models in cognitive science in general, and in hypnosis in particular (Jamieson, 2016; Martin & Pacherie, 2019). When sensory signals are precise, coherent and reliable, they guide model selection (i.e. perception). Conversely, when sensory signals are noisy, incoherent or unreliable (e.g. seeing at night, or earing in a noisy crowded station), model selection is primarily based on expectancies (i.e. model likelihood). In most of our experiments, sensory signals providing relevant information about finger-length were absent. Hence, the perception of finger-length was mainly shaped by prior knowledge and expectancies.

3.3.3. *The role of hypnotic suggestibility*

It is likely that hypnotic suggestibility reflects individual ability to ascribe more weight to expectancies compared to prior knowledge, giving them higher perceptual flexibility (see for example: Dienes et al., 2020). In one experiment Martin an colleagues (2018) showed that previously found higher reversal rate of the Necker cube for highly suggestible individuals (Crawford et al., 1993a; Wallace, 1986; Wallace et al., 1976) was actually highly dependent on expectancies. Highly suggestible participants expecting to perceive the Necker cube flipping frequently had high reversal rate (coherently with previous studies), while those expecting the cube to remain in the same perspective had as little reversals as medium and low suggestible individuals. In that case, faced with the same perceptual signals, highly suggestible individuals had higher flexibility in their perceptual experience, and it was directly influenced by expectancies. Our results obtained in all experiments are in line with this view. However, when perceptual signals are incompatible with suggestion, as in experiment 3, hypnotic suggestibility did not protect against sensory cues. Therefore, hypnotic suggestibility does *not* seem to be a tendency of individuals to put higher weight on prior expectations rather than on sensory evidence like hypothesised by Martin and Pacherie (2019). Rather it seems to be an ability to “bracket” prior knowledge and adopt novel expectancies. In that, it is less a matter of being locked in stable mental models, and more about seeing the world in a different light.

Let’s summarise these sections focussed on expectancies. Perceptual inference is a credible framework in which expectancies and prior knowledge are tested against sensory data. When sensory data are absent or ambiguous (as in most of our experiments), expectancies and prior knowledge prevail. Conversely, when they are precise and reliable, internal models (expectancies and prior knowledge) are updated on the basis of relevant sensory data. Hypnotic suggestibility seems to allow individuals to put more weight on contextual expectancies compared to the long-term prior knowledge. This ability might be only used if a certain epistemic attitude, comparable to immersion in fiction (book, movie, game, etc.), is called forth, which in turn is resting on motivational factors.

The model presented so far can account for our experimental data when sensory cues were absent, but it struggles to explain why the finger-elongation effect persisted when cues were present. In this case sensory data should suppress *all* suggested effect since they *unambiguously* support a normal finger-length model. It is therefore difficult to argue that expectancies are so precise that they are maintained in the face of disconfirming evidence. In the following sections, we will first consider a possible way to circumvent this problem by considering attention. After showing why we find this explanation unconvincing, we will develop the idea (introduced in chapter 2) that imagery confounded for perception can serve as justification for expectancies.

3.3.4. Attention

Attention could be one possible workaround to the problem of maintenance of the suggested effect in the presence of relevant sensory cues. Indeed, if individuals pay little attention to relevant sensory cues, the problem disappears altogether. This seems rather unlikely for two reasons. First, studies testing the link between various dimensions of attention and hypnotic responding are highly inconsistent. Some have found no significant association between hypnotic suggestibility and various attentional tasks (Cojan et al., 2015; Dienes et al., 2009; Egner et al., 2005; Iani et al., 2006, 2009; Raz et al., 2005b; Varga et al., 2011), and when significant differences are found, they go in either direction with no consistent trend (Crawford et al., 1993a; Dixon & Laurence, 1992; Farvolden & Woody, 2004; Martin et al., 2018; R. J. Miller, 1975; R. J. Miller et al., 1973; Rubichi et al., 2005; Wallace et al., 1974, 1976; Wallace & Garrett, 1973). Second, sensory cues in experiment 3 were highly salient. In particular, vision of the target finger lasted for several minutes (~10min), and participants were required to watch it for the whole duration of the condition. That would require (dis-)attentional abilities exceeding what can be reasonably expected from unselected participants. Therefore, it seems unlikely, though not impossible, that participants manage to maintain the suggested effect in presence of relevant sensory cues using only attention. We will now move to detail how imagery and source monitoring processes offer a more satisfying solution.

3.3.5. *Imagery, source monitoring and hypnotic hallucinations*

Cognitive theories of hypnotic hallucination converge on one point: they are the product of imagery taken for perception (Barnier et al., 2008; Jamieson, 2016; Woody & Sadler, 2008). However, they differ in the mechanisms they invoke to explain *how* this happens. For instance, in discrepancy-attribution theory (Barnier, Dienes, et al., 2008; Barnier & Mitchell, 2005), the ease of producing mental images during hypnosis (i.e. imagery fluency) results in a mismatch between the expected and actual effort. This difference is then attributed to the reality of the imagined object. Conversely, though not incompatible, the COLD control theory of hypnosis (Barnier, Dienes, et al., 2008; Dienes et al., 2020; Dienes & Perner, 2007) argues that hypnotic hallucinations are the result of a relinquishment of metacognitive abilities. In this case, the individual lacks high order thoughts (Rosenthal, 2006; Rosenthal & Weisberg, 2008) about his/her intention to imagine. Furthermore, the dissociated experience theory of hypnosis (Woody & Sadler, 2008) argues for a dissociation between executive control and monitoring functions (Norman & Shallice, 1986) to explain hypnotic hallucinations. In this view, executive control functions normally, but the failure to monitor the construction of mental images leads to the experience of hypnotic hallucination. Regardless of the mechanism invoked, these theories provide interesting accounts of the lack of agency for imagery, but they fall short of explaining why the phenomenology of hypnotic hallucinations is different from mere spontaneous imagery.

Indeed, as discussed in the introduction of this thesis (see p.38-40) individuals can experience hypnotic hallucinations without endorsing the reality of their perceptual experience, yet it appears as real (Kallio & Revonsuo, 2003; Tellegen, 1978). For example, an individual can experience heaviness in his/her hand with the "hand lowering" suggestion (Bowers, 1993) and know that there is no heavy object in his/her hand, nevertheless the feeling of heaviness is perceived as something "*in the world*", not as spontaneous imagery. Woody and Szechtman (2000a, 2000b, 2007) contended that the crucial feature of hypnotic hallucination is a metacognitive feeling. Indeed, it have been conceptualised as the feeling of presence or feeling of reality (Dokic & Martin, 2017). This feeling of reality can lead to false belief, but not necessarily, for example it has been show that virtual reality can elicit this feeling, but individuals are well aware that they are in a virtual environment (Sanchez-Vives & Slater, 2005). The lack of such a feeling is believed to be involved in a variety of psychopathologies such as in depersonalization / derealization disorder wherein patients report that the world (individuals and objects) or one's thoughts, feelings, body or action are fake, unreal, dreamlike or they appear as detached, foggy and numb (Dokic & Martin, 2017; DSM-5, 2013, p. 231). In the case of hypnotic (positive) hallucination, the reverse is occurring: imagery is associated with a feeling of reality that is unusually high. In this case, hypnotic hallucinations are not so much a matter of high-order thoughts, but rather low-level metacognitive feelings.

This raises the question of how this feeling of reality about mental images comes to be increased in hypnotic contexts. Woody and Szechtman (2007) posit that contextual cues present in hypnosis (but not restricted to this context) engage responses pertaining to dominance hierarchy wherein the hypnotised subject assumes the position of subordinate. They contend that this position leads the hypnotised individual to accept uncritically the communication of the hypnotist as true, placing him/her in a position of epistemic authority (Zagzebski, 2012). However, as argued above, this is unlikely to explain the effect we observed, as participants could generate it in autonomy (see chapter 2). In contrast, we do not think that individuals possess a privileged access to their own intentional states. Rather, when needed, these states are *inferred* and at times this process can fail (a view shared at a time by Bowers, 1990). This is supported by several studies showing that individuals are notoriously bad at introspecting their cognitive processes (Nisbett & Wilson, 1977). In particular, they can perform free choices based on personal preference and only a moment later justify a choice they did not make (choice blindness; Hall et al., 2013; Johansson et al., 2005, 2006, 2014). This indicates that there is probably no need to invoke dominance mechanisms to explain increased feeling of reality. The narrative about hypnosis might be enough.

In the case of hypnotic suggestion for modulating finger-length perception, imagery serves as justification for expectancies. In everyday cases, merely visualising that you are Usain Bolt, does not raise your expectancies relative to your running performance. However, in the context of hypnosis, several factors can make imagery seems like perception. First, spontaneous imagery, that is to say imagery for which no feeling of *agency* is present, is a necessary condition for being mistaken for perception. In experiment 2 we showed that voluntary imagery, in line with other studies (Comey & Kirsch, 1999; Hargadon et al., 1995), did not predict hypnotic response. This seems to be a sensible criterion to ensure that self-generated perceptual states are kept "offline" and do not interfere with other processes. Second, imagery vividness could be an important factor leading to confusion with perception. Imagery and perception have been shown to recruit overlapping neural networks (Dijkstra et al., 2019), and that the amount of overlap is correlated with vividness of imagery (Dijkstra et al., 2017). Therefore, it is reasonable to expect vividness of imagery to be a significant factor in confounding imagery and perception. Results drawn from the literature on hypnosis provide hints in this direction, with correlations between imagery vividness and hypnotic suggestibility (Glisky et al., 1995; Marucci & Meo, 2000; Sheehan & Robertson, 1996; Spanos, Stenstrom, et al., 1988) although the direction of causality (if any) is still unknown. Alongside, I would speculate that multisensory imagery leads to more confusion with perception than unimodal imagery. However, this is based on personal experience and discussion with some participants, so caution is advised. Fourth, as discussed above (Woody & Szechtman, 2007), a feeling of reality superior to what is expected of regular imagery could, on its own, cause imagery to be considered as perception. Therefore, an individual having a spontaneous vivid image accompanied by a feeling of reality superior to regular imagery would probably mistake it for perception.

Moreover, some sensory modalities would probably more readily fool source monitoring than other. We are indeed used to fantasise in our daily life using visual and auditory imagery, but cases where we use somatosensory or gustative imagery are rare. It is tempting to speculate that source monitoring is better at distinguishing auditory imagery from audition than distinguishing gustatory imagery from taste perception. That would explain why passing rate of the "taste hallucination" suggestion are much higher than the "music hallucination" suggestion in standard scales (de Saldanha da Gama et al., 2012a). In our case, it means that strategies relying on sensorimotor imagery would be easier than those based on visual imagery (some preliminary unpublished data were obtained in that direction).

To summarise, individual traits, abilities and contextual factors concur to generate spontaneous, vivid imagery that feels “real”. Source monitoring fails to recognise imagery for what it is and therefore, imagery taken for perception end up serving as justification for suggested expectations. In the next section we will briefly touch on plausible neural substrate for such a mechanism.

3.4. The neural level

The neural level lied outside the scope of our studies, nonetheless several brain imaging studies both in the field of body representations and hypnosis hint at the possible neural underpinning of body-size modulation by hypnotic suggestion. This section is only an extrapolation of these studies and should be considered as a best guess estimation before proper neuroimaging studies are conducted.

First, if body image is indeed modulated by hypnotic suggestion as we argued throughout this thesis, we can expect some overlap with the neural basis of the Lackner illusion. Ehrsson and colleagues (2005) conducted a functional magnetic resonance imaging (fMRI) study in which they elicited the Lackner illusion by vibrating tendons located in the wrist of both hands. The hands were either in contact with the waist or not, presenting a meaningful contrast where only waist size modulation (shrinking in this study) varied. What was found is a significantly larger activation in cortices lining the left postcentral sulcus and the anterior part of the intraparietal sulcus. Moreover, the magnitude of the activity (regional blood flow) correlated with the reported amount of shrinking. We can expect these parietal regions to be recruited during the body-size perception modulation induced by hypnotic suggestion. If not, it would be a challenge to our claim that we modulated body image in our experiments. The challenge would be tentative, as inferring cognitive processes from neuroimaging is a perilous task (Poldrack, 2006).

Secondly, participants are using imagery during hypnosis, whether it plays a causal role (as we claim) or not (e.g. Pekala & Kumar, 2007). As brain activity in imagery overlaps to some degree with perception (Dijkstra et al., 2017; Hardwick et al., 2018; Schmidt & Blankenburg, 2019), we expect activity in the occipital region (extending to the parietal and temporal lobes) for visual imagery, including most probably part of the superior occipital gyrus (Brodmann’s area BA 19), part of the posterior cingulate gyrus (BA 30) and posterior temporal cortex (BA 37) (for more details see: Fulford et al., 2018). There are less studies focused on somatosensory imagery, but available evidence suggest that highest subarea of the primary somatosensory cortex (BA 2, but not BA 1, 3a and 3b) is active during somatosensory imagery (Schmidt & Blankenburg, 2019). Finally, motor imagery has been linked with activation in premotor parietal networks (BA 6) with subcortical recruitment of the putamen and cerebellum (Hardwick et al., 2018). The activation of these networks depends on the strategy participants are using, so inconsistent activation is to be expected if there is no strategy prescription.

Thirdly, the literature on the neural correlates of hypnosis gives some indications on additional networks that are likely to be involved. Landry and colleagues (2017, 2015) reviewed the neuroimaging literature on hypnosis and performed a meta-analysis. The activation likelihood estimation meta-analysis only revealed the lingual gyrus as a reliable correlate of hypnotic suggestibility (Landry et al., 2017), which was interpreted as likely indexing mental imagery. Nonetheless, the authors revealed that three large-scale networks are implied in most brain imaging studies on hypnosis: the central executive network, salience network, and default mode network. The central executive network is key in planning and anticipating response and has been shown to display increased activity in hypnosis. Interestingly, it is also involved in subjective appraisal of agency and authorship. This network (also known as: frontoparietal network) is composed of the dorsolateral prefrontal cortex and posterior parietal cortex. Modulations of the salience network in hypnosis likely denotes modifications in the processing of internal and external signals. Indeed, this network's function is to detect, sort and integrate relevant signals coming from the environment, cognition and the body. It involves the anterior insula, anterior cingulate cortex and subcortical regions, including the amygdala. The central executive and salience networks have been shown to exert complex feedback loop, with increased functional connectivity after hypnotic induction. Lastly, the activity of the default mode network, comprising the medial prefrontal cortex, posterior cingulate cortex, angular gyrus and medial temporal lobe, is reduced during hypnosis. It is usually associated with mind-wandering, task disengagement and internal attention often centred on autobiographical events. So deactivation of this network plausibly indicates reduction of self-centred frame of reference and engagement in an outward directed task.

It is likely that a similar pattern of activity would be present if brain imaging were performed during hypnotic suggestion for modulation of body-size perception. Yet, it would largely depend on the kind of control condition to which it is compared. We will now weave together explanations given at various levels to give a general picture of our theoretical account.

3.5. Bringing the different levels together

Hypnotic suggestion for modulating body-size perception is foremost an active process requiring the individual to understand what is expected of him/her. In other words, it is necessary that he/she represents what would be experienced if the suggestion takes hold, and that he/she is motivated to use hypnosis to reach that experience. Motivation and understanding are the enabling conditions: minimal levels are necessary but higher levels do not help in producing the suggested experience. Motivation and knowledge are directly linked with the cultural background of the individual and the interaction with the hypnotist. If hypnosis (or any label corresponding to that kind of activity in the individual's culture) is regarded as dangerous (negative valence) or as quackery (low credibility), participant's motivation will suffer. The interaction with the hypnotist provides an opportunity to modulate cultural priors. Indeed, induction procedure starts with an introduction where counterproductive ideas (fears, myths, etc.) are addressed. In addition, performing an induction protocol can give a favourable context leading to positive expectations, although it is not necessary.

If motivation and understanding are secured, the second stage can ensue. Participant's expectancy that body-size perception is about to change competes with prior knowledge. Several factors will determine the outcome of this competition: attitude, hypnotic suggestibility, sensory signals, and imagery. First, if the individual has an attitude aiming at maximising truth, prior knowledge is guaranteed to outweigh suggested expectancies. A more fruitful attitude would be to immerse oneself into the suggested reality similarly to a spectator immersed in a movie, not questioning the fictional frame. At the implementation level, expectancies and attitude depend mostly on the activity of the dorsolateral prefrontal cortex for anticipation and maintenance of task-relevant responses. Second, hypnotic suggestibility allows participants to favour expectancies at the expense of prior knowledge. This arbitration is most likely performed by the salience network, and in particular the dorsal part of the anterior cingulate cortex. Third, sensory signal, when relevant to body-size, provide evidence in favour of no modulation (i.e. failed suggestion). In this case, expectancies alone should be unable to shift the perceived body-size beyond the accuracy of the available sensory modality. Finally, imaginative strategies are implemented to further shift the balance between prior knowledge and expectancies in favour of the latter and to counter sensory evidence. These strategies are either the result of direct instruction, implied meaning of suggestion or cultural norms about behaviour in hypnosis. In any case, our data show that voluntary imagery fails to provide evidence for the suggested effect. Conversely, spontaneous imagery can be mistaken for perception and improve response to suggestion. This effect is probably enhanced by vividness of imagery, multimodality, and feeling of reality. Imagery taken as perception provides evidence for expectancies, resulting in altered body-size perception.

This depicts a coherent picture where abilities (hypnotic suggestibility), attitude (immersion), and strategy (imagery) are coordinated with expectancies to achieve a perceptual shift in body-size.

4. CONCLUSION

Experimental work conducted during this thesis provide credible evidence that hypnotic suggestion can influence body-size representations, and that this effect is reliable and robust to relevant sensory cues. Importantly, this was the case at the perceptual level (body image) but also at the sensorimotor level (body schema). The near equivalence with imagery instruction reveals that the induction procedure, the identification of the procedure as “hypnosis” and the communication style typical of suggestion have altogether only a small effect on response to this suggestion. Integrating our results within the literature on hypnosis, we could derive a plausible mechanistic model. In our view, expectancies are the driving factor, likely supported by the dorsolateral prefrontal cortex. Predictions issued from these areas are competing with prior knowledge about body-size. Sensory data provide evidence in line with prior knowledge, while imagery mistaken for perception provide evidence for suggested expectancies. This error in source monitoring, we contend, results from a reduction in agency of imagery. The salience network is expected to play a key role in integrating these various sources (expectancies, prior knowledge, and perception). Hypnotic suggestibility in this framework would bias this integration in favour of top-down expectancies issued by the dorsolateral prefrontal cortex. One of the main implications of this work is that cognitive factors can have a greater influence over basic bodily representations than generally expected.

ANNEX 1: MOVEMENT SPEED AND SUGGESTION REDUCE THE SENSE OF AGENCY IN THE "HAND MOVING TOGETHER" ITEM

This section presents *preliminary unpublished* study. One of the most iconic effect of suggestion is reduction of the feeling of agency (Kihlstrom, 2008); and one of the most iconic and accessible suggestion is the "moving hands together" item of the SSHS:C (Weitzenhoffer & Hilgard, 1962). In this suggestion participants hold their hands with the palms facing each other about 30cm apart, and they are told that a force will pull the hands together. However, it is striking to observe that participants responding to such a suggestion are moving their hands at a slower pace than normal. One could only wonder if the reduction of the feeling of agency over this movement is the result of the mode of communication (i.e. suggestion rather than instruction), or if it results from performing the movement at a slower pace. To assess their relative influence on the feeling of agency, we performed an online experiment where participants performed several movements at a prescribed pace, with either instruction or suggestion.

Our results suggest that direct verbal suggestion reduces the self-reported feeling of agency in the "moving hands together" item of the SSHS:C (Weitzenhoffer & Hilgard, 1962) compared to instruction to move the hands together when movement speed of the hands is controlled. We also show promising results showing that slow movements reduce the sense of agency for hand movement independently of the mode of communication (instruction or suggestion). On a practical level, individuals failing to experience motor suggestions can alternatively use slow voluntary movements to reach similar levels of agency.

These preliminary results suggest that using suggestion leads to a reduction of the feeling of agency independently of movement speed, but that moving slowly is also an effective strategy to that end.

5. METHODS

5.1. Design

Each participant performed six times the same movement (moving hands together) either following suggestion or instruction to do so, at three prescribed speeds (0.25; 1; 4.29 $cm.s^{-1}$). In each case, a video of two pictograms was played on screen, moving at the prescribed speed to guide participants. After each condition participants filled a questionnaire to assess the level of agency they felt during the movement. The order of conditions was counterbalanced and randomized. Actual speed was evaluated by asking participants to report the distance separating the hands at the end of the condition and if zero, the time at which the hands touched.

5.2. Agency questionnaire

The agency questionnaire was inspired from the Sense Of Agency Rating Scale (Polito et al., 2013) and the Sense Of Agency Scale (Tapal et al., 2017) and was *not validated*. The six items of this questionnaire were:

- *"J'ai fait le mouvement de manière volontaire"* (I performed the movement voluntarily)
- *"Je contrôlais le mouvement"* (I did not control the movement)
- (R) *"Je n'ai PAS l'impression d'être à l'origine du movement"* (I do NOT feel that I am the author of the movement)
- (R) *"Le mouvement s'est fait tout seul"* (Movement occurred on its own)

- (R)*"Le mouvement s'est fait spontanément, par lui-même"* (Movement occurred spontaneously, on its own)
- (R)*"C'est comme si le mouvement était contrôlé par quelqu'un d'autre ou quelque chose d'externe"* (It is as if the movement was controlled by someone or something external)

(R) indicates that the questions are reverse-scored. Participants rated each question using a Likert 7-point scale (1-7) from "completely disagree" to "completely agree". Questions are averaged and scaled to [0; 1]. This questionnaire has excellent internal consistency α=.92 and its proximity with validated scales makes it a credible measure of agency for a pilot study.

5.3. Instruction / suggestion scripts

Instructions for moving hands together were given through a recorded audio following this script:

"Dans cette partie, il vous est demander de rapprocher vos mains, de façon à ce qu'elles se touchent au bout de 2 minutes. Pour vous aider, deux images de mains vont se rapprocher à l'écran à la bonne vitesse. Commencez à rapprocher vos mains lorsque le bip retentit, et arrêtez-vous lorsqu'il retentit de nouveau."

(In this section, you are asked to move your hands together so that they join after X seconds. To guide you, two hand pictograms will be moving on screen at the right speed. Start moving your hands when you hear a "Bip" sound played, and stop when you hear it again)

Suggestion for moving hands together was given in the same manner:

"Dans cette partie, vos mains vont se rapprocher l'une de l'autre sans que vous n'ayez quoi que ce soit à faire. Lorsque le bip retentira, vous sentirez une force qui agit sur vos mains et qui les forcera à se rapprocher, comme si les mains s'attiraient. Et en pensant aux mains qui se rapprochent, vous vous rendrez compte que les mains commenceront à se déplacer l'une vers l'autre, d'elles-mêmes. Les mains se rapprocheront à la même vitesse que les images de mains à l'écran, à la bonne vitesse. Et elles se

toucheront au bout de 2 minutes. Alors, préparez-vous à sentir vos mains se rapprocher quand le bip retentira."

(In this section, your hands will move together without you having to do anything. When you will hear a "Bip" sound played, you will feel a force acting upon your hands, forcing them to join, as if they were attracted. And by thinking to the hands moving together, you will notice that the hands will start to move, by themselves. The hands will move together at the same speed than the pictograms on screen, at the right speed. The hands will join after X seconds. So, brace yourself as you will feel your hands moving together when the "Bip" sound plays.)

In these scripts, "X" was replaced with the duration of the condition (120 / 30 / 7).

5.4. Procedure

This experiment was conducted online using Google form and lasted 25 minutes. Each participant completed six conditions corresponding to: mode of communication (instruction / suggestion) x requested speed of the hands (120s / 30s / 7s). Order of conditions was pseud-randomized, so that each possible order had the same number of participants. At the beginning of each block, participants received instruction to place their hands with palms facing each other about 30cm apart. A video of the experimentalist demonstrating the position was played at the beginning of the experiment. Then instruction or suggestion was given for moving hands together with an indication regarding the time for the hands to join (120s / 30s / 7s). The instruction / suggestion mentioned that the movement was to begin when a "bip" sound was played, and to stop when the same sound was played again after 120 / 30 / 7 seconds. Participants were instructed to look at the screen where pictograms of hands were moving at the instructed speed and a timer indicated the elapsed time since the first "bip". If participant's hands were to join before the end of the condition, they were instructed to remember the time (indicated by the timer) when their hands touched. If their hands did not touch when the second "bip" played, they were instructed to report the distance separating the hands. With these data, we could control the actual speed during each condition. After the task, participants answered questions relative to their experience to assess the level of agency felt during the movement.

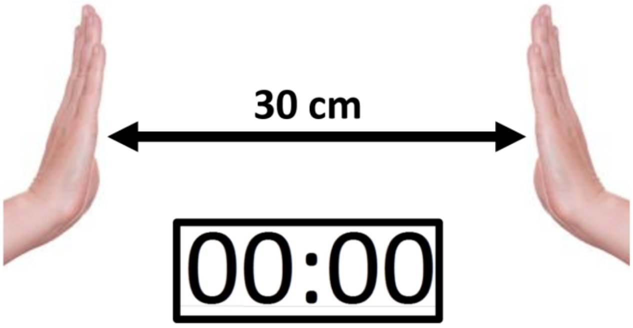

Figure 1: *Capture of the beginning of the video played in each block. Distance indication disappears when the first "Bip" is played, and the chronometer is started. Then, the hand pictograms move at the instructed / suggested speed.*

6. RESULTS

6.1. Sample description

52 participants completed the experiment, with 26 male and 26 female participants with a mean age of *M*=42.8 year, *SD*=9.7. All gave informed consent, and none reported any physical or mental disorder. Age and sex had no influence on agency ratings.

6.2. General data description

Figure A1.2 show an overall description of the data where one can visually perceive the reduction in the self-reported feeling of agency with both speed and mode of communication (instruction / suggestion).

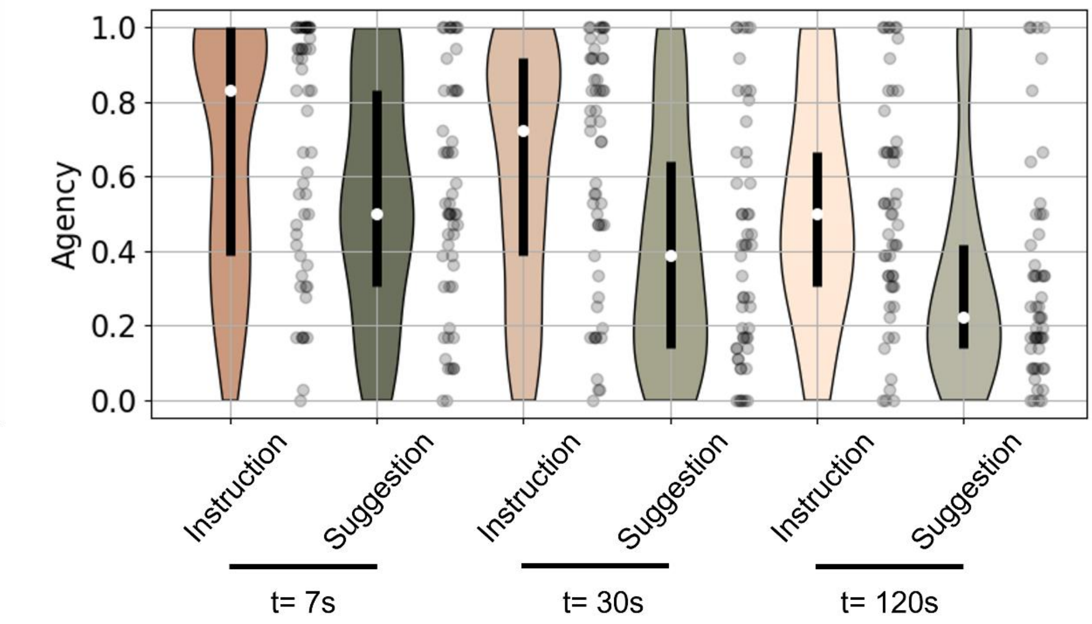

Figure 2: *Violin plots of experimental data (N=52). Distributions reflect kernel density estimation plots and markers reflect individual measurements. Central black lines represent the interquartile range and the white dots the median error in each condition.*

One confound in data presented in Figure 2 is that not every participant moved at the requested speed. Indeed, Figure 3 shows that many did not move at all. In the following, rather than to analyse the effect of prescribed duration, we will instead use reports of actual speed. Figure 3 shows that many participants failed to comply with the instructed / suggested speed, resulting in residual distance at the end of the block. Unsurprisingly, many participants had no movement at all in some suggestion conditions, but one can notice that the longer the duration of the bloc, the more participant succeed in enacting the suggested movement.

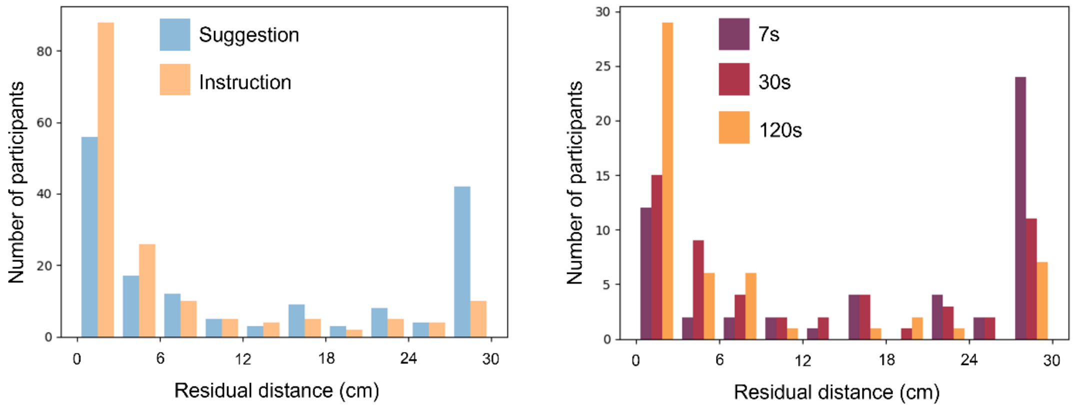

Figure 3: *histogram of the residual distance for a suggested or instructed movement (left) and for different durations in the suggested conditions (right).*

6.3. Effect of speed and mode of communication on agency ratings

We performed a mixed linear model to assess the effect of speed and mode of communication on agency ratings. Allowing for interaction did not significantly improve the model, $\chi^2(1,N=52)=1.96$, $p=.16$. Results are presented in Table 1 and show that suggestion decreases the feeling of agency for hand motion independently of speed, and that the slower the motion, the lower the feeling of agency.

Table 1

Best linear mixed effect model of agency (N=52)

	Agency ~ Mode of communication + Speed + (1|Participant)				
Fixed effects	Estimate	*SE*	95% *CI*		*p*
			LL	UL	
Intercept (Instruction)	**0.521**	**0.036**	**0.45**	**0.59**	**<.001**
Suggestion	**-0.218**	**0.029**	**-0.27**	**-0.16**	**<.001**
Speed ($cm.s^{-1}$)	**0.055**	**0.009**	**0.04**	**0.07**	**<.001**
			Within subject variance		0.04
			Residual variance		0.05

Notes. CI = confidence interval; LL = lower limit; UL = upper limit. Prescribed speed: s(7s)=4.286 $cm.s^{-1}$; s(30s)=1 $cm.s^{-1}$; s(120s)=0.25 $cm.s^{-1}$

7. CONCLUSION

In this experiment we found that the mode of communication (instruction or suggestion) and the prescribed speed of movement had a significant effect on the feeling of agency for moving hands together. Therefore, the classic motor suggestion effect is not confounded by speed. Nonetheless, leaving participants enough time to experience the suggestion seems to be an important factor in succeeding or failing this test suggestion. Following this idea, using different times windows could be a way to change the difficulty of this suggestion. Alternatively, one can circumvent inaction by instructing participants to move their hands slowly for individuals having issues with experiencing the suggestion.

ANNEX 2: EXPECTANCIES DO NOT CONFOUND THE EFFECT OF SUGGESTED FINGER-ELONGATION ON THE LINE REACHING TASK

This section presents unpublished results suggesting that the effect of the finger-elongation suggestion on the line reaching task used throughout this thesis is not confounded by expectancies. It is uncontroversial that some individuals can genuinely experience changes in conscious experience using hypnotic suggestions (for example see: Bryant & Mallard, 2005; Oakley, 2008; Terhune et al., 2017). However, one might be concerned that body schema indexed by the line reaching task is not really affected by the finger-elongation suggestion. Indeed, participants could index their response on their distorted body image (perceived length) based on the expectation that response on both tasks should be consistent. In this case, participants would be reinterpreting the instruction of the line reaching task ("match the position of line with your left index fingertip the best you can") as: "position your hand so that the fingertip would match the position of the line if the finger were as long as you perceive it". If it were the case, this would threaten the interpretation of many results of this thesis.

Hopefully, if the effect of the finger-size suggestion on the line reaching task depends on participants' interpretation of the task it should be highly sensitive to manipulation of expectancy. Hence, in this experiment we tried to manipulate participants' expectancies regarding the link between perceived finger-length and the line reaching task. Participants were led to think that a previous experiment demonstrated that individuals experiencing their finger longer as a result of hypnotic suggestion were biased towards pointing further than the line to reach (the opposite of what was observed in this thesis). They were told that the longer the finger was felt, the further individuals pointed beyond the line.

Our results suggest that the mean effect of hypnotic suggestion for finger-elongation was similar to a no-manipulation control group for both perceptual error and pointing error.

1. PROCEDURE

Participants were recruited thinking they would undergo two conditions. The first one was to be the control condition, presented as a replication of a previous experiment while the second one was to be the same condition with the lid of the box removed, as in Chapter 3. The second part of the experiment was not made, and only served to cover the manipulation. Upon arrival, the experimenter adopted a friendly demeanour and explained the context of the study. This was also done so that the manipulation appeared to flow naturally in the discussion. The tasks were then presented to the participant and the baseline measurements were done.

Immediately after that, manipulation was performed: participants were told that the next condition was a control condition replicating a previous experiment. The experimenter casually explained that he was surprised to find that the longer participants perceived their finger after hypnotic suggestion, the further they pointed in the line reaching task. While explaining, the experimenter demonstrated the movement in front of the participant to provide an example and ensure clarity.

Then the same induction and suggestion for finger-elongation as presented in Chapter 2 were performed, followed by measurements (finger length perception task and line reaching task) and de-induction. Then the experimenter asked the participant what he/she was expecting and if his/her results on the tasks were in line with the expectations. This was made to remove participants that did not believed in the manipulation. Finally, the experimenter revealed that the experiment was over and explained the real aim of the experiment and the need to use deception.

2. RESULTS

2.1. Sample

30 participants completed the experiment, with 3 male and 27 female participants, mean age *M*=39.7 year, *SD*=9.7. Post-experimental debrief revealed that 3 female participants understood that there was a manipulation and therefore were not deceived.

2.2. Comparison against non-manipulated participants

The 27 deceived participants were compared to the 82 unmanipulated participants of the experiment described in Chapter 2 (hypnotic suggestion condition). Bayesian independent sample two-tailed t-tests were performed using JASP (Love et al., 2019). The manipulated group was similar to the non-manipulated group on perceptual error B_{01}=4.065 (and odd ratio of 4:1 in support of identical means), Hedge's *g*=0.08 and on pointing error B_{01}=3.277, *g*=-0.18. Figure 1 presents descriptive statistics. These results indicate that there was likely no effect of the manipulation on perceptual and pointing errors. If anything, there is even a larger, though not significant, pointing error in the manipulated group.

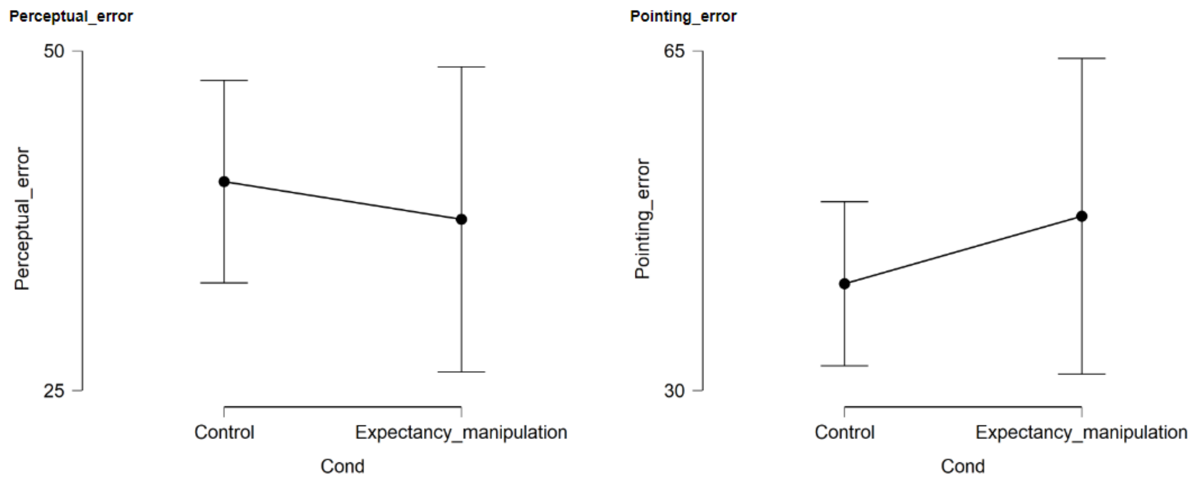

Figure 1: *Descriptive statistics for the manipulated and control groups.*

2.3. Comparison of perceptual and pointing errors correlations

We then computed the correlation of perceptual and pointing errors for both the manipulated and control group. As reported in Chapter 2, the control group had a strong and significant correlation between errors, r=.57, 95% CI=[.40; .70], p<.001. The manipulated group had even larger correlation between errors, with considerable overlap with the control group, r=.73, 95% CI=[.48; .87], p<.001. Linear regressions for both are presented in Figure 2 and reveal that it is unlikely that the expectancy manipulation altered the relationship between perceptual and pointing errors.

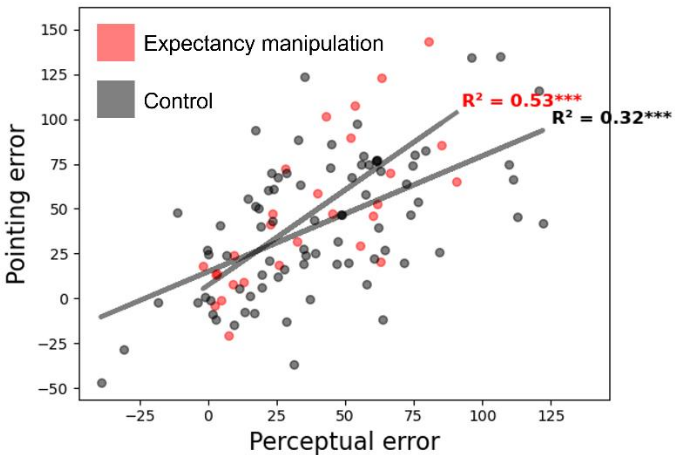

Figure 2: *Best linear fit of perceptual and pointing errors for both the expectancy manipulation group and the control group.*

3. CONCLUSION

Our results indicate that our expectancy manipulation had no sizable effect on either task, or on the relation between tasks. This is unlikely to be the result of failure of the manipulation as we removed participants who were not deceived, as revealed by the post-experimental interview. If the positive correlation between the two tasks was based on participants' expectation of consistency, the correlation should have been negative following our manipulation. Therefore, the finger-elongation suggestion effect on body schema is robust to expectancies.

ANNEX 3: FRENCH NORMS FOR THE ONLINE SUSSEX-WATERLOO SCALE OF HYPNOTIZABILITY

Clement Apelian[1,2]

1- Institut Jean Nicod, Département d'études cognitives, ENS, EHESS, CNRS, PSL University, UMR 8129, 29 rue d'Ulm 75005 Paris, France.

2- A.R.C.H.E. Research Center, 27 rue de Fontarabie 75020 Paris, France.

1. ABSTRACT

This paper presents French norms for the online version of the Sussex-Waterloo Scale of Hypnotizability. This scale is an online adaptation of the well-established Waterloo-Stanford Group C scale of hypnotic susceptibility with both behavioural and subjective scores. Insofar as hypnotizability (the ability to respond to suggestions in a hypnotic context) varies substantially in the general population and remains generally stable throughout life, it is important to measure it in experiments using hypnotic suggestion. However, these scales are time consuming, as they often require multiple sessions in order to achieve a suitable sample size for subsequent participant screening. One promising route for overcoming this inconvenience is to perform hypnotizability assessment online. The Sussex-Waterloo Scale of Hypnotizability is the first to have demonstrated the viability of online measurement. We show that our translation of this scale yields similar statistics. Alongside recent critics of the classic scales of hypnotizability, we point to limitations of this scale and discuss ways of accommodating some of its drawbacks.

Keywords: Hypnotic scale, French norms, SWASH, online scale

2. INTRODUCTION

Hypnotic suggestions have been widely used for better understanding the determinants of hypnotic behaviours and experiences (Lynn et al., 2020), as a tool to study cognition (Oakley & Halligan, 2013) and as an adjunct to traditional psychological treatments (Ramondo et al., 2021a). Hypnotizability, defined as the ability to successfully experience hypnotic suggestions (Laurence et al., 2008), has been shown to be stable, up to 25 year (Morgan et al., 1974; Piccione et al., 1989) and thus is often considered a trait-like ability. Since the first Stanford scale (Weitzenhoffer & Hilgard, 1959), studies using hypnotic suggestion have extensively used standardized measurements of hypnotizability. Two main approaches have been used : grouping subjects based on their level of hypnotizability (e.g. Terhune & Hedman, 2017), or using it as a predictor of some variable of interest (e.g. Sheiner et al., 2016). Either way, a substantial number of individuals needs to be tested in order to obtain a suitable number of highly hypnotizable participants, which is resource intensive.

A possible way to get around this hurdle is to automate testing with computer-based version of classic scales. To our knowledge, only two online scales have been proposed to measure suggestibility, the Brief Suggestibility Scale (Wieder & Terhune, 2019) assessing non-hypnotic suggestibility, and the Sussex-Waterloo Scale of Hypnotizability (SWASH; Lush et al., 2018), for hypnotic suggestibility (hypnotizability). The online SWASH demonstrated similar properties to the traditional version (Palfi et al., 2019). Online measurement has the potential to ease the research process while keeping measurements close to traditional scales (Weitzenhoffer & Hilgard, 1962). However, traditional scales have been criticized for being severely flawed, and the SWASH scale shares many of these limitations (Acunzo & Terhune, 2021). Despite their flaws, traditional scales will probably remain attractive in the field for some time since they allow for an easy comparison of hypnotizability scores with previous research. Moreover, it is likely that the new generation of scales will evolve from traditional ones, ensuring a continuity with current constructs of hypnotizability.

One concern of the SWASH scale compared to other is the low reliability of the behavioural score. Although traditional scales show sometimes questionable internal consistency in the [.62, .84] range

(Anlló & Sackur, 2017; K. S. Bowers, 1993; de Saldanha da Gama et al., 2012a; Shor & Orne, 1963a), the SWASH reliability has been reported to be low (Lush et al., 2018). Nonetheless, the SWASH is merely an adaptation of the WSGC without the "hypnotic dream" and "hypnotic regression" suggestions, removed because they often produce minor adverse events (Cardeña & Terhune, 2009). Otherwise, wording of suggestions is almost identical. Compliance could be one possible source contaminating the internal consistency of the SWASH. If this is the case, correcting for compliance should solve this issue (for an example of such correction, see: Anlló & Sackur, 2017). The SWASH has a subjective scale in addition to the standard behavioural scale, which is useful for applying correction for compliance. Normative data of hypnotic scales are often derived from university student populations with uncertain levels of acquaintance with hypnosis, yet this is seldom controlled. In contrast, the author could access participants during and after hypnosis training (professional training) in addition to participants drawn from the general population. This is valuable as hypnosis training attendees are expected to hold different expectancies (Molina-Peral et al., 2020), which are known to contribute to the hypnotic response to some degree (Benham et al., 2006; Kirsch, 2001; but see: Reategui, 2020). This paper presents data on our French translation of the online SWASH, and compares it to the English normative data.

3. MATERIAL & METHOD

3.1. Participants

360 participants, (240 female, 120 male) completed the French translation of the online SWASH (M_{age}=40.1; *SD*=11.6; range: 18-65). Participants were healthy adults recruited from both the general population and attendees of hypnosis training using the respective communication networks of the author's affiliations. Participation was voluntary and anonymous. Informed consent was obtained from all participants.

3.2. Materials

The online SWASH was translated by the author from English (Lush et al., 2018). Since the SWASH is an adaptation of the WSGC and a French version of the WSGC exists (de Saldanha da Gama et al., 2012a), we tried to stay close to this translation. An adaptation of the post-hypnotic suggestion was necessary, as the original suggestion was to draw a tree in the response booklet. We slightly modified the adaptation of Palfi et al. (2019). In Palfi et al. (2019) a screen with the mention "please wait" was displayed just before participants were asked to report for the items they remember. The post-hypnotic suggestion was "press the space bar six times". In our study,we suggested participants to start their response to the first recall task (testing the amnesia suggestion) by hitting the space bar four times. The whole scale was administered through Google form with audio/video inserts to guide the participant. The SWASH scale has a traditional behavioural score and a subjective score using respectively, binary scoring and Likert 6-point scale for each of the ten test suggestions. The total behavioural score is the sum of binary outcomes for each of the ten suggestions, while the total subjective score is the mean of each subjective score. The subjective scale is based on either involuntariness or veridicality of the experience. Veridicality is used for hallucinations or motor challenge suggestions instead of involuntariness for clarity. Indeed, from an experiential point of view the outcome of these suggestions is perceived, not performed). Hence, asking involuntariness for an experience that is not lived as an action is confusing for many participants, while veridicality is more appropriate. Participants reported their level of acquaintance with hypnosis (self-hypnosis, therapy, counselling, professional training) on a Likert 6-point scale (from 0- "I never experienced hypnosis" to 5- "I am acquainted with the experience of hypnosis") before starting the scale introduction. We also kept the hypnotic depth assessment from the original scale (Lush et al., 2018), a 6-point Likert scale (from 0- "Normal state" to 5- "Deep hypnosis") located after de-induction.

3.3. Procedure

Participants were contacted through the author's affiliations communication networks. The announcement presented the aim of the study, requirements (being in a calm and quiet place; aged 18 or more; no psychoactive drug intake; no history of psychiatric disease) and the time needed to complete the online scale (45 minutes in total). This announcement ended with a hyperlink to the scale. Participants had check a box to acknowledge they were fully informed and agreed to proceed to the scale. Age, gender, and familiarity with hypnosis were collected before the beginning of the scale. An introductory audio recording followed with instructions to adjust the sound level, a reminder of the study requirements, and what to do in case of a faulty internet connexion. Participants next proceeded to the induction procedure, and test suggestions. Procedure and testing were realized in the same way as the original scale. During the procedure, only the "negative visual hallucination", "post-hypnotic suggestion" and "amnesia" items were assessed. After de-induction, participants went through a description of each test suggestion and were asked to rate both their behavioural responses and subjective experience except for the behavioural response to the "negative visual hallucination", "post-hypnotic suggestion" and "amnesia" items. The procedure ended with thanking participants for their participation, explaining the misleading "music hallucination" and "negative visual hallucination" suggestions and offering closing remarks. Again, following the same procedure as the original scale. All items requiring human judgment (amnesia, post-hypnotic suggestion and negative visual hallucination) were scored by the author using the SWASH scoring guide (Lush et al., 2018).

3.4. Analyses

We computed behavioural and subjective scores as described in the SWASH manual (Lush et al., 2018) and doubled the subjective score to have both scores in the [0,10] range (Palfi et al., 2019). To correct for compliance, we used the built-in subjective scale and rated any (behavioural) test suggestion as failed if the subjective score was either 0 or 1 on the Likert 6-point scale. As the online procedure limits submission of incomplete forms, we did not reject any participant. Familiarity with hypnosis was either used as a continuous variable for correlations or binarized for analysing group statistics (low: 0,1,2; high: 3,4,5). When comparisons between group means are made, independent sample, two-tailed, Student *t*-tests are used, and Hedges' g effect sizes are reported. Comparisons between correlations where made using the cocor package (Diedenhofen & Musch, 2015) and linear mixed effect models using lme4 (Bates et al., 2015) and *R* studio software (Version 4.0.3 2020-10-10 RStudio, Inc.).

3.5. Ethics

The whole experiment was approved by the ethical comity of Paris Descartes under the IRB n° 00012020-81 in agreement with the Declaration of Helsinki (2008). Data are publicly available on the Open Science Framework :

https://mfr.osf.io/render?url=https://osf.io/jg69h/?direct%26mode=render%26action=download%26mode=render

4. RESULTS

4.1. Score distribution

The descriptive statistics of the behavioural score, both corrected and uncorrected, and the subjective score are presented in Table 1 (and Figure 1 in supplementary material). As can be seen in Figure 1, distributions of scores are roughly bell-shaped. However, a Shapiro-Wilk test of normality rejects the null hypothesis (normal distribution) for both the behavioural score distribution in the low familiarity, W=.97, p=.003, and whole sample, W=.97, p<.001, and the corrected behavioural score distribution in the low familiarity, W=.95, p<.001, and high familiarity group, W=.96, p<.001. Indeed, the low familiarity group has both the behavioural score distribution, *sk*=0.21, and the corrected behavioural distribution, *sk*=0.16, skewed to the right, while the whole sample has slightly left-skewed distributions, both for the behavioural score, *sk*=-0.08, and the corrected behavioural score, *sk*=-0.11. Conversely, the

Shapiro-Wilk test failed to reject normality of the subjective score distributions, both in the low familiarity group, *W*=98, p=.12, and in the high familiarity group, *W*=.99, p=.09.

We then compared the statistics of our low-familiarity sample against the English samples (Lush et al., 2018; Palfi et al., 2019). We chose the low-familiarity sample as it was expected to better represent the general population (who are not trained hypnotists). The mean score of our (low familiarity) sample was commensurate with the English online version (*N*=45; Palfi et al., 2019), yet slightly higher, both for the (uncorrected) behavioural scale, M_{diff}=0.31, *g*=0.15 and the subjective scale, M_{diff}=0.62, *g*=0.33. The reported depth of hypnosis was similar across the two samples, M_{diff}=0.29, *g*=0.22. Our scores are also commensurate with the in-person version of the SWASH (*N*=418; Lush et al., 2018) for the (uncorrected) behavioural scale, M_{diff}=0.14, *g*=0.08and subjective scale, M_{diff}=-0.06, *g*=-0.03, although our sample has lower depth of hypnosis, M_{diff}=-0.28, *g*=-0.23, nonetheless, the difference was small.

No significant gender difference was present in the low familiarity group (*n*=75 females, 49 males), either for the behavioural score, M_{diff}=0.31, *g*=0.17, *p*=.37, the corrected behavioural score, M_{diff}=0.37, *g*=0.18, *p*=.34, or the subjective score, M_{diff}=0.12, *g*=0.07, *p*=.72. These results are in line with previous studies which did not demonstrate meaningful gender difference in hypnotizability (Anlló & Sackur, 2017; de Saldanha da Gama et al., 2012a). However, for the whole sample (*n*=240 females, 120 males), results were more ambiguous. Whereas the subjective score did not show a significant difference in gender, M_{diff}=0.22, *g*=0.13, *p*=.25, the behavioural score, M_{diff}=0.45, *g*=0.24, *p*=.03, and the corrected behavioural score M_{diff}=0.64, *g*=0.31, *p*=.005, were significantly different, with higher scores for females compared to males. These differences are small and appear on behavioural scores, which are known to suffer from inconsistencies (Acunzo & Terhune, 2021). Hence, we chose to pool the data from both genders in subsequent analyses. These results show that our translation of the online SWASH scale is similar to the original version. This is in line with previous studies showing that hypnotic scales have similar properties in different languages (Anlló & Sackur, 2017; de Saldanha da Gama et al., 2012a).

Table 1

Descriptive statistics for the corrected and uncorrected SWASH behavioural score and subjective score in the full sample and in low and high familiarity with hypnosis groups.

	Group		
	Full sample (N=360)	Low familiarity (n=124)	High familiarity (n=236)
SWASH behavioural score (uncorrected)	4.24 (1.85)	3.84 (1.85)	4.45 (1.81)
SWASH behavioural score (corrected)	3.73 (2.05)	3.19 (2.13)	4.02 (1.95)
SWASH subjective score	3.89 (1.72)	3.34 (1.77)	4.18 (1.63)

Notes. Mean score (SD). Possible scores vary between 0 and 10.

4.2. Familiarity with hypnosis

124 participants reported a low level of familiarity with hypnosis whereas 236 reported high familiarity. Familiarity with hypnosis was associated with higher behavioural scores, M_{diff}=0.61, g=0.33, p=.003, corrected behavioural score, M_{diff}=0.84, g=0.41, p<.001, and subjective score, M_{diff}=0.84, g=0.50, p<.001. Additionally, we also observed that participants familiar with hypnosis reported significantly higher depth of hypnosis, M_{diff}=1.03, g=0.84, p<.001. These results coherently indicate that participants familiar with hypnosis score higher on hypnotizability and hypnotic depth scales.

4.3. Correlations

Expectedly, behavioural and subjective scales were highly correlated, r(360)=.70, p<.001. This correlation is identical to the English in-person sample (Lush et al., 2018), r(418)=.70, and similar to the online sample (Palfi et al., 2019), r(45)=.79, with no significant differences between correlations,

z=-1.25, p=0.21. Depth of hypnosis had a medium to large positive correlation with hypnotizability assessed either by the behavioural scale, $r(360)=.42$, $p<.001$, the corrected behavioural scale, $r(360)=.47$, $p<.001$, or the subjective scale, $r(360)=.61$, $p<.001$. These correlations are similar to those found in the English in-person and online datasets between depth of hypnosis and the behavioural scale, in-person: $r(418)=.44$; online: $r(45)=.54$, or the subjective scale, in-person: $r(418)=.62$; online: $r(45)=.81$. Indeed, no significant differences were found between correlations in these samples for the behavioural score, in-person: z=-0.34, p=0.73; online: z=-0.95, p=0.34. The correlation between the subjective score and hypnotic depth was similar to the English in-person sample, z=-0.22, p=0.82, but significantly larger in the English online sample, z=-2.56, p=0.01. Reported level of familiarity with hypnosis had a small positive correlation with behavioural scores, $r(360)=.20$, $p<.001$, corrected behavioural scores, $r(360)=.27$, $p<.001$, and subjective scores, $r(360)=.24$, $p<.001$. Taken together, these results depict a coherent construct of hypnotizability in the translated scale, coherent with the original version.

4.4. Reliability

Corrected item-total correlations (correlations of each item with the sum of the remaining items of the scale) and total scale reliability are presented in Table 2. Only the music hallucination item failed to correlate significantly with the whole scale, but other items (post-hypnotic hallucination, amnesia, negative visual hallucination, and arm immobilization) were close to the significance threshold. However, these items also correlate weakly with the whole scale in the English sample (in-person sample from Lush et al., 2018). Nonetheless, global behavioural and subjective scale reliability of the French version of the online SWASH are commensurate with the Sussex sample, M_{diff}=0.03, p=.50 and M_{diff}=0.02, p=.26 respectively. Overall, correcting for compliance significantly improved reliability, M_{diff}=0.14, p=.03.

Table 2.

Item-total correlations and total scale reliability

	Corrected item-total correlations[a]				
	French sample			University of Sussex sample[b]	
	Behavioural scale		Subjective scale	Behavioural scale	Subjective scale
	uncorrected	corrected			
Hand lowering	0.34 [0.24, 0.43]	0.43 [0.34, 0.51]	0.65 [0.59, 0.71]	0.19 [0.10, 0.28]	0.53 [0.46, 0.60]
Moving hands together	0.29 [0.19, 0.38]	0.34 [0.25, 0.43]	0.57 [0.50, 0.64]	0.20 [0.11, 0.29]	0.48 [0.40, 0.55]
Mosquito hallucination	0.28 [0.19, 0.38]	0.36 [0.27, 0.45]	0.56 [0.49, 0.63]	0.24 [0.15, 0.33]	0.50 [0.42, 0.57]
Taste hallucination	0.22 [0.12, 0.32]	0.29 [0.19, 0.38]	0.51 [0.43, 0.58]	0.32 [0.23, 0.40]	0.59 [0.52, 0.65]
Arm rigidity	0.28 [0.19, 0.38]	0.45 [0.36, 0.53]	0.68 [0.62, 0.73]	0.36 [0.27, 0.44]	0.61 [0.55, 0.67]
Arm immobilization	0.17 [0.06, 0.26]	0.32 [0.22, 0.41]	0.64 [0.58, 0.70]	0.23 [0.14, 0.32]	0.62 [0.56, 0.68]
Music hallucination	0.08 [-0.03, 0.18]	0.07 [-0.03, 0.18]	0.22 [0.12, 0.31]	0.12 [0.02, 0.21]	0.34 [0.25, 0.42]
Negative visual hallucination	0.15 [0.04, 0.25]	0.17, [0.07, 0.27]	0.16 [0.05, 0.26]	0.25 [0.16, 0.34]	0.35 [0.26, 0.43]
Amnesia	0.11 [0.01, 0.21]	0.20 [0.09, 0.29]	0.37 [0.28, 0.46]	0.18 [0.09, 0.27]	0.55 [0.48, 0.61]
Post-hypnotic hallucination	0.12 [0.01, 0.22]	0.24 [0.14, 0.34]	0.31 [0.21, 0.40]	0.11 [0.01, 0.20]	0.57 [0.50, 0.63]
Total scale reliability[c]	0.50 [0.42, 0.58]	0.64 [0.58, 0.69]	0.81 [0.78,0.84]	0.53 [0.44,0.60]	0.83 [0.80,0.85]

Notes. [a] correlations of each item with the sum of the remaining items of the scale. [b] offline sample from Lush et al., 2018. [c] McDonald's ω reliability. Numbers in brackets are 95% confidence intervals.

4.5. *Item analysis*

Table 3 presents items pass rates for the behavioural and corrected behavioural scales, and the mean subjective score for each item and behavioural score. This table reveals that except for the "moving hands together" item, all other items show commensurate or higher scores compared to the English sample (Lush et al., 2018). The easiest item was "hand lowering" in our sample, in line with the general tendency of scales in the Stanford tradition (K. S. Bowers, 1993; de Saldanha da Gama et al., 2012a; Weitzenhoffer & Hilgard, 1962), but contrary to the English sample. The most difficult item, "music hallucination" was also in line with previous studies. Post-hypnotic suggestion was most sensitive to compliance, followed by the "mosquito hallucination" suggestion and to a lesser degree both challenge motor suggestions ("arm rigidity" and "arm immobilization"). The general association between behavioural and subjective scores is also evident at the item level. Item pass rate and mean subjective scores (both on a 0-10 scale) were close, both for the corrected, Mabs diff=0.89 (mean of absolute differences), and the uncorrected behavioural score, Mabs diff=1.1. This is especially true when removing two troublesome items, "amnesia" (corrected Mdiff=3.84, uncorrected Mdiff=3.61) and post-hypnotic suggestion (corrected Mdiff=2.69, uncorrected Mdiff=4.8), lowering the mean difference to Mabs diff=0.3 for the corrected score and Mabs diff=0.41 for the uncorrected score. Indeed, these items are known to be flawed in many ways (Acunzo & Terhune, 2021). The score of the post-hypnotic suggestion, amnesia and taste hallucination are computed from multiple subscales. In the following, we analyse these three items separately.

Table 3.

Items pass rate and subjective scores for each level of behavioural score

Behavioural score	Passing rates of the French sample[a] 0	1	2	3	4	5	6	7	8	9	Total	Sussex sample
N	6 / 32	22 / 25	42 / 48	57 / 48	57 / 64	85 / 73	54 / 41	27 / 23	7 / 3	3 / 3	360	418
Hand lowering	0 / 0 (1.33 / 1.69)	18.2 / 24 (3.36 / 4.56)	38.1 / 56.3 (4.48 / 5.71)	59.6 / 60.4 (6.32 / 6.67)	77.2 / 82.8 (6.88 / 7.41)	81.2 / 86.3 (7.58 / 8.11)	98.1 / 95.1 (7.93 / 7.95)	96.3 / 95.6 (8.22 / 8.61)	100 / 100 (9.14 / 9.33)	100 / 100 (8 / 8)	71.1 / 68.1 (6.68)	71.8 (6.8)
Moving hands together	0 / 0 (1.67/1.38)	13.6 / 20 (2.55 / 2.88)	23.8 / 31.3 (3.33 / 4.63)	38.6 / 41.7 (4.88 / 5.58)	54.4 / 70.3 (6.21 / 6.78)	77.6 / 69.9 (6.96 / 7.23)	83.3 / 85.4 (6.93 / 6.88)	77.8 / 82.6 (8 / 8.35)	100 / 100 (7.14 / 9.33)	100 / 100 (7.33 / 7.33)	57.8 / 54.4 (5.81)	76.8 (5.8)
Mosquito hallucination	0 / 0 (0.33 / 0.31)	9.1 / 0 (0.45 / 0.4)	14.3 / 10.4 (1.19 / 1.58)	22.8 / 12.5 (2 / 2.46)	24.6 / 23.4 (2.04 / 2.34)	61.2 / 63 (3.95 / 4.77)	66.7 / 58.5 (4.96 / 5.37)	85.2 / 78.3 (5.48 / 5.91)	100 / 100 (7.14 / 8.67)	100 / 100 (6.67 / 6.67)	43.3 / 33.3 (3.09)	26.1 (2)
Taste hallucination	0 / 0 (2.5 / 0.94)	0 / 12 (0.86 / 1.64)	26.2 / 25 (2.88 / 2.67)	15.8 / 25 (2.54 / 3.5)	38.6 / 34.4 (3.63 / 3.97)	54.1 / 56.2 (4.55 / 4.74)	61.1 / 65.8 (4.59 / 5.07)	81.5 / 91.3 (5.70 / 6.22)	85.7 / 66.7 (5.71 / 6)	100 / 100 (5.67 / 5.67)	42.2 / 39.7 (3.76)	30.9 (2.8)
Arm rigidity	0 / 0 (1.67 / 1.31)	13.6 / 4 (1.82 / 1.84)	26.2 / 18.8 (3.05 / 3.71)	49.1 / 64.6 (4.70 / 6.21)	80.7 / 75 (6.07 / 6.47)	77.6 / 75.3 (7.01 / 7.73)	88.9 / 90.2 (7.48 / 7.76)	92.6 / 100 (8.81 / 8.87)	100 / 100 (9.14 / 10)	100 / 100 (10 / 10)	65.8 / 58.3 (5.9)	54.9 (5.4)
Arm immobilization	0 / 0 (2 / 1.44)	18.2 / 12 (2.36 / 3.12)	31 / 25 (3.95 / 4.42)	50.9 / 50 (5.33 / 5.88)	64.9 / 59.4 (5.75 / 6)	72.9 / 74 (6.61 / 7.48)	74.1 / 75.6 (6.96 / 7.46)	96.3 / 95.7 (8 / 8.61)	100 / 100 (9.14 / 9.33)	100 / 100 (9.33 / 9.33)	61.4 / 52.8 (5.86)	36.4 (4.6)
Music hallucination	0 / 0 (0 / 0.13)	0 / 0 (0.49 / 0.32)	4.8 / 4.2 (0.81 / 0.83)	5.3 / 4.2 (0.74 / 0.88)	3.5 / 6.3 (0.67 / 0.81)	10.6 / 9.6 (0.92 / 0.96)	14.8 / 9.8 (1.07 / 1.12)	18.5 / 17.4 (1.63 / 2)	57.1 / 33.3 (2.57 / 4)	33.3 / 33.3 (4 / 4)	9.4 / 6.9 (0.92)	5 (0.46)
Negative visual hallucination	0 / 0 (0 / 0.63)	0 / 4 (0 / 0.8)	2.4 / 0 (1.67 / 0.92)	3.4 / 2.1 (0.46 / 0.63)	5.3 / 7.8 (0.74 / 0.78)	5.9 / 4.1 (0.8 / 0.71)	20.4 / 24.4 (1.22 / 1.95)	37 / 26.1 (3.33 / 2.87)	0 / 0 (0.86 / 2)	100 / 100 (8 / 8)	9.7 / 8.1 (1.09)	9.3 (0.86)
Amnesia	0 / 0 (2 / 2.06)	0 / 0 (2.82 / 3.12)	0 / 0 (3.9 / 4.25)	7 / 4.2 (4.1 / 4.71)	8.8 / 4.7 (4.39 / 4.59)	9.4 / 8.2 (4.87 / 5.26)	16.7 / 22 (5.41 / 5.51)	22.2 / 21.7 (6.52 / 6.52)	57.1 / 100 (7.14 / 8.67)	66.7 / 66.7 (8.67 / 8.67)	10.6 / 8.3 (4.67)	14.6 (2.8)
Post-hypnotic hallucination	0 / 0 (0 / 0.26)	27.3 / 16 (0.39 / 0.49)	33.3 / 27.1 (0.7 / 0.61)	47.4 / 33.3 (0.96 / 1.16)	42.1 / 26.6 (0.42 / 0.62)	49.4 / 45.2 (0.63 / 0.94)	75.9 / 70.7 (2.21 / 2.23)	92.6 / 91.3 (3.45 / 3.48)	100 / 100 (2.21 / 4.22)	100 / 100 (7.45 / 7.45)	52.5 / 38.6 (1.17)	39.5 (1.86)
Mean subjective score	(1.15 / 1.01)	(1.5 / 1.92)	(2.6 / 2.93)	(3.2 / 3.77)	(3.68 / 3.98)	(4.39 / 4.79)	(4.88 / 5.13)	(5.92 / 6.14)	(6.02 / 7.15)	(7.51 / 7.51)	(3.89)	(3.4)

Notes. [a] percentage of participants successfully passing each suggestion. N = total number of participants corresponding to each behavioural score. Slash sign (/) separate values computed from uncorrected behavioural scores on the left and corrected behavioural scores on the right. Values in parenthesis correspond to mean subjective scores doubled to be over ten.

4.6. *Taste hallucination*

Scores of the items of the taste hallucination test are presented in Figure 2. Behavioural ratings capture 2x3x2 dimensions (Sweetness/Sourness suggestions x no/vague/strong taste x facial movement yes/no) while the subjective ratings capture taste strength from 0 (none) to 5 (strong). Subjective and "taste strength" items were highly correlated in our sample for both the sweet taste suggestion, *r*(360)=.81, *p*<.001, and sour taste suggestion, *r*(360)=.86, *p*<.001. Furthermore, subjective ratings (sweet and sour) were also highly correlated, *r*(360)=.68, *p*<.001, in line with the common practice of having a single taste score. Additionally, the sum of facial movement reports (a pure behavioural estimate) correlates with the rest of the scale $r(360)=.27$, $p<.001$, which is in the range of item-total correlation of the other test suggestions (see Table 2). This is not significantly different from using the regular taste score, $z=-0.71$, $p=0.48$.

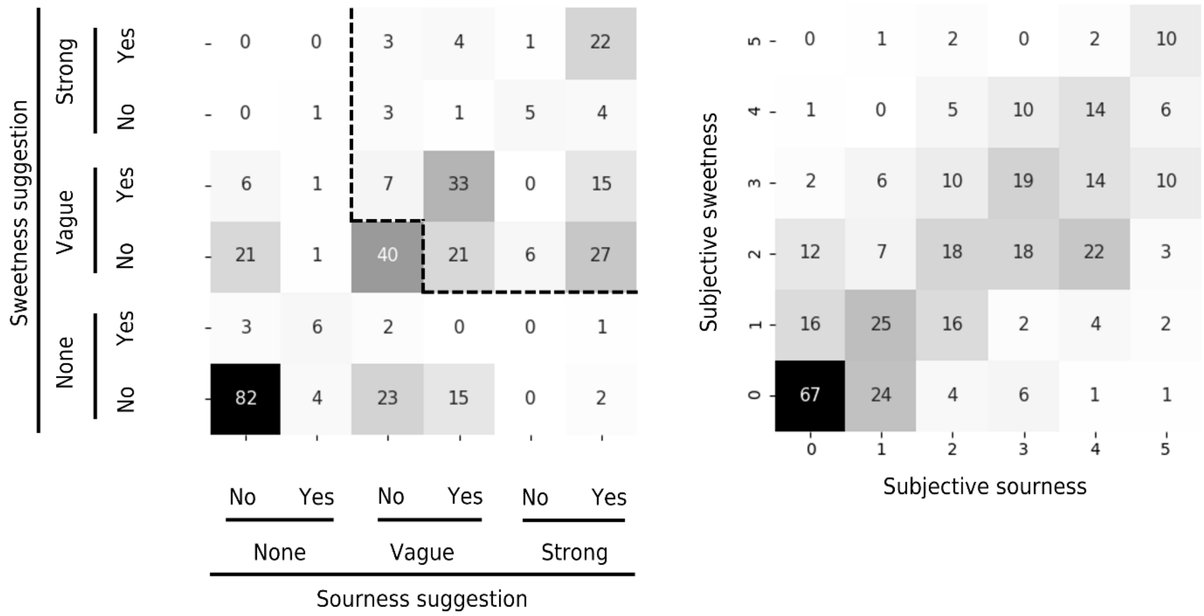

Figure 2. *Scores for the "taste hallucination" suggestion of the French online SWASH. The left panel presents responses for the behavioural scores and the right panel presents responses for the subjective scores. The dashed line represents the criterion for passing the taste suggestion. "None", "Vague" and "Strong" correspond to the "taste strength" questions, while "Yes" and "No" correspond to the facial movement questions. Each cell indicates the corresponding number of participants (N=360).*

4.7. Amnesia

Recall of specific scale items varied considerably, from 24.7% for "amnesia" to 75.3% for the "hand lowering" suggestion (See Figure 3). However, the proportion of additional item recalled after cancelling the suggestion is somewhat constant overall, M=12.4%, SD=2.9%, range=[6.1, 17.5]. During the first recall, participants reported an average of M=3.6 items, but only M=1.2 new items after cancelling amnesia. Using the usual criterion for scoring this item (K. S. Bowers, 1993; Lush et al., 2018), *N*=38 participants (7.8%) passed this suggestion, with *M*=1.8 items recalled before cancelling amnesia and *M*=3.7 afterwards.

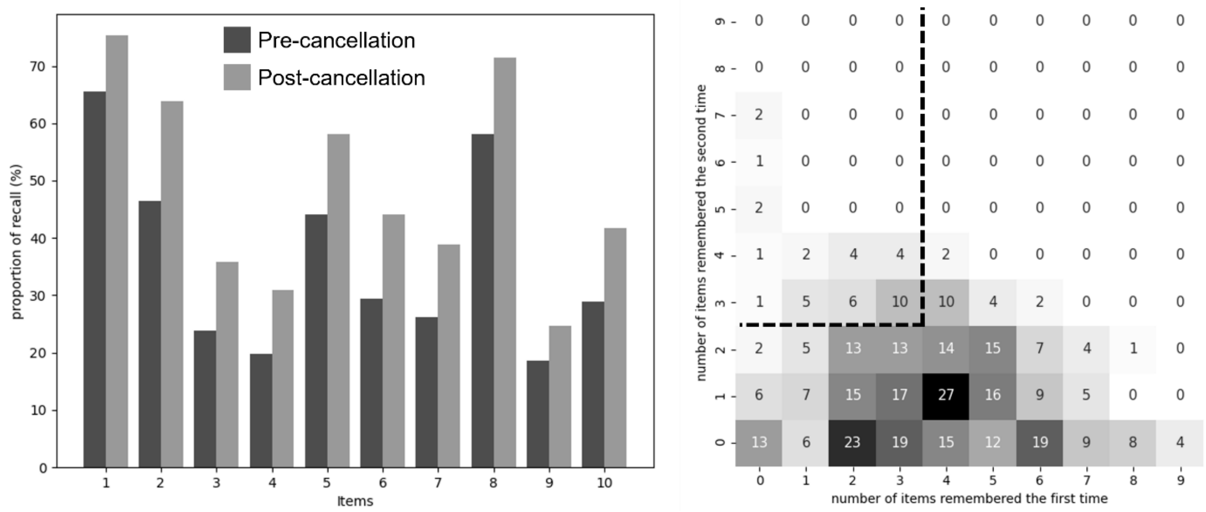

Figure 3. *The left panel presents percentage recall rate for each scale item for the whole sample (N=360) before (dark grey) and after (light grey) cancelling amnesia. Items are numbered as: 1- hand lowering; 2- moving hands together; 3- mosquito hallucination; 4- taste hallucination; 5- arm rigidity; 6- arm immobilization; 7- music hallucination; 8- negative visual hallucination; 9- amnesia; 10- post-hypnotic suggestion. On the right panel, each cell indicates the number of participants for each possible combination of number of items remembered before (first time) and after (second time) cancelling amnesia. The dashed line indicates the criterion for counting the amnesia suggestion as passed.*

4.8. Post-hypnotic suggestion (PHS)

Figure 4 presents the distribution of subjective PHS ratings (compulsiveness and amnesia) for participants that either failed (*N*=171) or passed (*N*=189) the behavioural criterion for post-hypnotic suggestion. As can be seen in the left panel of Figure 4, some participants (*N*=15, 8.8%) scored high (4 or 5) on the compulsiveness rating (“On a scale from 0 to 5, report how strong an urge you felt to draw a tree”), suggesting that they refrained the urge to enact the suggestion. Almost half of non-responders clearly remembered the suggestion (amnesia score 0-1; *N*=74, 43.3%) and almost the same proportion clearly forgot it (amnesia score 4-5; *N*=78, 45.6%). Conversely, almost all responders did clearly remember the suggestion (amnesia score 0-1; *N*=156, 91.2%). Although approximately 27% of responders reported explicitly complying with the suggestion (compulsiveness score 0-1; *N*=50). This indicate that these two ratings (amnesia and compulsiveness) about the suggested post-hypnotic behaviour capture aspects of experience that are not commensurable. This is further supported by their significant negative correlation, $r(360)=-.31$, $p<.001$.

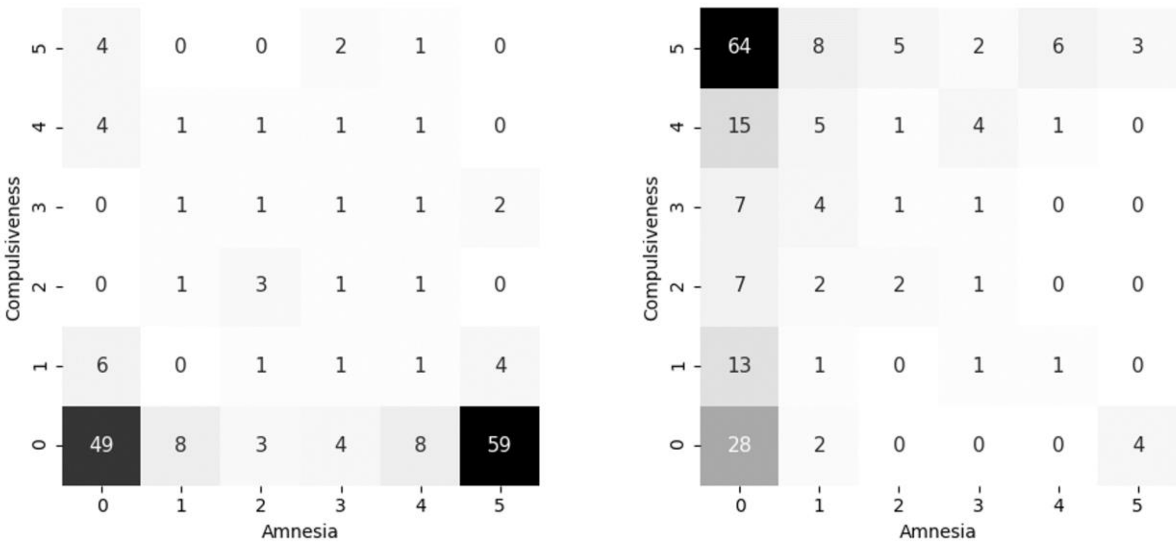

Figure 4. *Distribution of participants on the two subjective ratings of post-hypnotic suggestion (compulsiveness and amnesia). The left and right panels present the distribution of participants respectively failing (N=171) and passing (N=189) the behavioural criterion.*

5. DISCUSSION

Our data suggest that the French version of the online SWASH is a valuable tool for assessing hypnotizability. Our results are commensurate with previous studies, both online (Palfi et al., 2019) and in-person (Lush et al., 2018), and in line with results obtained on the germane WSGC in several languages (reported in: de Saldanha da Gama et al., 2012). However, reliability of the behavioural scale was poor, similarly to previous statistics of the SWASH (Lush et al., 2018) although correcting behavioural scores for compliance helped to raise reliability to acceptable levels. Conversely, the subjective scale was highly reliable and commensurate with previous reports. Studies using this translation would benefit from reporting statistics using the corrected behavioural scale and the subjective scales.

We analysed three test suggestions that have composite measurement: taste hallucination, amnesia, and post-hypnotic suggestion. The traditional method collapsing both taste suggestions into one measurement appears sound given the high correlation between subjective responses to sweetness and sourness. Amnesia is often considered one of the most striking hypnotic phenomena (Wagstaff et al., 2008), yet it seems quite sensitive to contextual factors and compliance (Wagstaff, 1977) and has been viewed as flawed for a lack of control condition (Acunzo & Terhune, 2021; Freedman, 2012). In our sample 84 (23%) participants rated their experience as "blank memory" (4-5 on the amnesia subjective scale). However, one defining feature of hypnotic amnesia is its ability to be reversed (Kihlstrom & Shor, 1978). If one cannot remember items after cancelling the amnesia suggestion, it is usually considered as a case of *normal* forgetting, leading to false positives (Freedman, 2012). Continuous measurements could solve part of the problem. For example, Woody et al., 2005 took the difference between the number of items recalled before and after cancelling the amnesia suggestion, which is preferable to dichotomous scoring. Lush et al., (2018) noted that few participants reported amnesia for the subjective scale assessing the post-hypnotic suggestion. The authors interpreted this result as evidence that previous rates of responding to this suggestion were overestimated. Accordingly, they proposed to combine the compulsiveness and amnesia subscales using a geometric mean (square root of the product). With this method only high levels of compulsiveness *and* amnesia lead to high scores, while having low levels of compulsiveness *or* amnesia leads to low scores. We found the same pattern in our results (Figure 4). However, two issues proved concerning, one about the method, the other about the interpretation. First, using 0-5 scales imply that participants indicating “0” on one of the ratings will get a subjective score of zero for this item, regardless of the score on the other rating. Offsetting these subscales by one unit and rescaling after the geometric mean has been computed would solve this issue. Additionally, we believe that the authors’ interpretation might be overstated. When post-hypnotic behaviour is suggested, two suggestions are made: one aims at eliciting a behaviour (“you will draw a small tree in the upper right hand corner…”), and the other aims at forgetting the suggestion (“…but forget that I told you to do so”). We contend that these two suggestions are independent and are even conflicting with each other. This is evidenced by our results presented in Figure 4 showing that most participants having enacted the suggested behaviour did not report amnesia and *vice versa*. Therefore, we recommend using only the “compulsiveness” subjective rating for assessing the post-hypnotic suggestion, as amnesia is a different suggestion.

Our results indicate that the French version of the online SWASH estimates hypnotizability similarly to the original English scale, both online and in-person (Lush et al., 2018; Palfi et al., 2019). Automated, online screening is a considerable benefit for research, and no shortcoming was evident. For example, no participant used our hotline consequently to report adverse experiences, nor reported a difficult user experience. Taken together, our results suggest that our translation of the online SWASH is true to the original version and a credible tool for assessing hypnotizability for French-speaking communities.

Traduit de la version originale :
Lush, P., Moga, G., McLatchie, N., & Dienes, Z. (2018). The Sussex-Waterloo Scale of Hypnotizability (SWASH): measuring capacity for altering conscious experience. *Neuroscience of consciousness*, *2018*(1), niy006.

Traduction Française :
Apelian (2022) : French norms for the online Sussex-Waterloo Scale of Hypnotizability

Echelle d'hypnotisabilité en ligne de Sussex-Waterloo *Adaptation française* Manuel et questionnaire de réponse

Adaptation Française : Clément APELIAN (PhD), Institut Jean Nicod, Département d'études cognitives, ENS, EHESS, CNRS, PSL University, UMR 8129, 29 rue d'Ulm 75005 Paris, France / A.R.C.H.E. Research Center, 27 rue de Fontarabie 75020 Paris, France.

Résumé

Ce document présent le manuel et le questionnaire de réponse de l'adaptation française de l'échelle d'hypnotisabilité en ligne de Sussex-Waterloo (Sussex-Waterloo Scale of Hypnotisability ; SWASH). Cette échelle constitue la dernière adaptation en date des échelles issues de l'échelle d'hypnotisabilité de Stanford (Stanford Hypnotic Susceptibility Scale Form C ; SHSS :C ; Weitzenhoffer & Hilgard, 1962), après une adaptation collective (Waterloo-Stanford Group Scale of Hypnosis Susceptibility, From C ; WSGC ; Bowers 1998). Les données normalisées de l'échelle sont accessibles en anglais (Lush et al. 2018 pour la version traditionnelle et Palfi et al. 2019 pour la version en ligne) et en français (Apelian 20XX).

Préparation

Note aux expérimentateurs

La version en ligne de cette échelle nécessite de réaliser différents enregistrements. Des notes aux expérimentateurs sont laissées à différents emplacements du script afin de signaler les limites des fichiers audios et autres détails techniques utiles à la réalisation du dispositif en ligne.

Introduction et instructions préliminaires

Dans quelques instants je vais vous faire passer une procédure standard qui va évaluer votre aptitude à l'hypnose. A la fin de cette procédure standard, vous rapporterez votre expérience dans le questionnaire qui se trouve sous cette vidéo.

Cette échelle d'hypnotisabilité est pré-enregistrée et votre plateforme y accède via internet. Vérifiez donc que votre connexion est suffisamment bonne pour ne pas avoir de moment de latence ou d'arrêts inopinés de l'enregistrement. Si vous avez des problèmes de connexion en cours d'expérience, il vous est conseillé d'arrêter, de laisser les effets se dissiper naturellement et de recommencer avec une meilleure connexion.

Je vous recommande également d'éteindre votre téléphone et toute autre source de notification pour la durée de l'expérience et de vous assurer de ne pas être dérangé par les personnes de votre entourage.

Profitez de ce moment pour ajuster le volume pour avoir un son qui soit facile et agréable à entendre.

A plusieurs moments vous devrez passer sur d'autres parties de ce questionnaire. A chaque fois que vous rencontrez une vidéo, vous devrez cliquer dessus pour la lancer et suivre les instructions avant de passer à la suite.

Nous allons pouvoir commencer.

0- Induction

(1) Installez-vous confortablement et laissez vos mains reposer sur vos genoux. Très bien. Maintenant, fermez les yeux et concentrez-vous simplement sur ma voix. Je vais vous aider à vous détendre et en même temps, je vous donnerais quelques instructions qui vont vous aider à progressivement entrer dans un état hypnotique. Et vous pouvez entrer dans cet état si vous suivez les instructions et que vous vous concentrez sur ma voix. Je vous remercie d'avoir bien voulu participer à cette étude aujourd'hui, et je vous remercie d'autant plus de vouloir vivre tout ce que vous pouvez vivre ici. L'hypnose, c'est un état tout à fait normal et naturel, et cet état est le résultat de votre attention et des suggestions que nous allons utiliser ensemble. Ce qui est important ici, c'est que vous vouliez bien suivre les idées que je vous suggère et de laisser venir ce qui va se passer. Rassurez-vous, c'est un moment agréable et respectueux de votre personne. Faites attention aux mots que je prononce, et laissez se produire ce qui vient. Laissez-vous aller. Faites très attention à ce que je vous demande de penser ; si vous décrochez, c'est OK ; ramenez simplement vos pensées sur ma voix, et vous pourrez facilement vivre encore plus intensément ce que ça fait d'être hypnotisé.

(2) Maintenant, laissez votre corps se relâcher. Peu importe ce que vous vivez : c'est très bien. Permettez-vous de vivre ce qui vient et restez focalisé sur ma voix.

(3) Vous allez découvrir que vous pouvez en même temps vous relâcher complètement et rester assis naturellement. Vous pourrez à tout moment bouger si vous en ressentez le besoin pour être aussi confortable que possible et ça aussi, ça se fera tout naturellement sans que vous n'y pensiez. Pour l'instant, je vous invite simplement à vous détendre de plus en plus. Et en pensant à la détente, vos muscles vont commencer à se relâcher. Commençons par le pied droit. (…) Relâchez les muscles de votre jambe droite. (…) Et maintenant de votre jambe gauche, détendez tout ça. (…) Détendez votre main droite… votre avant-bras droit… remontez le bras jusqu'à l'épaule droite. (…) C'est ça. Passons à la main gauche… l'avant-bras gauche… remontez le bras jusqu'à l'épaule gauche. (…) Relâchez votre coup et tout le haut du corps… Relâché, de plus en plus relâché, complètement relâché. (…)

(4) Au plus vous devenez détendu et au plus votre corps va se sentir en paix… confortable, dense, lourd. Vous allez commencer à sentir cette sensation agréable de pesanteur et de confort dans vos jambes

et dans vos pieds. (…) Dans vos mains et dans vos bras. (…) Qui envahi tout votre corps, comme si vous vous enfoncez profondément dans votre environnement. Votre corps se sent bien, il se sent lourd. Vos paupières se sentent lourdes elles aussi, lourdes et fatiguées. Vous commencez à vous sentir bien détendu et confortable. Votre respiration est fluide et profonde. Fluide et profonde. Et vous êtes de plus en plus profondément et confortablement relâché.

(5) Vous vous sentez très relâché, mais vous allez pouvoir allez encore plus loin. Vous vous sentez dans cet état agréable tandis que vous continuez d'écouter ma voix. Laissez ma voix habiter vos pensées. Dans quelques instants vous allez être profondément hypnotisé. Vous continuerez à m'entendre distinctement et vous resterez profondément hypnotisé jusqu'à ce que je vous demande de vous réveiller plus tard. Je vais commencer à compter de 1 à 20. Et à chaque chiffre, vous vous sentirez descendre de plus en plus loin dans un état hypnotique profond. Et vous serez capable de faire toute sorte de choses que je vous demande de faire tout en restant profondément hypnotisé. 1. Vous allez vous sentir descendre plus profondément dans cet état d'hypnose. 2. Descendez, plus profondément, plus loin. 3. 4. De plus en plus profondément hypnotisé. 5. 6. 7. Vous vous enfoncez de plus en plus profondément dans l'hypnose. Vous êtes en paix, laissez vos pensées suivre ma voix. C'est tellement simple de juste écouter ma voix. 8. 9. 10. La moitié du chemin, toujours plus loin. 11. 12. 13. 14. 15. Et vous m'entendez toujours aussi clairement même en étant aussi loin dans cet état d'hypnose. 16. 17. 18. Toujours plus profondément hypnotisé… tellement paisible, tellement de calme. Vous allez vivre tellement de chose que je vais vous proposer de vivre. 19. 20. (…) Vous êtes désormais dans un état d'hypnose profonde et vous y resterez jusqu'à ce que je vous réveille. Et vous désirez rester dans cet état et vivre toutes les expériences que je vais vous proposer, n'est-ce pas ?

(6) Dans cet état profondément relâché et hypnotisé, j'aimerais que vous réalisiez que vous allez pouvoir bouger vos bras, vos mains et même ouvrir les yeux si je vous le demande, et tout de même rester aussi profondément confortable et hypnotisé que vous l'êtes maintenant. Ça vous paraitra tellement simple de bouger vos mains ou d'ouvrir les yeux quand je vous le demanderai. Et vous resterez hypnotisé jusqu'à ce que je vous réveille. Très bien…

1- Abaissement de la main

Maintenant, j'aimerais que vous leviez votre main droite au niveau de l'épaule, avec la paume vers le haut. Votre main droite bien en étendue devant vous, paume vers le haut. Voilà, comme ça… Faites attention à cette main, à ce qu'elle ressent, à ce qui se passe à l'intérieur. Remarquez si elle est légèrement engourdie, s'il y a des picotements. Remarquez l'effort qu'elle fait pour ne pas plier votre poignet. Et remarquez la caresse de l'air sur votre peau. Faites bien attention à votre main. Imaginez que vous êtes en train de tenir quelque chose de lourd dans votre main… Peut-être aussi lourd qu'une boule de bowling, ou autre chose, quelque chose de lourd. Laissez vos doigts se refermer sur cet objet pesant que vous imaginez maintenant dans votre main. C'est ça… et maintenant la main et le bras se sentent lourd, n'est-ce pas ? Comme si le poids appuyait vers le bas. Et tandis que ce poids se fait sentir de plus en plus lourd, le bras commence à descendre. Comme s'il était pressé vers le bas… Il cède de plus en plus… Descend… et descend de plus en plus… de plus en plus bas… de plus en plus lourd. Le bras se sent de plus en plus fatigué par tant d'effort. Plus bas… à votre rythme… inexorablement… plus bas… plus lourd… le poids est si pesant, la main tellement lourde… Vous ressentez de plus en plus cette pesanteur. Et le bras est trop lourd pour lutter… Il descend de plus en plus, toujours plus bas…

[pause de dix secondes]

C'est très bien… maintenant vous pouvez ramener votre main dans sa position de repos, sur votre genou, et vous relâcher. Vous avez probablement senti votre bras et votre main bien plus lourds et fatigués qu'habituellement. Si vous n'aviez pas imaginé quelque chose de lourd et que vous ne vous étiez pas concentré dessus comme vous l'avez fait, votre bras n'aurait probablement pas bougé, vous

vous en rendez compte ? Maintenant détendez-vous. Votre main et votre bras sont revenu à leur place et les dernières sensations de fatigue ou de lourdeur peuvent finir de se dissiper progressivement…

2- Rapprochement des mains

Je vais maintenant vous demander d'étendre vos deux mains devant vous, avec les paumes qui se font face. Vous pouvez les séparer à peu près de 30cm, c'est à peu près la largeur de vos épaules, avec vos paumes face à face. J'aimerais que vous imaginiez qu'une force agit sur vos mains, elle les attire l'une vers l'autre, comme si elles étaient poussées l'une vers l'autre. Vous imaginez ces mains tirées l'une vers l'autre, tandis qu'elles commencent à se rejoindre… à se rassembler… se rapprocher… de plus en plus proches… toujours plus proches…

[pause de dix secondes]

C'est très bien. Vous avez remarqué à quel point l'imagination et le mouvement sont intimement reliés ? Maintenant je vous invite à ramener vos mains sur vos genoux et à vous relâcher… Voilà, de retour à votre position de repos et bien détendu.

3- Hallucination du moustique (insecte)

Note. Le moustique de la version originale a été remplacé par le terme générique « insecte »

Depuis un moment, vous m'écoutez très attentivement. Et je ne sais pas si vous avez remarqué cet insecte qui tourne autour de vous, avec ce bourdonnement particulier quand il passe proche de votre oreille… Ecoutez… Vous pouvez entendre le son qu'il fait quand il s'approche de votre main droite ? Oh, il se pose sur votre main ! Vous sentez peut-être que ça chatouille un peu… peut-être qu'il pourrait vous piquer… cette idée ne vous plait pas trop… chassez-le ! Allez-y chassez-le pour qu'il ne vous ennuie plus…

[pause de dix secondes]

Cet insecte a décidé de partir… C'est bien mieux… il ne vous ennuiera plus. Vous pouvez complètement vous détendre… voilà, complètement relâché.

4- Hallucination gustative

Je vous invite maintenant à penser à quelque chose de sucré. Imaginez quelque chose avec un gout sucré dans votre bouche, comme un petit morceau de sucre. Et tandis que vous imaginez ce gout sucré, vous pouvez réellement sentir la douceur de ce goût. Ça peut parfois être léger au début, mais vous allez remarquer que ça se développe et que ça s'intensifie… de plus en plus. Vous commencez à en prendre conscience, n'est-ce pas ? Ce gout sucré qui s'intensifie dans votre bouche… de plus en plus doux… de plus en plus sucré… et ça continue de se développer. Ça prend parfois un petit moment avant qu'un goût comme celui-ci n'atteigne son plein potentiel. Et maintenant, ça continue de s'amplifier…

[pause de dix secondes]

Parfait. J'aimerais que vous remarquiez maintenant que quelque chose est en train de changer dans ce goût : il évolue. Vous commencez peut-être à réaliser qu'il se transforme en acidité dans votre bouche. Un goût acide… comme si vous aviez croqué dans un citron… comme si vous buviez du vinaigre. Vous sentez ce gout qui devient de plus en plus acide… aigre… Et ça continue à s'amplifier…

[pause de dix secondes]

Super ! Maintenant vous pouvez sentir que le goût revient à la normale, l'acidité se dissipe et vous retrouvez un gout plus habituel. Ça va se dissiper assez vite vous allez voir. D'ailleurs, maintenant c'est plutôt banal tandis que vous continuez de vous détendre… et vous êtes de plus en plus relâché.

5- Rigidité du bras

Vous allez maintenant tendre votre bras droit devant vous, si vous voulez bien. Tendez-le avec tous les doigts bien tendus également. Parfait, votre bras droit bien étiré, bien tendu. Imaginez maintenant que ce bras devienne de plus en plus raide. De plus en plus raide et rigide, comme s'il était pris dans un plâtre, comme si le coude était verrouillé… raide… bien rigide et droit, complètement verrouillé. Et vous savez qu'un bras étroitement plâtré ne peut plus bouger. Et ce bras se sent aussi rigide qu'étroitement plâtré. Testez… Testez sa rigidité, essayez de le plier… essayez.

[pause de dix secondes]

C'est très bien. Vous aurez la possibilité de vivre plein de choses différentes dans cette expérience. Vous avez probablement remarqué à quel point votre bras est devenu raide quand vous l'avez imaginé rigide et l'effort qu'il a fallu faire pour le plier, n'est-ce pas ? Maintenant votre bras est de nouveau détendu, encore plus détendu et relâché. Vous pouvez le replacer sur votre genou et vous détendre.

6- Immobilisation du bras (bras gauche)

A présent, votre main gauche devrait être sur votre genou. Sinon, vous pouvez la replacer. Et vous êtes très détendu et confortable, avec une sensation de pesanteur dans tout votre corps. J'aimerais que vous vous concentriez sur votre main gauche et votre bras gauche. Faites bien attention à cette main et à ce bras. Ils sont engourdis et lourds. Très lourds. A quel point ressentez-vous cette lourdeur dans votre main gauche ? Et pendant que vous vous concentrez sur cette sensation de lourdeur, elle s'alourdit de plus en plus… Et votre main devient de plus en plus pesante, plus lourde, lourde comme si elle était compressée sur votre genou. Et vous pourrez constater dans quelques instants à quel point cette main est lourde. Beaucoup trop lourde pour la déplacer. Mais malgré son poids démesuré, peut être que vous pouvez essayer de la décoller un petit peu ? Mais elle est probablement déjà trop lourde, même pour ça… Pourquoi ne pas tester à quel point elle est lourde ? Allez-y, essayez de la lever… essayez.

[pause de dix secondes]

C'est très bien. Vous sentez à quel point c'était plus dur que d'habitude de lever votre main ? C'est dû à l'état dans lequel vous êtes maintenant. Maintenant reposez votre main et ramenez-là dans son état détendu. Votre main et votre bras sont revenus à la normale, plus légers et relâchés. Profitez-en pour vous relâcher complètement.

7- Hallucination musicale

Dans quelques instants vous pourrez entendre un extrait de la musique « joyeux anniversaire ». Au début de l'enregistrement, le volume sera extrêmement faible et vous ne serez peut-être pas en mesure de l'entendre, ou alors très faiblement. Puis le volume va monter à chaque étape et j'aimerais que vous signaliez le moment où vous entendez la musique correctement en levant la main droite. Ça vous permettra d'avoir un repère précis où vous avez entendu la musique et vous pourrez le rapporter plus tard dans le questionnaire. Donc, quand vous entendez la musique « joyeux anniversaire » correctement, levez la main droite. Ok ? C'est parti, voici le premier niveau. *[pause de cinq secondes]* Maintenant le volume va être un peu augmenter… vous êtes au deuxième niveau. N'oubliez pas de lever la main quand vous entendez la musique. *[pause de cinq secondes]*On continue de monter le son. Niveau trois. *[pause de cinq secondes]* Et maintenant le niveau le plus fort, le quatrième niveau. Levez la main si vous l'entendez maintenant. *[pause de cinq secondes]* Ok, la musique est maintenant terminée et vous pouvez ramener votre main sur le genou si vous l'aviez encore en l'air. Prenez ce moment pour tout simplement vous relâcher et savourer cette expérience hypnotique.

8- Hallucination visuelle négative

Et pendant que vous vous relâchez, vous allez approfondir d'avantage cet état hypnotique. Et au plus vous respirez librement et confortablement, au plus vous vous enfoncez dans un état hypnotique profond. Tout en étant assis confortablement comme vous l'êtes maintenant, je vais vous bientôt vous demander d'ouvrir les yeux. Quand vous ouvrirez les yeux, vous verrez une croix grise sur un fond noir. Puis cette croix va disparaitre et faire place à une image contenant deux balles de couleur. Ces deux balles seront au centre de l'écran, bien en vue pour que vous les voyez clairement. Vous verrez ces deux balles et rien que ces deux balles. Ok, maintenant ouvrez les yeux et fixez la croix grise qui est affichée à l'écran.

[faire coïncider l'enregistrement et l'affichage de la croix grise de fixation pendant cinq secondes. Puis afficher à l'écran les trois balles de couleur (rouge, vert et bleu) pendant dix secondes en continuant le paragraphe suivant]

Regardez les deux balles qui sont affichées. Souvenez-vous de la couleur des deux balles que vous voyez pour pouvoir les rapporter plus tard.

[retirer les trois balles de couleur de l'écran]

Parfait, vous pouvez maintenant rapporter sous cette vidéo les couleurs des balles que vous avez vu. Une fois que vous aurez noté votre réponse, vous cliquerez sur le bouton 'suivant' qui se trouve en dessous. Vous arriverez sur une nouvelle page et cliquerez sur la vidéo et continuerez l'expérience.

[Fin du premier enregistrement]

[Second enregistrement]

Parfait, vous pouvez maintenant retourner dans votre position de repos, les yeux fermés, avec vos mains sur vos genoux et votre corps bien détendu. Allez-y, relâchez-vous complètement. C'est parfait, complètement relâché.

9- (& 10-) Suggestion post-hypnotique (quatre espaces) et amnésie

Et tout en restant complètement relâché, vous allez faire particulièrement attention à ce que je vais vous dire maintenant. Dans quelques instants, je vais compter à rebours de 20 à 1. Vous allez vous réveillez progressivement, mais pour la plus grande partie du décompte vous resterez dans l'état plaisant et détendu dans lequel vous êtes à présent. Au moment où j'atteindrai '5' vous ouvrirez les yeux, mais vous ne serez pas encore complètement réveillé. Quand j'atteindrai '1' vous serez complètement réveillé, dans un niveau de vigilance normal. Vous aurez probablement l'impression d'avoir dormi, parce que vous aurez du mal à vous rappeler de ce qui s'est passé depuis que vous avez commencé à écouter ma voix. En fait, ça vous demandera tellement d'effort de vous rappeler tout ça que vous n'aurez même pas envie de la faire. Ça sera bien plus facile de simplement oublier tout ça jusqu'à ce que je vous demande de vous souvenir. Vous n'arriverez pas à vous souvenir de ce que vous avez vécu depuis que vous écoutez ma voix jusqu'à ce que je vous dise : « vous pouvez vous souvenir de tout ce que vous avez vécu maintenant ». Et avant ça, vous ne pourrez vous souvenir de rien. Rien. Quand vous ouvrirez les yeux, vous vous sentirez bien. Je vais maintenant compter à rebours de 20 à 1 et à '5' et pas avant, vous ouvrirez les yeux. Mais vous ne serez complètement réveillé qu'à '1'. Et à '1' vous serez complètement réveillé. Un peu après, je vous demanderais de commencer à remplir le questionnaire qui se trouve à la page suivante. Et quand vous commencerez à répondre à la question, vous commencerez avec un quatre petits espaces avant d'écrire votre réponse. Vous ferez quatre petits espaces en appuyant 4 fois sur la barre d'espace. Et puis vous commencerez à répondre à la question. Vous ferez ces quarte petits espaces, mais vous oublierez que je vous l'ai demandé, comme vous oublierez tout le reste… Jusqu'à ce que je vous dise « vous pouvez vous souvenir de tout ce que vous avez vécu maintenant ». Vous êtes prêt ? 20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, La moitié du chemin, on remonte. 9, 8, 7, 6, CINQ, 4, 3, 2… 1 ! Réveillez-vous ! Bien de retour ! Vous allez sentir que les signes de torpeur vont se dissiper assez rapidement.

Test

Vous allez maintenant cliquer sur le bouton 'suivant' juste en dessous de cette vidéo et en arrivant sur la prochaine page vous lancerez la vidéo avant de lire la question qui se trouve en dessous.

[Fin du second enregistrement]

[Troisième enregistrement]

Parfait ! Vous allez maintenant écrire ce dont vous vous souvenez de l'expérience que vous venez de vivre. Ne rentrez pas dans les détails, faites simplement une liste de ce dont vous vous souvenez depuis l'induction hypnotique avec le comptage de 1 à 20. Vous avez deux minutes pour faire cela, laissez cette vidéo tourner pendant que vous rapportez vos souvenirs. Quand vous n'avez plus rien à ajouter, vous pouvez cliquer sur le bouton 'suivant' en bas de la page. Je vous dirai quand les deux minutes seront écoulées, et vous devrez arrêter là où vous en êtes et cliquer sur le bouton suivant.

[pause de deux minutes]

Ok, appuyez sur le bouton 'suivant' en dessous et en arrivant sur la prochaine page vous lancerez la vidéo avant de lire la question qui se trouve en dessous.

[Fin du troisième enregistrement]

[Quatrième enregistrement]

Parfait ! Je vais vous demander de ne plus revenir en arrière dans le questionnaire. Ecoutez-moi bien attentivement. Vous pouvez vous souvenir de tout ce que vous avez vécu maintenant. Vous allez maintenant écrire ce dont vous vous souvenez en plus de ce que vous avez déjà rapporté tout à l'heure. Encore une fois ne rentrez pas dans les détails, faites simplement une liste de ce dont vous vous souvenez depuis l'induction hypnotique avec le comptage de 1 à 20 et que vous n'avez pas rapporté précédemment. Vous avez là aussi deux minutes pour cette section et je vous indiquerai quand elles seront écoulées. Quand ce sera fini, vous devrez arrêter là où vous en êtes et cliquer sur le bouton suivant.

[pause de deux minutes]

Ok, appuyez sur le bouton 'suivant' en dessous. Dans la suite du questionnaire, vous trouverez une liste des différentes suggestions qui vous ont été proposées au cours de cette expérience hypnotique. Lisez attentivement les instructions s'il vous plait et répondez aux questions du mieux que vous pouvez.

[Fin du quatrième enregistrement]

[Cinquième enregistrement]

Merci pour votre participation à cette échelle d'hypnotisabilité ! Par votre participation, vous faites avancer la recherche scientifique sur l'hypnose. Vous vous souvenez peut-être que durant la session d'aujourd'hui on vous a demandé de lever votre main si vous entendiez la musique 'Joyeux anniversaire'. En réalité, il n'y avait pas de musique. De la même façon, vers la fin de la session je vous ai dit que vous verriez deux balles à l'écran alors qu'en réalité il y en avait trois.

Le but de ces deux suggestions n'était pas de vous abuser. La recherche a démontré que quelques individus exceptionnels pouvaient parfois altérer leur perception pour qu'elle coïncide avec ce qui leur était suggéré sous hypnose. Le but de ces deux tests était d'évaluer votre capacité à modifier votre perception.

Au nom de notre équipe de recherche et de l'ensemble de la communauté scientifique, je vous remercie pour votre participation.

Texte utilisé dans le questionnaire en ligne

MERCI DE NE PAS RETOURNER EN ARRIÈRE DANS LE QUESTIONNAIRE

Ci-dessous vous trouverez une liste des phénomènes qui vous ont été suggérés pendant l'expérience hypnotique par ordre chronologique. Nous vous demandons d'estimer si vous avez objectivement répondu à chacune de ces neuf suggestions, c'est-à-dire si un observateur extérieur aurait pu juger de la réussite ou de l'échec de la suggestion par des critères qui vous seront précisé à chaque fois. Vous aurez également à renseigner votre expérience subjective pour chaque suggestion, c'est-à-dire à quel point vous avez fortement vécu l'effet de la suggestion.

Nous comprenons que dans certains cas votre estimation peut ne pas être aussi précise que vous voudriez. Nous vous demandons néanmoins de répondre de votre mieux aux questions qui vous sont posées.

Nous vous prions de répondre à l'ensemble des questions. Si une question n'a pas de réponse, nous serons dans l'obligation de supprimer vos données.

Les instructions pour évaluer chaque suggestion est donnée après chaque description.

0- Induction hypnotique

Nous avons commencé la session par une induction vous invitant à entrer dans un état d'hypnotique.

Sur une échelle de 0 à 5, à quel point avez-vous eu l'impression d'entrer dans un état hypnotique. '0' signifie que votre état de conscience était tout à fait normal, '1' signifie que vous étiez légèrement hypnotisé et '5' signifie que vous étiez dans un état hypnotique très profond.

Etat normal (0) ------------------ (5) Etat hypnotique profond

1- Abaissement de la main droite

Nous vous avons demandé d'étendre votre bras droit devant vous et de ressentir de la lourdeur, comme si un poids le forçait à descendre.

Estimeriez-vous qu'un observateur extérieur aurait vu votre main s'abaisser d'au moins 15 centimètres ?

(A) Ma main s'est abaissée de PLUS de 15 centimètres
(B) Ma main s'est abaissée de MOINS de 15 centimètres

Sur une échelle de 0 à 5, à quel point avez-vous ressenti que votre main devenez lourde. '0' signifie que vous avez ressenti votre main n'était pas plus lourde que d'habitude. '5' signifie que vous avez ressenti votre main lourde comme s'il y avait réellement un objet lourd qui la tirait vers le bas.

Poids normal (0) ------------------ (5) Très lourd

2- Mains qui se rapprochent

Nous vous avons demandé de positionner vos mains devant vous, à environ 30 centimètres de distance et d'imaginer une force qui les attirent.

Estimeriez-vous qu'un observateur extérieur aurait vu vos mains s'approcher d'au moins 15 centimètres ?

(A) Mes mains se sont approchées de PLUS de 15 centimètres
(B) Mes mains se sont approchées de MOINS de 15 centimètres

Sur une échelle de 0 à 5, à quel point avez-vous ressenti une force entre vos mains. '0' signifie que vous n'avez ressenti aucune force. '5' signifie que vous avez ressenti une force comme si vos mains étaient des aimants.

Aucune force (0) ------------------ (5) Force intense

3- Expérience de l'insecte

Nous vous avons demandé par la suite de prendre conscience d'un insecte qui volait autour de vous et qui s'est posé sur votre main. Nous vous avons demandé de le chasser.

Estimeriez-vous qu'un observateur extérieur vous aurait vu grimacer, faire un mouvement ou tout autre signe lui permettant de voir l'effet ? (en dehors de ce que vous avez pu vivre)

(A) J'ai eu des mimiques ou des gestes pouvant indiquer que j'expérimentais la présence d'un insecte
(B) Rien ne pouvait indiquer ce que je vivais à l'extérieur

Sur une échelle de 0 à 5, à quel point avez-vous ressenti la présence d'un insecte, soit par le son, soit par le toucher. '0' signifie que vous n'avez rien ressenti. '5' signifie que vous avez ressenti un insecte comme s'il était vraiment présent.

Aucun ressenti (0) ------------------ (5) Comme un vrai insecte

4- Expérience du gout

Nous vous avons ensuite demandé d'imaginer un goût sucré dans la bouche et puis un goût acide.

A quel point le gout sucré était fort ?

(A) Je n'ai pas ressenti le gout sucré
(B) Le gout était vague ou faible
(C) Le gout était fort

Avez-vous fait une mimique qui pourrait indiquer à un observateur externe votre expérience du goût sucré ?

(A) Oui
(B) Non

A quel point le gout acide était fort ?

(A) Je n'ai pas ressenti le gout acide
(B) Le gout était vague ou faible
(C) Le gout était fort

Avez-vous fait une mimique qui pourrait indiquer à un observateur externe votre expérience du goût acide ?

(A) Oui
(B) Non

A quel point avez-vous ressenti le gout sucré dans votre bouche ?

Sur une échelle de 0 à 5, à quel point avez-vous ressenti un gout sucré dans votre bouche. '0' signifie que vous n'avez pas eu de gout sucré du tout et '5' signifie que le gout sucré était très fort.

Pas de goût (0) ------------------ (5) Gout très sucré

A quel point avez-vous ressenti le gout acide dans votre bouche ?

Sur une échelle de 0 à 5, à quel point avez-vous ressenti un gout acide dans votre bouche. '0' signifie que vous n'avez pas eu de gout acide du tout et '5' signifie que le gout acide était très fort.

Pas de goût (0) ------------------ (5) Gout très acide

5- Rigidité du bras droit

Nous vous avons demandé ensuite d'étendre votre bras droit devant vous et de ressentir qu'il devenait rigide. Nous vous avons ensuite demandé de le plier.

Estimeriez-vous qu'un observateur extérieur aurait vu votre bras se plier de plus de 5 centimètres avant qu'on vous demande d’arrêter ?

(A) Mon bras s'est plié de MOINS de 5 centimètres
(B) Mon bras s'est plié de PLUS de 5 centimètres

Sur une échelle de 0 à 5, à quel point avez-vous ressenti de la rigidité dans votre bras. '0' signifie que vous n'avez pas ressenti plus de rigidité que d'habitude et '5' signifie que vous ressentiez le bras complètement immobile et qu'aucune force ne pouvait le faire bouger.

Pas de rigidité (0) ------------------ (5) Forte rigidité

6- Immobilisation de la main gauche

Nous vous avons ensuite dit que votre main gauche était très lourde et nous vous avons demandé d'essayer de la lever.

Estimeriez-vous qu'un observateur extérieur aurait vu que votre main ne s'est pas levé de plus de 2 centimètres avant que l'on vous dise d’arrêter.

(A) Je n'ai PAS levé ma main de plus de 2 centimètres
(B) J'ai levé ma main de plus de 2 centimètres

Sur une échelle de 0 à 5, à quel point avez-vous ressenti de la lourdeur dans votre main. '0' signifie que vous n'avez pas ressenti plus de lourdeur que d'habitude et '5' signifie que vous ressentiez votre main comme si un objet très lourd appuyait dessus.

Pas de lourdeur (0) ------------------ (5) Lourdeur intense

7- Expérience musicale

Nous vous avons ensuite demandé de lever la main quand vous entendez 'Joyeux anniversaire'.

(A) J'ai levé ma main
(B) Je n'ai PAS levé ma main

Sur une échelle de 0 à 5, à quel point avez-vous clairement entendu la musique. '0' signifie que vous n'avez pas entendu de musique et '5' signifie que vous avez entendu la musique très clairement.

Aucune musique (0) ------------------ (5) Musique clairement entendue

8- Expérience des balles

Nous vous avons ensuite demandé de regarder une image contenant deux balles colorées. Vous avez ensuite rapporté la couleur des balles que vous avez vu à l'écran.

Sur une échelle de 0 à 5, à quel point la troisième balle était invisible. '0' signifie que vous avez clairement vu trois balles, '5' signifie que vous avez seulement vu deux balles et chaque nombre entre 1 et 4 signifie que vous avez eu quelques difficultés à discerner la troisième balle.

J'ai vu trois balles (0) ------------------ (5) J'ai vu deux balles

9- Amnésie

Nous vous avons dit que vous ne vous souviendrai pas de ce que vous avez vécu au cours de l'expérience d'hypnose avant que l'on vous dise « vous pouvez vous souvenir de tout ce que vous avez vécu maintenant ».

Sur une échelle de 0 à 5, à quel point avez-vous eu du mal à vous souvenir des évènements avant que l'on vous dise de vous souvenir de tout ? '0' signifie que vous vous souveniez clairement de tout, '5' signifie que vous avez eu tellement de mal à vous souvenir que c'était comme un trou de mémoire.

Je me souvenais de tout (0) ------------------ (5) J'ai eu un trou de mémoire

10- Suggestion post-hypnotique

Nous vous avons demandé enfin de faire un espace en tapant 4 fois sur la barre d'espace avant de rentrer votre réponse suite à l'amnésie.

Sur une échelle de 0 à 5, à quel point avez-vous ressenti le besoin de faire un espace avant votre réponse ? '0' signifie que vous n'en avez pas ressenti le besoin du tout, '5' signifie que vous avez ressenti un besoin très fort de faire un espace.

Je n'ai pas ressenti le besoin de faire un espace avant ma réponse (0) ------------------ (5) J'ai ressenti un besoin très clair de faire un espace avant ma réponse

Sur une échelle de 0 à 5, à quel point avez-vous vous rappelez-vous qu'on vous ait demandé de faire un espace avant votre réponse ? '0' signifie que vous vous en souveniez au moment de le faire, '5' signifie que vous n'en avez aucun souvenir au moment de le faire.

Je m'en souvenais au moment de le faire (0) -------- (5) Je ne m'en souvenais pas au moment de le faire

Guide de cotation de l'échelle d'hypnotisabilité en ligne de Sussex-Waterloo

SUGGESTION	CRITERE DE VALIDATION ECHELLE COMPORTEMENTALE
1. Abaissement de la main droite	Réponse A, indiquant que la main est descendue d'au moins 15cm en 10 secondes.
2. Mains qui se rapprochent	Réponse A, indiquant que les mains étaient espacées de moins de 15cm après 10 secondes.
3. Hallucination de l'insecte	Réponse A, indiquant une réaction visible à l'insecte halluciné.
4. Hallucination gustative	Réponse « vague » ou « fort » aux deux goûts (sucré et acide) ET « Oui » indiquant une mimique en réaction au goût au moins une fois ; OU « vague » ou « fort » pour l'un des deux goûts ET « fort » à l'autre.

5. Rigidité du bras droit	Réponse A, indiquant que le bras s'est plié de moins de 5cm en 10 secondes.
6. Immobilisation de la main gauche	Réponse A, indiquant que le bras n'a pas été levé de plus de 2cm en 10 secondes.
7. Hallucination musicale	Réponse A, indiquant que la main droite a été levée pour indiquer avoir entendu la musique.
8. Hallucination visuelle négative	Rapport d'exactement deux couleurs.
9. Amnésie	Rapport de trois items ou moins avant l'annulation de la suggestion et rapport de trois items supplémentaires ou plus après annulation de la suggestion.
10. Suggestion post-hypnotique	Présence d'exactement 4 espaces au début du test de mémoire avant l'annulation de la suggestion.

Cotation :

Score comportemental (0-10) : nombre d'items validés par les critères de l'échelle comportementale.

Score subjectif (0-5) : moyenne des scores subjectifs pour chaque item. (généralement multiplié par deux pour étendre la mesure à l'intervalle 0-10)

Note : La réponse subjective pour l'item 4 (hallucination gustative) et 10 (suggestion post-hypnotique) est générée à partir de deux réponses et nécessite d'être calculée avant de pouvoir générer le score subjectif global. Le score subjectif de l'item 4 est la moyenne des réponses aux sous-échelles subjectives pour le goût sucré et acide. Le score subjectif de l'item 10 est la moyenne géométrique (la racine carrée du produit) des sous-échelles subjectives de compulsion et d'amnésie de la suggestion post-hypnotique.

Un score combiné peut être généré en prenant la moyenne des scores (comportemental et subjectif) en prenant soin de multiplier le score subjectif par 2 afin de l'étendre à l'intervalle 0-10.

Un score comportemental corrigé peut être calculé en comptant systématiquement un item comme échoué dès lors que le rapport subjectif correspondant à cet item est inférieur ou égal à 1.

BIBLIOGRAPHY

Acunzo, D., & Terhune, D. (2019). *A critical review of standardized measures of hypnotic suggestibility*. XXX. https://doi.org/10.31234/osf.io/m93uy

Acunzo, D., & Terhune, D. (2021). A critical review of standardized measures of hypnotic suggestibility. *International Journal of Clinical & Experimental Hypnosis*, *69*, 50-71. https://doi.org/10.31234/osf.io/m93uy

Aglioti, S., DeSouza, J. F. X., & Goodale, M. A. (1995). Size-contrast illusions deceive the eye but not the hand. *Current Biology, 5*(6), 679-685. https://doi.org/10.1016/S0960-9822(95)00133-3

Albrecht, F., Mueller, K., Ballarini, T., Lampe, L., Diehl-Schmid, J., Fassbender, K., Fliessbach, K., Jahn, H., Jech, R., Kassubek, J., Kornhuber, J., Landwehrmeyer, B., Lauer, M., Ludolph, A. C., Lyros, E., Prudlo, J., Schneider, A., Synofzik, M., Wiltfang, J., … Schroeter, M. L. (2019). Unraveling corticobasal syndrome and alien limb syndrome with structural brain imaging. *Cortex, 117*, 33-40. https://doi.org/10.1016/j.cortex.2019.02.015

Anders, D., Berisha, A., Selaskowski, B., Asché, L., Thorne, J. D., Philipsen, A., & Braun, N. (2021). Experimental Induction of Micro- and Macrosomatognosia : A Virtual Hand Illusion Study. *Frontiers in Virtual Reality*, *2*, 47. https://doi.org/10.3389/frvir.2021.656788

Andersen, M., Pfeiffer, T., Müller, S., & Schjoedt, U. (2019). Agency detection in predictive minds : A virtual reality study. *Religion, Brain & Behavior, 9*(1), 52-64. https://doi.org/10.1080/2153599X.2017.1378709

Anema, H. A., van Zandvoort, M. J. E., de Haan, E. H. F., Kappelle, L. J., de Kort, Paul. L. M., Jansen, B. P. W., & Dijkerman, H. C. (2009). A double dissociation between somatosensory processing for perception and action. *Neuropsychologia*, *47*(6), 1615-1620. https://doi.org/10.1016/j.neuropsychologia.2008.11.001

Anlló, H., & Sackur, J. (2017). *French Norms for the Harvard Group Scale of Hypnotic Susceptibility, Form A*. Brunner/Mazel.

Apelian, C. (2021). *French norms for the online Sussex-Waterloo Scale of Hypnotizability*. PsyArXiv. https://doi.org/10.31234/osf.io/f34xb

Baccarini, M., Martel, M., Cardinali, L., Sillan, O., Farnè, A., & Roy, A. C. (2014). Tool use imagery triggers tool incorporation in the body schema. *Frontiers in Psychology*, *5*. https://doi.org/10.3389/fpsyg.2014.00492

Bach, D. R., Castegnetti, G., Korn, C. W., Gerster, S., Melinscak, F., & Moser, T. (2018). Psychophysiological modeling : Current state and future directions. *Psychophysiology*, *55*(11), e13214. https://doi.org/10.1111/psyp.13209

Bányai, É. I. (2018). Active-Alert Hypnosis : History, Research, and Applications. *American Journal of Clinical Hypnosis*, *61*(2), 88-107. https://doi.org/10.1080/00029157.2018.1496318

Barber, J. (1994). The Locksmith Model. In *Ericksonian Methods*. Routledge.

Barber, T. X. (1957). Hypnosis as perceptual-cognitive restructuring : III. From somnambulism to autohypnosis. *Journal of Psychology*, *44*. http://search.proquest.com/docview/1290654770/citation/80A848196CB94D73PQ/1

Barber, T. X. (1969). *Hypnosis : A scientific approach*. http://psycnet.apa.org/record/1970-19931-000

Barber, T. X. (1999). A comprehensive three-dimensional theory of hypnosis. In *Clinical hypnosis and self-regulation : Cognitive-behavioral perspectives* (p. 21-48). American Psychological Association. https://doi.org/10.1037/10282-001

Bardinet, T. (2001). *Les papyrus médicaux de l'Égypte pharaonique : Traduction intégrale et commentaire* (Fayard).

Barnier, A. J., Cox, R. E., O'Connor, A., Coltheart, M., Langdon, R., Breen, N., & Turner, M. (2008a). Developing hypnotic analogues of clinical delusions : Mirrored-self misidentification. *Cognitive Neuropsychiatry*, *13*(5), 406-430. https://doi.org/10.1080/13546800802355666

Barnier, A. J., Cox, R. E., O'Connor, A., Coltheart, M., Langdon, R., Breen, N., & Turner, M. (2008b). Developing hypnotic analogues of clinical delusions : Mirrored-self misidentification. *Cognitive Neuropsychiatry*, *13*(5), 406-430. https://doi.org/10.1080/13546800802355666

Barnier, A. J., Dienes, Z., & Mitchell, C. J. (2008). How hypnosis happens : New cognitive theories of hypnotic responding. *The Oxford handbook of hypnosis: Theory, research, and practice*, 141-177.

Barnier, A. J., & McConkey, K. M. (2004). Defining and identifying the highly hypnotizable person. In *The Highly Hypnotizable Person*. Routledge.

Barnier, A. J., & Mitchell, C. J. (2005). *Looking for the fundamental effects of hypnosis. In Invited address at the 35th annual congress of the Australian society of hypnosis (scientific program), Sydney, Australia.*

Barnier, A. J., & Nash, M. R. (2008). Introduction : For explanation, a working definition. *The Oxford handbook of hypnosis: Theory, research, and practice*, 1.

Barnier, A. J., Terhune, D. B., Polito, V., & Woody, E. (2020). A componential approach to individual differences in hypnotizability. *Psychology of Consciousness: Theory, Research, and Practice*.

Bartlett, L., Angela, M., Neil, A. L., Memish, K., Otahal, P., Kilpatrick, M., & Sanderson, K. (2019). A systematic review and meta-analysis of workplace mindfulness training randomized controlled trials. *Journal of Occupational Health Psychology*, *24*(1), 108-126. https://doi.org/10.1037/ocp0000146

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, *67*(1), 1-48. https://doi.org/10.18637/jss.v067.i01

Benham, G., Bowers, S., Nash, M., & Muenchen, R. (1998). Self-fulfilling prophecy and hypnotic response are not the same thing. *Journal of Personality and Social Psychology*, *75*(6), 1604-1613. https://doi.org/10.1037/0022-3514.75.6.1604

Benham, G., Woody, E. Z., Wilson, K. S., & Nash, M. R. (2006). Expect the unexpected : Ability, attitude, and responsiveness to hypnosis. *Journal of Personality and Social Psychology*, *91*(2), 342-350. https://doi.org/10.1037/0022-3514.91.2.342

Benham, G., & Younger, J. (2008). Hypnosis and mind–body interactions. *The Oxford handbook of hypnosis*, 393-435.

Bernardi, N. F., Marino, B. F., Maravita, A., Castelnuovo, G., Tebano, R., & Bricolo, E. (2013). Grasping in wonderland : Altering the visual size of the body recalibrates the body schema. *Experimental Brain Research*, *226*(4), 585-594. https://doi.org/10.1007/s00221-013-3467-7

Bernardy, K., Füber, N., Klose, P., & Häuser, W. (2011). Efficacy of hypnosis/guided imagery in fibromyalgia syndrome—A systematic review and meta-analysis of controlled trials. *BMC Musculoskeletal Disorders*, *12*, 133. https://doi.org/10.1186/1471-2474-12-133

Bernheim, H. (1897). *L'hypnotisme et la suggestion* (O. Doin).

Bertamini, M., & O'Sullivan, N. (2014). The use of realistic and mechanical hands in the rubber hand illusion, and the relationship to hemispheric differences. *Consciousness and Cognition*, *27*, 89-99. https://doi.org/10.1016/j.concog.2014.04.010

Blanke, O. (2012). Multisensory brain mechanisms of bodily self-consciousness. *Nature Reviews Neuroscience*, *13*(8), 556-571. https://doi.org/10.1038/nrn3292

Blanke, O., Slater, M., & Serino, A. (2015). Behavioral, Neural, and Computational Principles of Bodily Self-Consciousness. *Neuron*, *88*(1), 145-166. https://doi.org/10.1016/j.neuron.2015.09.029

Bloch, M. (1983). *Les rois thaumaturges ; étude sur le caractère surnaturel attribué à la puissance royale* (Gallimard). https://www.librairie-gallimard.com/livre/9782070227044-les-rois-thaumaturges-etude-sur-le-caractere-surnaturel-attribue-a-la-puissance-royale-particulie-marc-bloch/

Blom, J. D. (2016). Alice in Wonderland syndrome : A systematic review. *Neurology: Clinical Practice*, *6*(3), 259-270. https://doi.org/10.1212/CPJ.0000000000000251

Bortolotti, L. (2011). Double Bookkeeping in Delusions : Explaining the Gap between Saying and Doing. In J. H. Aguilar, A. A. Buckareff, & K. Frankish (Éds.), *New Waves in Philosophy of Action* (p. 237-256). Palgrave Macmillan UK. https://doi.org/10.1057/9780230304253_12

Botvinick, M., & Cohen, J. (1998a). Rubber hands 'feel' touch that eyes see. *Nature*, *391*(6669), 756-756. https://doi.org/10.1038/35784

Botvinick, M., & Cohen, J. (1998b). Rubber hands 'feel' touch that eyes see. *Nature*, *391*(6669), 756-756. https://doi.org/10.1038/35784

Bowers, K. S. (1990). Unconscious influences and hypnosis. In *Repression and Dissociation : Implications for Personality Theory, Psychopathology, and Health* (University of Chicago Press, p. 143-179).

Bowers, K. S. (1993). The Waterloo-Stanford Group C (WSGC) Scale of Hypnotic Susceptibility : Normative and Comparative Data. *International Journal of Clinical and Experimental Hypnosis*, *41*(1), 35-46. https://doi.org/10.1080/00207149308414536

Bowers, K. S. (1998). Waterloo-stanford group scale of hypnotic susceptibility, form c : Manual and response booklet. *International Journal of Clinical and Experimental Hypnosis*, *46*(3), 250-268. https://doi.org/10.1080/00207149808410006

Bowers, P. (1982). The classic suggestion effect : Relationships with scales of hypnotizability, effortless experiencing, and imagery vividness. *International Journal of Clinical and Experimental Hypnosis*, *30*(3), 270-279. https://doi.org/10.1080/00207148208407264

Boyle, R. E. (2007). *Neoshamanism and the shadow : « the soul's journey »*. https://researchdirect.westernsydney.edu.au/islandora/object/uws%3A2482/

Braffman, W., & Kirsch, I. (1999). *Imaginative suggestibility and hypnotizability : An empirical analysis*. http://psycnet.apa.org/record/1999-11174-011

Brown, R. J., Antonova, E., Langley, A., & Oakley, D. A. (2001). The effects of absorption and reduced critical thought on suggestibility in an hypnotic context. *Contemporary Hypnosis*, *18*(2), 62-72. https://doi.org/10.1002/ch.220

Bryant, R. A., & Mallard, D. (2005). Reality Monitoring in Hypnosis : A Real-Simulating Analysis. *International Journal of Clinical and Experimental Hypnosis*, *53*(1), 13-25. https://doi.org/10.1080/00207140490914216

Bryant, R. A., & McConkey, K. M. (1989). *Hypnotic Blindness : A Behavioral and Experiential Analysis*. 7.

Bryant, R. A., Moulds, M. L., Guthrie, R. M., & Nixon, R. D. V. (2005). The Additive Benefit of Hypnosis and Cognitive-Behavioral Therapy in Treating Acute Stress Disorder. *Journal of Consulting and Clinical Psychology*, *73*(2), 334-340. https://doi.org/10.1037/0022-006X.73.2.334

Burin, D., Kilteni, K., Rabuffetti, M., Slater, M., & Pia, L. (2019). Body ownership increases the interference between observed and executed movements. *PLOS ONE*, *14*(1), e0209899. https://doi.org/10.1371/journal.pone.0209899

Burrack, A., & Brugger, P. (2005). Individual differences in susceptibility to experimentally induced phantom sensations. *Body Image*, *2*(3), 307-313. https://doi.org/10.1016/j.bodyim.2005.04.002

Cangas, A. J., & Pérez, M. (1998). The effect of two procedures on hypnotic susceptibility modification. *Contemporary Hypnosis*, *15*(4), 212-218. https://doi.org/10.1002/ch.137

Cardeña, E., Jönsson, P., Terhune, D., & Marcusson-Clavertz, D. (2013). The neurophenomenology of neutral hypnosis. *Cortex*, *49*(2), 375-385. http://dx.doi.org/10.1016/j.cortex.2012.04.001

Cardeña, E., & Krippner, S. (2010). The cultural context of hypnosis. In *Handbook of clinical hypnosis, 2nd ed* (p. 743-771). American Psychological Association. https://doi.org/10.2307/j.ctv1chs5qj.34

Cardeña, E., & Terhune, D. B. (2009). A Note of Caution on the Waterloo-Stanford Group Scale of Hypnotic Susceptibility : A Brief Communication. *International Journal of Clinical and Experimental Hypnosis*, *57*(2), 222-226. https://doi.org/10.1080/00207140802665484

Cardeña, E., & Terhune, D. B. (2014). Hypnotizability, personality traits, and the propensity to experience alterations of consciousness. *Psychology of Consciousness: Theory, Research, and Practice*, *1*(3), 292-307. https://doi.org/10.1037/cns0000026

Cardeña, E., & terhune, D. B. (2019). The Roles of Response Expectancies, Baseline Experiences, and Hypnotizability in Spontaneous Hypnotic Experiences. *International Journal of Clinical and Experimental Hypnosis*, *67*(1), 1-27. https://doi.org/10.1080/00207144.2019.1553759

Cardinali, L., Frassinetti, F., Brozzoli, C., Urquizar, C., Roy, A. C., & Farnè, A. (2009). Tool-use induces morphological updating of the body schema. *Current Biology*, *19*(12), R478-R479. https://doi.org/10.1016/j.cub.2009.05.009

Cassidy, C. M., Balsam, P. D., Weinstein, J. J., Rosengard, R. J., Slifstein, M., Daw, N. D., Abi-Dargham, A., & Horga, G. (2018). A Perceptual Inference Mechanism for Hallucinations Linked to Striatal Dopamine. *Current Biology*, *28*(4), 503-514.e4. https://doi.org/10.1016/j.cub.2017.12.059

Champigny, C. M., & Raz, A. (2015). Transcultural Factors in Hypnotizability Scales : Limits and Prospects. *American Journal of Clinical Hypnosis*, *58*(2), 171-194. https://doi.org/10.1080/00029157.2015.1061473

Chertok, L. (1965). *L'hypnose* (Payot).

Clark, A. (2015). *Surfing Uncertainty : Prediction, Action, and the Embodied Mind*. Oxford University Press.

Cojan, Y., Piguet, C., & Vuilleumier, P. (2015). What makes your brain suggestible? Hypnotizability is associated with differential brain activity during attention outside hypnosis. *NeuroImage*, *117*, 367-374. https://doi.org/10.1016/j.neuroimage.2015.05.076

Colloca, L., & Barsky, A. J. (2020). Placebo and Nocebo Effects. *New England Journal of Medicine*, *382*(6), 554-561. https://doi.org/10.1056/NEJMra1907805

Colombo, M., & Seriès, P. (2012). Bayes in the Brain—On Bayesian Modelling in Neuroscience. *The British Journal for the Philosophy of Science*, *63*(3), 697-723. https://doi.org/10.1093/bjps/axr043

Comey, G., & Kirsch, I. (1999). Intentional and spontaneous imagery in hypnosis : The phenomenology of hypnotic responding. *International Journal of Clinical and Experimental Hypnosis*, *47*(1), 65-85. https://doi.org/10.1080/00207149908410023

Connors, M. H. (2015). Hypnosis and belief : A review of hypnotic delusions. *Consciousness and Cognition*, *36*, 27-43. https://doi.org/10.1016/j.concog.2015.05.015

Connors, M. H., Cox, R. E., Barnier, A. J., Langdon, R., & Coltheart, M. (2012). Mirror agnosia and the mirrored-self misidentification delusion : A hypnotic analogue. *Cognitive Neuropsychiatry*, *17*(3), 197-226. https://doi.org/10.1080/13546805.2011.582770

Council, J. R., & Green, J. P. (2004). Examining the absorption-hypnotizability link : The roles of acquiescence and consistency motivation. *The International Journal of Clinical and Experimental Hypnosis*, *52*(4), 364-377. https://doi.org/10.1080/00207140490883950

Council, J. R., & Kirsch, I. (1996). Explaining context effects : Expectancy and consistency. *Contemporary Hypnosis*, *13*(1), 29-32. https://doi.org/10.1002/ch.40

Council, J. R., Kirsch, I., & Hafner, L. P. (1986). *Expectancy versus absorption in the prediction of hypnotic responding*. http://psycnet.apa.org/record/1986-16331-001

Cox, R. E., & Bryant, R. A. (2008). Advances in hypnosis research : Methods, designs and contributions of intrinsic and instrumental hypnosis. *The Oxford handbook of hypnosis: Theory, research, and practice*, *2008*, 311-336.

Cozzolino, M., Celia, G., Rossi, K. L., & Rossi, E. L. (2020). Hypnosis as Sole Anesthesia for Dental Removal in a Patient with Multiple Chemical Sensitivity. *International Journal of Clinical and Experimental Hypnosis*, *68*(3), 371-383. https://doi.org/10.1080/00207144.2020.1762494

Crawford, H. J., Brown, A. M., & Moon, C. E. (1993a). Sustained attentional and disattentional abilities : Differences between low and highly hypnotizable persons. *Journal of Abnormal Psychology*, *102*(4), 534-543. https://doi.org/10.1037/0021-843X.102.4.534

Crawford, H. J., Brown, A. M., & Moon, C. E. (1993b). Sustained attentional and disattentional abilities : Differences between low and highly hypnotizable persons. *Journal of Abnormal Psychology*, *102*(4), 534-543.

Cumming, J., & Eaves, D. L. (2018). The Nature, Measurement, and Development of Imagery Ability. *Imagination, Cognition and Personality*, *37*(4), 375-393. https://doi.org/10.1177/0276236617752439

D'Amour, S., Pritchett, L. M., & Harris, L. R. (2015). Bodily illusions disrupt tactile sensations. *Journal of Experimental Psychology: Human Perception and Performance*, *41*(1), 42-49. https://doi.org/10.1037/a0038514

D'Angelo, M., di Pellegrino, G., & Frassinetti, F. (2019). The illusion of having a tall or short body differently modulates interpersonal and peripersonal space. *Behavioural Brain Research*, *375*, 112146. https://doi.org/10.1016/j.bbr.2019.112146

Daselaar, S. M., Porat, Y., Huijbers, W., & Pennartz, C. M. A. (2010). Modality-specific and modality-independent components of the human imagery system. *NeuroImage*, *52*(2), 677-685. https://doi.org/10.1016/j.neuroimage.2010.04.239

Dawes, A. J., Keogh, R., Andrillon, T., & Pearson, J. (2020). A cognitive profile of multi-sensory imagery, memory and dreaming in aphantasia. *Scientific Reports*, *10*(1), 10022. https://doi.org/10.1038/s41598-020-65705-7

De Pascalis, V., Gheorghiu, V. A., Sheehan, P. W., & Kirsch, I. I. (2000). *Suggestion and Suggestibility. Theory and Research (Proceedings of the « 2nd International Symposium on Suggestion and*

Suggestibility », 1994 at the University of Rome, Italy) (MEG-Stiftung). https://www.meg-stiftung.de/index.php/de/publikationen/3-hypnosis-international-monographs/19-suggestion-and-suggestgibility-theory-and-research

De Vignemont, F. (2018). *Mind the body : An exploration of bodily self-awareness*. Oxford University Press.

De Vignemont, F., & Farnè, A. (2010). Widening the body to rubber hands and tools : What's the difference? *Revue de neuropsychologie*, *2*(3), 203-211.

Deeley, Q., Walsh, E., Oakley, D. A., Bell, V., Koppel, C., Mehta, M. A., & Halligan, P. W. (2013). Using Hypnotic Suggestion to Model Loss of Control and Awareness of Movements : An Exploratory fMRI Study. *PLoS ONE*, *8*(10), e78324. https://doi.org/10.1371/journal.pone.0078324

Delhaye, B. P., Long, K. H., & Bensmaia, S. J. (2018). Neural Basis of Touch and Proprioception in Primate Cortex. In *Comprehensive Physiology* (p. 1575-1602). John Wiley & Sons, Ltd. https://doi.org/10.1002/cphy.c170033

Dell, P. F. (2021). Hypnotizability and the Natural Human Ability to Alter Experience. *International Journal of Clinical and Experimental Hypnosis*, *69*(1), 7-26. https://doi.org/10.1080/00207144.2021.1834859

Derbyshire, S. W. G., Whalley, M. G., Stenger, V. A., & Oakley, D. A. (2004). Cerebral activation during hypnotically induced and imagined pain. *NeuroImage*, *23*(1), 392-401. https://doi.org/10.1016/j.neuroimage.2004.04.033

de Saldanha da Gama, P. A. M., Davy, T., & Cleeremans, A. (2012a). Belgian Norms for the Waterloo-Stanford Group C (WSGC) Scale of Hypnotic Susceptibility. *International Journal of Clinical and Experimental Hypnosis*, *60*(3), 356-369. https://doi.org/10.1080/00207144.2012.675299

de Saldanha da Gama, P. A. M., Davy, T., & Cleeremans, A. (2012b). Belgian Norms for the Waterloo-Stanford Group C (WSGC) Scale of Hypnotic Susceptibility. *International Journal of Clinical and Experimental Hypnosis*, *60*(3), 356-369. https://doi.org/10.1080/00207144.2012.675299 de Vignemont, F. (2010). Body schema and body image—Pros and cons. *Neuropsychologia*, *48*(3), 669-680. https://doi.org/10.1016/j.neuropsychologia.2009.09.022

de Vignemont, F., Ehrsson, H. H., & Haggard, P. (2005a). Bodily Illusions Modulate Tactile Perception. *Current Biology*, *15*(14), 1286-1290. https://doi.org/10.1016/j.cub.2005.06.067

de Vignemont, F., Ehrsson, H. H., & Haggard, P. (2005b). Bodily Illusions Modulate Tactile Perception. *Current Biology*, *15*(14), 1286-1290. https://doi.org/10.1016/j.cub.2005.06.067

Diedenhofen, B., & Musch, J. (2015). cocor : A Comprehensive Solution for the Statistical Comparison of Correlations. *PLOS ONE*, *10*(4), e0121945. https://doi.org/10.1371/journal.pone.0121945

Dienes, Z., Brown, E., Hutton, S., Kirsch, I., Mazzoni, G., & Wright, D. B. (2009). Hypnotic suggestibility, cognitive inhibition, and dissociation. *Consciousness and Cognition*, *18*(4), 837-847. https://doi.org/10.1016/j.concog.2009.07.009

Dienes, Z., Lush, P., Palfi, B., Roseboom, W., Scott, R., Parris, B., Seth, A., & Lovell, M. (2020). Phenomenological control as cold control. *Psychology of Consciousness: Theory, Research, and Practice*, No Pagination Specified-No Pagination Specified. https://doi.org/10.1037/cns0000230

Dienes, Z., & Perner, J. (2007). Executive control without conscious awareness : The cold control theory of hypnosis. *Hypnosis and conscious states: The cognitive neuroscience perspective*, 293-314.

Dijkerman, H. C., & Haan, E. H. F. (2007). Somatosensory processes subserving perception and action. *Behavioral and Brain Sciences*, *30*(02), 222. https://doi.org/10.1017/S0140525X07001392

Dijkstra, N., Bosch, S. E., & van Gerven, M. A. J. (2017). Vividness of Visual Imagery Depends on the Neural Overlap with Perception in Visual Areas. *The Journal of Neuroscience*, *37*(5), 1367-1373. https://doi.org/10.1523/JNEUROSCI.3022-16.2016

Dijkstra, N., Bosch, S. E., & van Gerven, M. A. J. (2019). Shared Neural Mechanisms of Visual Perception and Imagery. *Trends in Cognitive Sciences*, *23*(5), 423-434. https://doi.org/10.1016/j.tics.2019.02.004

Dixon, M., & Laurence, J.-R. (1992). Hypnotic susceptibility and verbal automaticity : Automatic and strategic processing differences in the Stroop color-naming task. *Ournal of Abnormal Psychology*, *101*(2), 344-347.

Dokic, J., & Martin, J.-R. (2017). Felt Reality and the Opacity of Perception. *Topoi*, *36*(2), 299-309. https://doi.org/10.1007/s11245-015-9327-2

Dominici, N., Daprati, E., Nico, D., Cappellini, G., Ivanenko, Y. P., & Lacquaniti, F. (2009). Changes in the Limb Kinematics and Walking-Distance Estimation After Shank Elongation : Evidence for a Locomotor Body Schema? *Journal of Neurophysiology*, *101*(3), 1419-1429. https://doi.org/10.1152/jn.91165.2008

Dupuis, D. (2018). L'ayahuasca et son ombre. L'apprentissage de la possession dans un centre chamanique d'Amazonie péruvienne. *Journal de la Société des américanistes*, *104*(104-2), 33-63. https://doi.org/10.4000/jsa.16320

Egner, T., Jamieson, G., & Gruzelier, J. (2005). Hypnosis decouples cognitive control from conflict monitoring processes of the frontal lobe. *NeuroImage*, *27*(4), 969-978. https://doi.org/10.1016/j.neuroimage.2005.05.002

Ehrsson, H. (2020). Multisensory processes in body ownership. In *Multisensory Perception* (p. 179-200). Elsevier. https://doi.org/10.1016/B978-0-12-812492-5.00008-5

Ehrsson, H. H. (2012). The concept of body ownership and its relation to multisensory integration. In *The New Handbook of Multisensory Process*.

Ehrsson, H. H., Fotopoulou, A., Radziun, D., Longo, M., & Tsakiris, M. (2021). *No specific relationship between hypnotic suggestibility and the rubber hand illusion : A commentary with new and verification analyses*. PsyArXiv. https://doi.org/10.31234/osf.io/pmzgc

Ehrsson, H. H., Kito, T., Sadato, N., Passingham, R. E., & Naito, E. (2005a). Neural Substrate of Body Size : Illusory Feeling of Shrinking of the Waist. *PLOS Biology*, *3*(12), e412. https://doi.org/10.1371/journal.pbio.0030412

Ehrsson, H. H., Kito, T., Sadato, N., Passingham, R. E., & Naito, E. (2005b). Neural Substrate of Body Size : Illusory Feeling of Shrinking of the Waist. *PLOS Biology*, *3*(12), e412. https://doi.org/10.1371/journal.pbio.0030412

Ellenberger, H. F. (1970). *The discovery of the unconscious : The history and evolution of dynamic psychiatry* (New York: Basic books).

Ellis, A., & Yeager, R. J. (1989). *Why some therapies don't work : The dangers of transpersonal psychology* (p. 189). Prometheus Books.

Erickson, M. H. (1958). Naturalistic Techniques of Hypnosis. *American Journal of Clinical Hypnosis*, *51*(4), 333-340. https://doi.org/10.1080/00029157.2009.10404313

Erickson, M. H., & Rossi, E. L. (1979). *Hypnotherapy* (Irvington).

Esplen, M. J., Wong, J., Warner, E., & Toner, B. (2018). Restoring Body Image After Cancer (ReBIC) : Results of a Randomized Controlled Trial. *Journal of Clinical Oncology*, *36*(8), 749-756. https://doi.org/10.1200/JCO.2017.74.8244

Evans, F. J. (1989). The Independence of Suggestibility, Placebo Response, and Hypnotizability. In *Suggestion and Suggestibility* (p. 145-154). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-73875-3_10

Farooq, O., & Fine, E. J. (2017). Alice in Wonderland Syndrome : A Historical and Medical Review. *Pediatric Neurology*, *77*, 5-11. https://doi.org/10.1016/j.pediatrneurol.2017.08.008

Farvolden, P., & Woody, E. Z. (2004). Hypnosis, Memory, And Frontal Executive Functioning. *International Journal of Clinical and Experimental Hypnosis*, *52*(1), 3-26. https://doi.org/10.1076/iceh.52.1.3.23926

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1 : Tests for correlation and regression analyses. *Behavior Research Methods*, *41*(4), 1149-1160. https://doi.org/10.3758/BRM.41.4.1149

Fazekas, P. (2021). Hallucinations as intensified forms of mind-wandering. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *376*(1817), 20190700. https://doi.org/10.1098/rstb.2019.0700

Fellows, B. J., & Ragg, L. (1992). The Carleton Skills Training Program : A preliminary British trial. *Contemporary Hypnosis*, *9*(3), 169-174.

Fernandez, E., & Turk, D. C. (1989). The utility of cognitive coping strategies for altering pain perception : A meta-analysis. *Pain*, *38*(2), 123-135. https://doi.org/10.1016/0304-3959(89)90230-3

Fiorio, M., Modenese, M., & Cesari, P. (2020). The rubber hand illusion in hypnosis provides new insights into the sense of body ownership. *Scientific Reports*, *10*(1), 5706. https://doi.org/10.1038/s41598-020-62745-x

First, M. B. (2013). *DSM-5 Handbook of Differential Diagnosis*. American Psychiatric Pub.

Fourneret, P., & Jeannerod, M. (1998). Limited conscious monitoring of motor performance in normal subjects. *Neuropsychologia*, *36*(11), 1133-1140. https://doi.org/10.1016/S0028-3932(98)00006-2

Freedman, S. (2012). *The Measurement of Posthypnotic Amnesia with the Harvard Group Scale of Hypnotic Susceptibility, Form A* [Masters, Concordia University]. https://spectrum.library.concordia.ca/974776/

Friston, K., & Kiebel, S. (2009). Predictive coding under the free-energy principle. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1521), 1211-1221. https://doi.org/10.1098/rstb.2008.0300

Fulford, J., Milton, F., Salas, D., Smith, A., Simler, A., Winlove, C., & Zeman, A. (2018). The neural correlates of visual imagery vividness – An fMRI study and literature review. *Cortex*, *105*, 26-40. https://doi.org/10.1016/j.cortex.2017.09.014

Gadsby, S. (2017a). Distorted body representations in anorexia nervosa. *Consciousness and Cognition*, *51*, 17-33. https://doi.org/10.1016/j.concog.2017.02.015

Gadsby, S. (2017b). Distorted body representations in anorexia nervosa. *Consciousness and Cognition*, *51*, 17-33. https://doi.org/10.1016/j.concog.2017.02.015

Gadsby, S. (2017c). Anorexia nervosa and oversized experiences. *Philosophical Psychology*, *30*(5), 594-615. https://doi.org/10.1080/09515089.2017.1315083

Gadsby, S. (2017d). Anorexia nervosa and oversized experiences. *Philosophical Psychology*, *30*(5), 594-615. https://doi.org/10.1080/09515089.2017.1315083

Galea, V., Woody, E. Z., Szechtman, H., & Pierrynowski, M. R. (2010). Motion in Response to the Hypnotic Suggestion of Arm Rigidity : A Window on Underlying Mechanisms. *International Journal of Clinical and Experimental Hypnosis*, *58*(3), 251-268. https://doi.org/10.1080/00207141003760561

Gallagher, S. (2005). Dynamic models of body schematic processes. In H. De Preester & V. Knockaert (Éds.), *Advances in Consciousness Research* (Vol. 62, p. 233-250). John Benjamins Publishing Company. https://doi.org/10.1075/aicr.62.15gal

Gallagher, S. (2009). Delusional realities. In *Psychiatry as Cognitive Neuroscience : Philosophical Perspectives* (Oxford University Press, p. 245-266). https://ro.uow.edu.au/lhapapers/1460

Gallagher, S. (2013). Ambiguity in the sense of agency. In *Decomposing the will* (Oxford University Press, p. 118-135).

Gandevia, S. C., Refshauge, K. M., & Collins, D. F. (2002). Proprioception : Peripheral Inputs and Perceptual Interactions. In S. C. Gandevia, U. Proske, & D. G. Stuart (Éds.), *Sensorimotor Control of Movement and Posture* (p. 61-68). Springer US. https://doi.org/10.1007/978-1-4615-0713-0_8

Gandhi, B., & Oakley, D. A. (2005). Does ‘hypnosis’ by any other name smell as sweet? The efficacy of ‘hypnotic’ inductions depends on the label ‘hypnosis’. *Consciousness and Cognition*, *14*(2), 304-315. https://doi.org/10.1016/j.concog.2004.12.004

Gendler, T. S. (2008). Alief in Action (and Reaction). *Mind & Language*, *23*(5), 552-585. https://doi.org/10.1111/j.1468-0017.2008.00352.x

Giurgola, S., Crico, C., Farnè, A., & Bolognini, N. (2021). The sense of body ownership shapes the visual representation of body size. *Journal of Experimental Psychology: General*, No Pagination Specified-No Pagination Specified. https://doi.org/10.1037/xge0001111

Glass, L. B., & Barber, T. X. (1961). A NOTE ON HYPNOTIC BEHAVIOR, THE DEFINITION OF THE SITUATION AND THE PLACEBO EFFECT. *The Journal of Nervous and Mental Disease*, *132*(6), 539.

Glisky, M. L., Tataryn, D. J., & Kihlstrom, J. F. (1995). Hypnotizability and Mental Imagery. *International Journal of Clinical and Experimental Hypnosis*, *43*(1), 34-54. https://doi.org/10.1080/00207149508409374

Gorassini, D. R. (1999). Hypnotic responding : A cognitive–behavioral analysis of self-deception. In *Clinical hypnosis and self-regulation : Cognitive-behavioral perspectives* (p. 73-103). American Psychological Association. https://doi.org/10.1037/10282-003

Gorassini, D. R. (2003). Brief Hypnotic Suggestibility Training : A Confirmation of its Effectiveness and a Test of Self-Report Validity. *Imagination, Cognition and Personality*, *22*(3), 291-302. https://doi.org/10.2190/L111-3X0R-W5PW-738M

Gorassini, D. R. (2004). Enhancing hypnotizability. In *The Highly Hypnotizable Person*. Routledge.

Gorassini, D. R., & Spanos, N. P. (1999). *The Carleton Skill Training Program for modifying hypnotic suggestibility : Original version and variations*. http://psycnet.apa.org/record/1998-06696-006

Gravitz, M. A. G. (1993). Etienne Félix d’Hénin de Cuvillers : A Founder of Hypnosis. *American Journal of Clinical Hypnosis*, *36*(1), 7-11. https://doi.org/10.1080/00029157.1993.10403033

Grinder, J., DeLozier, J., & Bandler, R. (1977). *Patterns of the hypnotic techniques of Milton H. Erickson, MD* (Meta Publications).

Guardia, D., Lafargue, G., Thomas, P., Dodin, V., Cottencin, O., & Luyat, M. (2010). Anticipation of body-scaled action is modified in anorexia nervosa. *Neuropsychologia*, *48*(13), 3961-3966. https://doi.org/10.1016/j.neuropsychologia.2010.09.004

Haggard, P. (2017). Sense of agency in the human brain. *Nature Reviews Neuroscience*, *18*(4), 196-207. https://doi.org/10.1038/nrn.2017.14

Hall, L., Strandberg, T., Pärnamets, P., Lind, A., Tärning, B., & Johansson, P. (2013). How the Polls Can Be Both Spot On and Dead Wrong : Using Choice Blindness to Shift Political Attitudes and Voter Intentions. *PLOS ONE*, *8*(4), e60554. https://doi.org/10.1371/journal.pone.0060554

Halloy, A. (2012). Gods in the Flesh : Learning Emotions in the Xangô Possession Cult (Brazil). *Ethnos*, *77*(2), 177-202. https://doi.org/10.1080/00141844.2011.586465

Hardwick, R. M., Caspers, S., Eickhoff, S. B., & Swinnen, S. P. (2018). Neural correlates of action : Comparing meta-analyses of imagery, observation, and execution. *Neuroscience & Biobehavioral Reviews*, *94*, 31-44. https://doi.org/10.1016/j.neubiorev.2018.08.003

Hargadon, R., Bowers, K. S., & Woody, E. Z. (1995). *Does counterpain imagery mediate hypnotic analgesia?* http://psycnet.apa.org/record/1995-42864-001

Hart, C. M., Ritchie, T. D., Hepper, E. G., & Gebauer, J. E. (2015). The Balanced Inventory of Desirable Responding Short Form (BIDR-16). *SAGE Open*, *5*(4), 215824401562111. https://doi.org/10.1177/2158244015621113

Hawkins, R., & Bartsch, J. (2000). The effects of an educational lecture about hypnosis. *Australian Journal of Clinical & Experimental Hypnosis*, *28*(1), 82-99.

Heap, M., Brown, R. J., & Oakley, D. A. (2004). *The Highly Hypnotizable Person : Theoretical, Experimental, and Clinical Issues*. Psychology Press.

Heed, T., Gründler, M., Rinkleib, J., Rudzik, F. H., Collins, T., Cooke, E., & O'Regan, J. K. (2011). Visual information and rubber hand embodiment differentially affect reach-to-grasp actions. *Acta Psychologica*, *138*(1), 263-271. https://doi.org/10.1016/j.actpsy.2011.07.003

Helmholtz, H. von. (1867). *Handbuch der physiologischen Optik [Treatise on physiological optics]*. Voss.

Henry, D. (1985). *Subjects' expectancies and subjective experience of hypnosis*. Unpublished doctoral dissertation, University of Connecticut.

Hilgard, J. R. (1979). *Personality and Hypnosis : A study of imaginative involvement* (University of chicago).

Hohwy, J. (2013). *The Predictive Mind*. Oxford University Press.

Holman, L., Head, M. L., Lanfear, R., & Jennions, M. D. (2015). Evidence of Experimental Bias in the Life Sciences : Why We Need Blind Data Recording. *PLOS Biology*, *13*(7), e1002190. https://doi.org/10.1371/journal.pbio.1002190

Huber, A., Lui, F., & Porro, C. A. (2013). Hypnotic susceptibility modulates brain activity related to experimental placebo analgesia. *PAIN®*, *154*(9), 1509-1518. https://doi.org/10.1016/j.pain.2013.03.031

Iani, C., Ricci, F., Baroni, G., & Rubichi, S. (2009). Attention control and susceptibility to hypnosis. *Consciousness and Cognition*, *18*(4), 856-863. https://doi.org/10.1016/j.concog.2009.07.002

Iani, C., Ricci, F., Gherri, E., & Rubichi, S. (2006). Hypnotic Suggestion Modulates Cognitive Conflict : The Case of the Flanker Compatibility Effect. *Psychological Science*, *17*(8), 721-727. https://doi.org/10.1111/j.1467-9280.2006.01772.x

Irvine, K. R., McCarty, K., McKenzie, K. J., Pollet, T. V., Cornelissen, K. K., Tovée, M. J., & Cornelissen, P. L. (2019). Distorted body image influences body schema in individuals with negative bodily attitudes. *Neuropsychologia*, *122*, 38-50. https://doi.org/10.1016/j.neuropsychologia.2018.11.015

James, W. (1890). *Principles of psychology*.

Jamieson, G. (2007). *Hypnosis and Conscious States : The Cognitive Neuroscience Perspective*. OUP Oxford.

Jamieson, G. A. (2016). A unified theory of hypnosis and meditation states : The interoceptive predictive coding approach. In *Hypnosis and meditation : Towards an integrative science of conscious planes* (p. 313-342). Oxford University Press.

Jamieson, G. A. (2021). An insula view of predictive processing in hypnotic responses. *Psychology of Consciousness: Theory, Research, and Practice*, No Pagination Specified-No Pagination Specified. https://doi.org/10.1037/cns0000266

Janet, P. (1923). *La médecine psychologique* (Flammarion).

Jensen, M. P., Jamieson, G. A., Lutz, A., Mazzoni, G., McGeown, W. J., Santarcangelo, E. L., Demertzi, A., De Pascalis, V., Bányai, É. I., Rominger, C., Vuilleumier, P., Faymonville, M.-E., & Terhune, D. B. (2017). New directions in hypnosis research : Strategies for advancing the cognitive and clinical neuroscience of hypnosis. *Neuroscience of Consciousness*, *2017*(1), Article 1. https://doi.org/10.1093/nc/nix004

Jensen, M. P., & Patterson, D. R. (2008). Hypnosis in the relief of pain and pain disorders. In *The Oxford Handbook of Hypnosis*. https://doi.org/10.1093/oxfordhb/9780198570097.013.0020

Johansson, P., Hall, L., Sikström, S., & Olsson, A. (2005). Failure to Detect Mismatches Between Intention and Outcome in a Simple Decision Task. *Science*, *310*(5745), 116-119. https://doi.org/10.1126/science.1111709

Johansson, P., Hall, L., Sikström, S., Tärning, B., & Lind, A. (2006). How something can be said about telling more than we can know : On choice blindness and introspection. *Consciousness and Cognition*, *15*(4), 673-692. https://doi.org/10.1016/j.concog.2006.09.004

Johansson, P., Hall, L., Tärning, B., Sikström, S., & Chater, N. (2014). Choice Blindness and Preference Change : You Will Like This Paper Better If You (Believe You) Chose to Read It!: Choice

Blindness and Preference Change. *Journal of Behavioral Decision Making*, *27*(3), 281-289. https://doi.org/10.1002/bdm.1807

Kallio, S., & Revonsuo, A. (2003). Hypnotic phenomena and altered states of consciousness : A multilevel framework of description and explanation. *Contemporary Hypnosis*, *20*(3), 111-164. https://doi.org/10.1002/ch.273

Kammers, M. P. M., de Vignemont, F., Verhagen, L., & Dijkerman, H. C. (2009). The rubber hand illusion in action. *Neuropsychologia*, *47*(1), 204-211. https://doi.org/10.1016/j.neuropsychologia.2008.07.028

Kammers, M. P. M., Kootker, J. A., Hogendoorn, H., & Dijkerman, H. C. (2010). How many motoric body representations can we grasp? *Experimental Brain Research*, *202*(1), 203-212. https://doi.org/10.1007/s00221-009-2124-7

Kammers, M. P. M., van der Ham, I. J. M., & Dijkerman, H. C. (2006). Dissociating body representations in healthy individuals : Differential effects of a kinaesthetic illusion on perception and action. *Neuropsychologia*, *44*(12), 2430-2436. https://doi.org/10.1016/j.neuropsychologia.2006.04.009

Keogh, R., & Pearson, J. (2018). The blind mind : No sensory visual imagery in aphantasia. *Cortex*, *105*, 53-60. https://doi.org/10.1016/j.cortex.2017.10.012

Kersten, D., Mamassian, P., & Yuille, A. (2004). Object Perception as Bayesian Inference. *Annual Review of Psychology*, *55*(1), 271-304. https://doi.org/10.1146/annurev.psych.55.090902.142005

Kihlstrom, J. F. (2008). The domain of hypnosis, revisited. *The Oxford handbook of hypnosis: Theory, research, and practice*, 21-52.

Kihlstrom, J. F., & Shor, R. E. (1978). Recall and Recognition During Posthypnotic Amnesia. *International Journal of Clinical and Experimental Hypnosis*, *26*(4), 330-349. https://doi.org/10.1080/00207147808411257

Kilteni, K., Maselli, A., Kording, K. P., & Slater, M. (2015). Over my fake body : Body ownership illusions for studying the multisensory basis of own-body perception. *Frontiers in Human Neuroscience, 9*. https://doi.org/10.3389/fnhum.2015.00141

Kilteni, K., Normand, J.-M., Sanchez-Vives, M. V., & Slater, M. (2012a). Extending Body Space in Immersive Virtual Reality : A Very Long Arm Illusion. *PLoS ONE*, *7*(7), Article 7. https://doi.org/10.1371/journal.pone.0040867

Kilteni, K., Normand, J.-M., Sanchez-Vives, M. V., & Slater, M. (2012b). Extending Body Space in Immersive Virtual Reality : A Very Long Arm Illusion. *PLoS ONE*, *7*(7). https://doi.org/10.1371/journal.pone.0040867

Kirsch, I. (1985). Response expectancy as a determinant of experience and behavior. *American Psychologist*, *40*(11), 1189.

Kirsch, I. (1991). The social learning theory of hypnosis. In *Theories of Hypnosis : Current Models and Perspectives* (Guilford Press, p. 439-466). http://psycnet.apa.org/record/1991-98913-014

Kirsch, I. (1997). Response expectancy theory and application : A decennial review. *Applied and Preventive Psychology*, *6*(2), 69-79. https://doi.org/10.1016/S0962-1849(05)80012-5

Kirsch, I. (1999). Clinical hypnosis as a nondeceptive placebo. In *Clinical hypnosis and self-regulation : Cognitive-behavioral perspectives* (p. 211-225). American Psychological Association. https://doi.org/10.1037/10282-008

Kirsch, I. (2000a). The Response Set Theory of Hypnosis. *American Journal of Clinical Hypnosis*, *42*(3-4), 274-292. https://doi.org/10.1080/00029157.2000.10734362

Kirsch, I. (2000b). The Response Set Theory of Hypnosis. *American Journal of Clinical Hypnosis*, *42*(3-4), 274-292. https://doi.org/10.1080/00029157.2000.10734362

Kirsch, I. (2001a). The response set theory of hypnosis : Expectancy and physiology. *American Journal of Clinical Hypnosis*, *44*(1), 69-73.

Kirsch, I. (2001b). The Response Set Theory of Hypnosis : Expectancy and Physiology. *American Journal of Clinical Hypnosis*, *44*(1), 69-73. https://doi.org/10.1080/00029157.2001.10403458

Kirsch, I. (2018). Chapter Five—Response Expectancy and the Placebo Effect. In L. Colloca (Éd.), *International Review of Neurobiology* (Vol. 138, p. 81-93). Academic Press. https://doi.org/10.1016/bs.irn.2018.01.003

Kirsch, I., & Braffman, W. (2001). Imaginative Suggestibility and Hypnotizability. *Current Directions in Psychological Science*, *10*(2), 57-61. https://doi.org/10.1111/1467-8721.00115

Kirsch, I., Capafons, A., Cardeña-Buelna, E., & Amigó, S. (1999). *Clinical hypnosis and self-regulation : Cognitive-behavioral perspectives* (p. ix, 370). American Psychological Association. https://doi.org/10.1037/10282-000

Kirsch, I., Council, J. R., & Mobayed, C. (1987). Imagery and response expectancy as determinants of hypnotic behavior. *British Journal of Experimental & Clinical Hypnosis*, *4*(1), 25-31.

Kirsch, I., & Lynn, S. J. (1998). Social–Cognitive Alternatives to Dissociation Theories of Hypnotic Involuntariness. *Review of General Psychology*, *2*(1), 66-80. https://doi.org/10.1037/1089-2680.2.1.66

Knill, D. C., & Richards, W. (1996). *Perception as Bayesian Inference*. Cambridge University Press.

Kosslyn, S. M., Thompson, W. L., Costantini-Ferrando, M. F., Alpert, N. M., & Spiegel, D. (2000a). Hypnotic Visual Illusion Alters Color Processing in the Brain. *American Journal of Psychiatry*, *157*(8), 1279-1284. https://doi.org/10.1176/appi.ajp.157.8.1279

Kosslyn, S. M., Thompson, W. L., Costantini-Ferrando, M. F., Alpert, N. M., & Spiegel, D. (2000b). Hypnotic Visual Illusion Alters Color Processing in the Brain. *American Journal of Psychiatry*, *157*(8), 1279-1284. https://doi.org/10.1176/appi.ajp.157.8.1279

Kumar, V. K., & Lankton, S. R. (2018). *Hypnotic Induction : Perspectives, strategies and concerns*. Routledge.

Lackner, J. R. (1988a). SOME PROPRIOCEPTIVE INFLUENCES ON THE PERCEPTUAL REPRESENTATION OF BODY SHAPE AND ORIENTATION. *Brain*, *111*(2), 281-297. https://doi.org/10.1093/brain/111.2.281

Lackner, J. R. (1988b). SOME PROPRIOCEPTIVE INFLUENCES ON THE PERCEPTUAL REPRESENTATION OF BODY SHAPE AND ORIENTATION. *Brain*, *111*(2), 281-297. https://doi.org/10.1093/brain/111.2.281

Lackner, J. R., & Taublieb, A. B. (1984). Influence of vision on vibration-induced illusions of limb movement. *Experimental Neurology*, *85*(1), 97-106. https://doi.org/10.1016/0014-4886(84)90164-X

LaFaver, K., Lang, A. E., Stone, J., Morgante, F., Edwards, M., Lidstone, S., Maurer, C. W., Hallett, M., Dwivedi, A. K., & Espay, A. J. (2020). Opinions and clinical practices related to diagnosing and managing functional (psychogenic) movement disorders : Changes in the last decade. *European Journal of Neurology*, *27*(6), 975-984. https://doi.org/10.1111/ene.14200

Landry, M., Da Silva Castanheira, J., Sackur, J., & Raz, A. (2020). Difficult Turned Easy : Suggestion Renders a Challenging Visual Task Simple. *Psychological Science*, 0956797620954856. https://doi.org/10.1177/0956797620954856

Landry, M., Lifshitz, M., & Raz, A. (2017). Brain correlates of hypnosis : A systematic review and meta-analytic exploration. *Neuroscience & Biobehavioral Reviews*, *81*, 75-98. https://doi.org/10.1016/j.neubiorev.2017.02.020

Landry, M., & Raz, A. (2015). Hypnosis and Imaging of the Living Human Brain. *American Journal of Clinical Hypnosis*, *57*(3), 285-313. https://doi.org/10.1080/00029157.2014.978496

Lankton, S. R. (2008). An Ericksonian approach to clinical hypnosis. In *The Oxford Handbook of Hypnosis*.

Laurence, J.-R., Beaulieu-Prévost, D., & Du Chéné, T. (2008). Measuring and understanding individual differences in hypnotizability. *The Oxford handbook of hypnosis: Theory, research and practice*, 255-282.

Lifshitz, M., Sheiner, E. O., Olson, J. A., Thériault, R., & Raz, A. (2017). On Suggestibility and Placebo : A Follow-Up Study. *American Journal of Clinical Hypnosis*, *59*(4), 385-392. https://doi.org/10.1080/00029157.2016.1225252

Linardon, J., Anderson, C., Messer, M., Rodgers, R. F., & Fuller-Tyszkiewicz, M. (2021). Body image flexibility and its correlates : A meta-analysis. *Body Image*, *37*, 188-203. https://doi.org/10.1016/j.bodyim.2021.02.005

Longo, M. R. (2021). Distortion of mental body representations. *Trends in Cognitive Sciences*. https://doi.org/10.1016/j.tics.2021.11.005

Longo, M. R., Azañón, E., Tamè, L., Ferrè, E. R., Maravita, A., Tajadura-Jiménez, A., & Linkenauger, S. A. (2016). Multimodal Contributions to Body Representation. *Multisensory Research*, *29*(6-7), 635-661. https://doi.org/10.1163/22134808-00002531

Love, J., Selker, R., Marsman, M., Jamil, T., Dropmann, D., Verhagen, J., Ly, A., Gronau, Q. F., Šmíra, M., Epskamp, S., Matzke, D., Wild, A., Knight, P., Rouder, J. N., Morey, R. D., & Wagenmakers, E.-J. (2019). JASP : Graphical Statistical Software for Common Statistical Designs. *Journal of Statistical Software*, *88*, 1-17. https://doi.org/10.18637/jss.v088.i02

Ludwig, A. M. (1966). *Possession States in Primitive People, from the Symposium Sponsored by RM Bucke Society, Montreal. Archives of General Psychiatry, 15.*

Lush, P. (2020a). Demand characteristics confound the rubber hand illusion. *Collabra: Psychology*, *6*(1), a22. https://doi.org/10.1525/collabra.325

Lush, P. (2020b). Demand characteristics confound the rubber hand illusion. *Collabra: Psychology*, *6*(1), a22. https://doi.org/10.1525/collabra.325

Lush, P., Botan, V., Scott, R. B., Seth, A. K., Ward, J., & Dienes, Z. (2020). Trait phenomenological control predicts experience of mirror synaesthesia and the rubber hand illusion. *Nature Communications*, *11*(1), 4853. https://doi.org/10.1038/s41467-020-18591-6

Lush, P., Botan, V., Scott, R. B., Seth, A., Ward, J., & Dienes, Z. (2019). *Phenomenological control : Response to imaginative suggestion predicts measures of mirror touch synaesthesia, vicarious pain and the rubber hand illusion* [Preprint]. PsyArXiv. https://doi.org/10.31234/osf.io/82jav

Lush, P., Caspar, E. A., Cleeremans, A., Haggard, P., Magalhães De Saldanha da Gama, P. A., & Dienes, Z. (2017). The Power of Suggestion : Posthypnotically Induced Changes in the Temporal Binding of Intentional Action Outcomes. *Psychological Science*, *28*(5), 661-669. https://doi.org/10.1177/0956797616687015

Lush, P., Moga, G., McLatchie, N., & Dienes, Z. (2018). The Sussex-Waterloo Scale of Hypnotizability (SWASH) : Measuring capacity for altering conscious experience. *Neuroscience of Consciousness*, *2018*(1), Article 1. https://doi.org/10.1093/nc/niy006

Lush, P., Naish, P., & Dienes, Z. (2016). Metacognition of intentions in mindfulness and hypnosis. *Neuroscience of Consciousness*, *2016*(1), Article 1. https://doi.org/10.1093/nc/niw007

Lynn, S. J. (2004). Enhancing Suggestibility : The Effects of Compliance vs. Imagery. *American Journal of Clinical Hypnosis*, *47*(2), 117-128. https://doi.org/10.1080/00029157.2004.10403630

Lynn, S. J., & Kirsch, I. (2006). *Essentials of clinical hypnosis : An evidence-based approach* (p. viii, 271). American Psychological Association. https://doi.org/10.1037/11365-000

Lynn, S. J., Kirsch, I., & Hallquist, M. N. (2008). Social cognitive theories of hypnosis. *The Oxford handbook of hypnosis: Theory, research, and practice*, 111-139.

Lynn, S. J., Kirsch, I., Terhune, D. B., & Green, J. P. (2020). Myths and misconceptions about hypnosis and suggestion : Separating fact and fiction. *Applied Cognitive Psychology*, *n/a*(n/a). https://doi.org/10.1002/acp.3730

Makin, T. R., & Flor, H. (2020). Brain (re)organisation following amputation : Implications for phantom limb pain. *NeuroImage*, *218*, 116943. https://doi.org/10.1016/j.neuroimage.2020.116943

Maloney, L. T., & Mamassian, P. (2009). Bayesian decision theory as a model of human visual perception : Testing Bayesian transfer. *Visual Neuroscience*, *26*(1), 147-155. https://doi.org/10.1017/S0952523808080905

Marotta, A., Tinazzi, M., Cavedini, C., Zampini, M., & Fiorio, M. (2016). Individual Differences in the Rubber Hand Illusion Are Related to Sensory Suggestibility. *PLOS ONE*, *11*(12), e0168489. https://doi.org/10.1371/journal.pone.0168489

Martin, J.-R., & Pacherie, E. (2019). Alterations of agency in hypnosis : A new predictive coding model. *Psychological Review*, *126*(1), 133-152. https://doi.org/10.1037/rev0000134

Martin, J.-R., Sackur, J., & Dienes, Z. (2018). Attention or instruction : Do sustained attentional abilities really differ between high and low hypnotisable persons? *Psychological Research*, *82*(4), 700-707. https://doi.org/10.1007/s00426-017-0850-1

Marucci, F. S., & Meo, M. (2000). Suggestibility and imagery during attribution of meaning to ambiguous figures. In *Suggestion and suggestibility : Theory and research* (p. 167-175).

McConkey, K. M. (2008). Generations and landscapes of hypnosis : Questions we've asked, questions we should ask. *The Oxford handbook of hypnosis: Theory, research and practice*, 53-77.

McGeown, W. J., Venneri, A., Kirsch, I., Nocetti, L., Roberts, K., Foan, L., & Mazzoni, G. (2012). Suggested visual hallucination without hypnosis enhances activity in visual areas of the brain. *Consciousness and Cognition*, *21*(1), 100-116. https://doi.org/10.1016/j.concog.2011.10.015

McGlashen, T. H., Evans, F. J., & Orne, M. T. (1969). The nature of hypnotic analgesia and placebo response to experimental pain. *Psychosomatic Medicine*, *31*(3), 227-246.

Miller, J. J. (1998). Textbook of Transpersonal Psychiatry and Psychology. *Psychiatric Services*, *49*(4), 541-542. https://doi.org/10.1176/ps.49.4.541

Miller, R. J. (1975). Response to the ponzo illusion as a reflection of hypnotic susceptibility. *International Journal of Clinical and Experimental Hypnosis*, *23*(2), 148-157. https://doi.org/10.1080/00207147508415939

Miller, R. J., Hennessy, R. T., & Leibowitz, H. W. (1973). The effect of hypnotic ablation of the background on the magnitude of the ponzo perspective illusion. *International Journal of Clinical and Experimental Hypnosis, 21*(3), 180-191. https://doi.org/10.1080/00207147308409122

Milling, L. S., Gover, M. C., & Moriarty, C. L. (2018). The effectiveness of hypnosis as an intervention for obesity : A meta-analytic review. *Psychology of Consciousness: Theory, Research, and Practice, 5*(1), 29-45. https://doi.org/10.1037/cns0000139

Mizuguchi, N., Suezawa, M., & Kanosue, K. (2019). Vividness and accuracy : Two independent aspects of motor imagery. *Neuroscience Research, 147*, 17-25. https://doi.org/10.1016/j.neures.2018.12.005

Mölbert, S. C., Thaler, A., Mohler, B. J., Streuber, S., Romero, J., Black, M. J., Zipfel, S., Karnath, H.-O., & Giel, K. E. (2018). Assessing body image in anorexia nervosa using biometric self-avatars in virtual reality : Attitudinal components rather than visual body size estimation are distorted. *Psychological Medicine, 48*(04), 642-653. https://doi.org/10.1017/S0033291717002008

Molina-Peral, J. A., Rodríguez, J. S.-, Capafons, A., & Mendoza, M. E. (2020). Attitudes Toward Hypnosis Based on Source of Information and Experience With Hypnosis. *American Journal of Clinical Hypnosis, 62*(3), 282-297. https://doi.org/10.1080/00029157.2019.1584741

Morgan, A. H., Johnson, D. L., & Hilgard, E. R. (1974). The stability of hypnotic susceptibility : A longitudinal study. *International Journal of Clinical and Experimental Hypnosis, 22*(3), 249-257. https://doi.org/10.1080/00207147408413004

Naito, E. (1994). Controllability of Motor Imagery and Transformation of Visual Imagery. *Perceptual and Motor Skills, 78*(2), 479-487. https://doi.org/10.2466/pms.1994.78.2.479

Naito, E., Ehrsson, H. H., Geyer, S., Zilles, K., & Roland, P. E. (1999). Illusory Arm Movements Activate Cortical Motor Areas : A Positron Emission Tomography Study. *The Journal of Neuroscience, 19*(14), 6134-6144. https://doi.org/10.1523/JNEUROSCI.19-14-06134.1999

Naito, E., Morita, T., & Amemiya, K. (2016). Body representations in the human brain revealed by kinesthetic illusions and their essential contributions to motor control and corporeal awareness. *Neuroscience Research*, *104*, 16-30. https://doi.org/10.1016/j.neures.2015.10.013

Nash, M. R. (2005). The Importance of Being Earnest When Crafting Definitions : Science and Scientism Are not the Same Thing. *International Journal of Clinical and Experimental Hypnosis*, *53*(3), 265-280. https://doi.org/10.1080/00207140590961934

Newport, R., Auty, K., Carey, M., Greenfield, K., Howard, E. M., Ratcliffe, N., Thair, H., & Themelis, K. (2015). Give It a Tug and Feel It Grow : Extending Body Perception Through the Universal Nature of Illusory Finger Stretching. *I-Perception*, *6*(5), 2041669515599310. https://doi.org/10.1177/2041669515599310

Newport, R., Pearce, R., & Preston, C. (2010). Fake hands in action : Embodiment and control of supernumerary limbs. *Experimental Brain Research*. https://doi.org/10.1007/s00221-009-2104-y

Newport, R., & Preston, C. (2011). Disownership and disembodiment of the real limb without visuoproprioceptive mismatch. *Cognitive Neuroscience,* *2*(3-4), 179-185. https://doi.org/10.1080/17588928.2011.565120

Niedzwieñska, A. (2000). Goal-directed fantasy does not explain the training effect of the carleton skills training package. *International Journal of Clinical and Experimental Hypnosis*, *48*(4), 404-417. https://doi.org/10.1080/00207140008410369

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know : Verbal reports on mental processes. *Psychological review*, *84*(3), 231.

Noble, J., & McConkey, K. M. (1995a). Hypnotic sex change : Creating and challenging a delusion in the laboratory. *Journal of Abnormal Psychology*, *104*(1), 69.

Noble, J., & McConkey, K. M. (1995b). Hypnotic sex change : Creating and challenging a delusion in the laboratory. *Journal of Abnormal Psychology*, *104*(1), 69.

Norman, D. A., & Shallice, T. (1986). Attention to Action. In *Consciousness and Self-Regulation* (p. 1-18). Springer, Boston, MA. https://doi.org/10.1007/978-1-4757-0629-1_1

Normand, J.-M., Giannopoulos, E., Spanlang, B., & Slater, M. (2011). Multisensory Stimulation Can Induce an Illusion of Larger Belly Size in Immersive Virtual Reality. *PLOS ONE*, *6*(1), e16128. https://doi.org/10.1371/journal.pone.0016128

Oakley, D. A. (2008). Hypnosis, trance and suggestion : Evidence from neuroimaging. *The Oxford handbook of hypnosis: Theory, research and practice*, 365-392.

Oakley, D. A., & Halligan, P. W. (2009a). Hypnotic suggestion and cognitive neuroscience. *Trends in Cognitive Sciences*, *13*(6), 264-270. https://doi.org/10.1016/j.tics.2009.03.004

Oakley, D. A., & Halligan, P. W. (2009b). Hypnotic suggestion and cognitive neuroscience. *Trends in Cognitive Sciences*, *13*(6), 264-270. https://doi.org/10.1016/j.tics.2009.03.004

Oakley, D. A., & Halligan, P. W. (2011). Using hypnosis to gain insights into healthy and pathological cognitive functioning. *Consciousness and Cognition*, *20*(2), 328-331. https://doi.org/10.1016/j.concog.2010.01.013

Oakley, D. A., & Halligan, P. W. (2013). Hypnotic suggestion : Opportunities for cognitive neuroscience. *Nature Reviews Neuroscience*, *14*(8), 565-576. https://doi.org/10.1038/nrn3538

Oikawa, T., Hirano, D., Taniguchi, T., & Maruyama, H. (2017). The effects of tool holding on body schema during motor imagery : A near-infrared spectroscopy study. *Journal of Physical Therapy Science*, *29*(4), 702-706. https://doi.org/10.1589/jpts.29.702

Oldfield, R. C. (1971). The assessment and analysis of handedness : The Edinburgh inventory. *Neuropsychologia*, *9*(1), 97-113. https://doi.org/10.1016/0028-3932(71)90067-4

Orne, M. T. (1962a). On the social psychology of the psychological experiment : With particular reference to demand characteristics and their implications. *American Psychologist*, *17*(11), 776-783. https://doi.org/10.1037/h0043424

Orne, M. T. (1962b). *On the social psychology of the psychological experiment : With particular reference to demand characteristics and their implications*. http://psycnet.apa.org/record/1963-05917-001

Paillard, J. (1999). *Body schema and body image—A double dissociation in deafferented patients*. 18.

Palfi, B., Moga, G., Lush, P., Scott, R. B., & Dienes, Z. (2019). Can hypnotic suggestibility be measured online? *Psychological Research*. https://doi.org/10.1007/s00426-019-01162-w

Pavani, F., & Zampini, M. (2007). The Role of Hand Size in the Fake-Hand Illusion Paradigm. *Perception*, *36*(10), 1547-1554. https://doi.org/10.1068/p5853

Pederzoli, L., Giroldini, W., Duma, G. M., Mento, G., Prati, E., & Tressoldi, P. (2018, mars 2). *Out of body experience induced by hypnotic induction A neurophenomenological study*. http://www.evanlab.org/wp-content/uploads/2015/12/13e-OBE-induced-by-hypnotic-induction-A-neurophenomenological-study.pdf

Pekala, R. J., & Kumar, V. K. (2007). An empirical-phenomenological approach to quantifying consciousness and states of consciousness : With particular reference to understanding the nature of hypnosis. In *Hypnosis and conscious states : The cognitive neuroscience perspective* (p. 167-194). Oxford University Press.

Peres, M. F. P., & Lucchetti, G. (2010). Coping Strategies in Chronic Pain. *Current Pain and Headache Reports*, *14*(5), 331-338. https://doi.org/10.1007/s11916-010-0137-3

Piccione, C., Hilgard, E. R., & Zimbardo, P. G. (1989). On the degree of stability of measured hypnotizability over a 25-year period. *Journal of Personality and Social Psychology*, *56*(2), 289.

Pintar, J., & Lynn, S. J. (2009). *Hypnosis : A Brief History*. John Wiley & Sons.

Pitron, V., Alsmith, A., & de Vignemont, F. (2018a). How do the body schema and the body image interact? *Consciousness and Cognition*, *65*, 352-358. https://doi.org/10.1016/j.concog.2018.08.007

Pitron, V., Alsmith, A., & de Vignemont, F. (2018b). How do the body schema and the body image interact? *Consciousness and Cognition*, *65*, 352-358. https://doi.org/10.1016/j.concog.2018.08.007

Pitron, V., & de Vignemont, F. (2017). Beyond differences between the body schema and the body image : Insights from body hallucinations. *Consciousness and Cognition*, *53*, 115-121. https://doi.org/10.1016/j.concog.2017.06.006

Poldrack, R. (2006). Can cognitive processes be inferred from neuroimaging data? *Trends in Cognitive Sciences*, *10*(2), 59-63. https://doi.org/10.1016/j.tics.2005.12.004

Polito, V., Barnier, A. J., & Connors, M. H. (2018). Hypnotic clever hands : Agency and automatic responding. *Journal of Experimental Psychology: General*, *147*(6), 815-828. https://doi.org/10.1037/xge0000451

Polito, V., Barnier, A. J., & Woody, E. Z. (2013). Developing the Sense of Agency Rating Scale (SOARS) : An empirical measure of agency disruption in hypnosis. *Consciousness and Cognition*, *22*(3), 684-696. https://doi.org/10.1016/j.concog.2013.04.003

Popkirov, S., Grönheit, W., & Wellmer, J. (2015). A systematic review of suggestive seizure induction for the diagnosis of psychogenic nonepileptic seizures. *Seizure*, *31*, 124-132. https://doi.org/10.1016/j.seizure.2015.07.016

Pratkanis, A. R. (2011). *The Science of Social Influence : Advances and Future Progress*. Psychology Press.

Purcell, J. B., Winter, S. R., Breslin, C. M., White, N. C., Lowe, M. R., & Coslett, H. B. (2018). Implicit Mental Motor Imagery Task Demonstrates a Distortion of the Body Schema in Patients With Eating Disorders. *Journal of the International Neuropsychological Society*, *24*(7), 715-723. https://doi.org/10.1017/S1355617718000371

Pylyshyn, Z. (1999). Is vision continuous with cognition? : The case for cognitive impenetrability of visual perception. *Behavioral and Brain Sciences*, *22*(3), 341-365. https://doi.org/10.1017/S0140525X99002022

Rahmanovic, A., Barnier, A. J., Cox, R. E., Langdon, R. A., & Coltheart, M. (2012). “That’s not my arm” : A hypnotic analogue of somatoparaphrenia. *Cognitive Neuropsychiatry*, *17*(1), 36-63. https://doi.org/10.1080/13546805.2011.564925

Rainville, P., Carrier, B., Hofbauer, R. K., Bushnell, M. C., & Duncan, G. H. (1999). Dissociation of sensory and affective dimensions of pain using hypnotic modulation. *Pain*, *82*(2), 159-171. https://doi.org/10.1016/S0304-3959(99)00048-2

Ramondo, N., Gignac, G. E., Pestell, C. F., & Byrne, S. M. (2021a). Clinical Hypnosis as an Adjunct to Cognitive Behavior Therapy : An Updated Meta-Analysis. *International Journal of Clinical and Experimental Hypnosis*, *0*(0), 1-34. https://doi.org/10.1080/00207144.2021.1877549

Ramondo, N., Gignac, G. E., Pestell, C. F., & Byrne, S. M. (2021b). Clinical Hypnosis as an Adjunct to Cognitive Behavior Therapy : An Updated Meta-Analysis. *International Journal of Clinical and Experimental Hypnosis*, *69*(2), 169-202. https://doi.org/10.1080/00207144.2021.1877549

Rangwani, R., & Park, H. (2021). A new approach of inducing proprioceptive illusion by transcutaneous electrical stimulation. *Journal of NeuroEngineering and Rehabilitation*, *18*(1), 73. https://doi.org/10.1186/s12984-021-00870-y

Rao, R. P. N., & Ballard, D. H. (1999). Predictive coding in the visual cortex : A functional interpretation of some extra-classical receptive-field effects. *Nature Neuroscience*, *2*(1), 79-87. https://doi.org/10.1038/4580

Raz, A. (2005). Attention and Hypnosis : *Neural Substrates and Genetic Associations of Two Converging Processes*. *International Journal of Clinical and Experimental Hypnosis*, *53*(3), 237-258. https://doi.org/10.1080/00207140590961295

Raz, A. (2007). Hypnobo : Perspectives on hypnosis and placebo. *American Journal of Clinical Hypnosis*, *50*(1), 29-36.

Raz, A., Fan, J., & Posner, M. I. (2005a). Hypnotic suggestion reduces conflict in the human brain. *Proceedings of the National Academy of Sciences*, *102*(28), 9978-9983. https://doi.org/10.1073/pnas.0503064102

Raz, A., Fan, J., & Posner, M. I. (2005b). Hypnotic suggestion reduces conflict in the human brain. *Proceedings of the National Academy of Sciences*, *102*(28), 9978-9983. https://doi.org/10.1073/pnas.0503064102

Raz, A., Landzberg, K. S., Schweizer, H. R., Zephrani, Z. R., Shapiro, T., Fan, J., & Posner, M. I. (2003). Posthypnotic suggestion and the modulation of Stroop interference under cycloplegia. *Consciousness and Cognition*, *12*(3), 332-346. https://doi.org/10.1016/S1053-8100(03)00024-2

Reategui, R. (2020). The relationship between expectation and hypnotic susceptibility : A literature review. *American Journal of Clinical Hypnosis*, *63*(1), 14-27. https://doi.org/10.1080/00029157.2020.1742085

Regnard, P. (1887). *Les maladies épidémiques de l'esprit; sorcellerie, magnétisme, morphinisme, délire des grandeurs*. Paris, E. Plon, Nourrit et cie. http://archive.org/details/lesmaladiespid00regn

Richet, C. (1922). *Traité de métapsychique* (Alcan).

Röder, C. H., Michal, M., Overbeck, G., Ven, V. G. van de, & Linden, D. E. J. (2007). Pain Response in Depersonalization : A Functional Imaging Study Using Hypnosis in Healthy Subjects. *Psychotherapy and Psychosomatics*, *76*(2), 115-121. https://doi.org/10.1159/000097970

Rogers, C. B., Webb, J. B., & Jafari, N. (2018). A systematic review of the roles of body image flexibility as correlate, moderator, mediator, and in intervention science (2011–2018). *Body Image*, *27*, 43-60. https://doi.org/10.1016/j.bodyim.2018.08.003

Rosenthal, D. M. (2006). Consciousness and Higher-Order Thought. In *Encyclopedia of Cognitive Science*. John Wiley & Sons, Ltd. https://doi.org/10.1002/0470018860.s00149

Rosenthal, D., & Weisberg, J. (2008). Higher-order theories of consciousness. *Scholarpedia*, *3*(5), 4407. https://doi.org/10.4249/scholarpedia.4407

Roux, F.-E., Djidjeli, I., & Durand, J.-B. (2018). Functional architecture of the somatosensory homunculus detected by electrostimulation. *The Journal of Physiology*, *596*(5), 941-956. https://doi.org/10.1113/JP275243

Rubichi, S., Ricci, F., Padovani, R., & Scaglietti, L. (2005). Hypnotic susceptibility, baseline attentional functioning, and the Stroop task. *Consciousness and Cognition*, *14*(2), 296-303. https://doi.org/10.1016/j.concog.2004.08.003

Ruch, J. C. (1975). Self-hypnosis : The result of heterohypnosis or vice versa? *International Journal of Clinical and Experimental Hypnosis*, *23*(4), 282-304. https://doi.org/10.1080/00207147508415952

Salomon, R., Noel, J.-P., Łukowska, M., Faivre, N., Metzinger, T., Serino, A., & Blanke, O. (2017). Unconscious integration of multisensory bodily inputs in the peripersonal space shapes bodily self-consciousness. *Cognition*, *166*, 174-183. https://doi.org/10.1016/j.cognition.2017.05.028

Salter, A. (1941). Three techniques of autohypnosis. *Journal of General Psychology*, *25*. http://search.proquest.com/docview/1290488247/citation/621F82405EFC4BE9PQ/1

Samad, M., Chung, A. J., & Shams, L. (2015). Perception of Body Ownership Is Driven by Bayesian Sensory Inference. *PLOS ONE*, *10*(2), e0117178. https://doi.org/10.1371/journal.pone.0117178

Sanchez-Vives, M. V., & Slater, M. (2005). From presence to consciousness through virtual reality. *Nature Reviews Neuroscience*, *6*(4), 332-339. https://doi.org/10.1038/nrn1651

Santé et itinéraire professionnel (Sip)—Ministère du Travail. (2010). https://dares.travail-emploi.gouv.fr/publications/sante-et-itineraire

Sarbin, T., & Allen, V. (1968). Role Theory. In G. Lindzey (Éd.), *Handbook of Social Psychology* (Vol. 1, p. 488-559).

Sarbin, T. R. (1950a). Contribution to role-taking theory. *The psychological review*, *57*(5), 255-270.

Sarbin, T. R. (1950b). *Contributions to role-taking theory : I. Hypnotic behavior*. http://psycnet.apa.org/record/1951-04360-001

Scacchia, P., & De Pascalis, V. (2020). Effects of Prehypnotic Instructions on Hypnotizability and Relationships Between Hypnotizability, Absorption, and Empathy. *American Journal of Clinical Hypnosis*, *62*(3), 231-266. https://doi.org/10.1080/00029157.2019.1586639

Schaefer, M., Flor, H., Heinze, H.-J., & Rotte, M. (2007). Morphing the body : Illusory feeling of an elongated arm affects somatosensory homunculus. *NeuroImage*, *36*(3), 700-705. https://doi.org/10.1016/j.neuroimage.2007.03.046

Schaefert, R., Klose, P., Moser, G., & Häuser, W. (2014). Efficacy, Tolerability, and Safety of Hypnosis in Adult Irritable Bowel Syndrome : Systematic Review and Meta-Analysis. *Psychosomatic Medicine*, *76*(5), 389-398. https://doi.org/10.1097/PSY.0000000000000039

Schmidt, T. T., & Blankenburg, F. (2019). The Somatotopy of Mental Tactile Imagery. *Frontiers in Human Neuroscience*, *13*, 10. https://doi.org/10.3389/fnhum.2019.00010

Schwoebel, J., Boronat, C. B., & Branch Coslett, H. (2002). The man who executed "imagined" movements : Evidence for dissociable components of the body schema. *Brain and Cognition*, *50*(1), 1-16. https://doi.org/10.1016/S0278-2626(02)00005-2

Schwoebel, J., & Coslett, H. B. (2005). Evidence for Multiple, Distinct Representations of the Human Body. *Journal of Cognitive Neuroscience*, *17*(4), 543-553. https://doi.org/10.1162/0898929053467587

Schwoebel, J., Friedman, R., Duda, N., & Coslett, H. B. (2001). Pain and the body schema : Evidence for peripheral effects on mental representations of movement. *Brain*, *124*(10), 2098-2104. https://doi.org/10.1093/brain/124.10.2098

Sharot, T., & Sunstein, C. R. (2020). How people decide what they want to know. *Nature Human Behaviour*, *4*(1), 14-19. https://doi.org/10.1038/s41562-019-0793-1

Sheehan, P., & McConkey, K. (2015). *Hypnosis and Experience (Psychology Revivals) : The Exploration of Phenomena and Process*. Routledge. https://doi.org/10.4324/9781315715797

Sheehan, P. W., & McConkey, K. M. (1982). *Hypnosis and Experience (Psychology Revivals) : The Exploration of Phenomena and Process*. Routledge.

Sheehan, P. W., & Robertson, R. (1996). Imagery and Hypnosis : Trends and Patternings in Effects. In *Hypnosis And Imagination*. Routledge.

Sheiner, E. O., Lifshitz, M., & Raz, A. (2016). Placebo response correlates with hypnotic suggestibility. *Psychology of Consciousness: Theory, Research, and Practice*, *3*(2), 146-153. https://doi.org/10.1037/cns0000074

Shor, R. E., & Orne, E. C. (1963a). Norms on the Harvard Group Scale of Hypnotic Susceptibility, Form A. *International Journal of Clinical and Experimental Hypnosis*, *11*(1), 39-47. https://doi.org/10.1080/00207146308409226

Shor, R. E., & Orne, E. C. (1963b). Norms on the Harvard Group Scale of Hypnotic Susceptibility, Form A. *International Journal of Clinical and Experimental Hypnosis*, *11*(1), 39-47. https://doi.org/10.1080/00207146308409226

Sirigu, A., GRAFMAN, J., BRESSLER, K., & SUNDERLAND, T. (1991). MULTIPLE REPRESENTATIONS CONTRIBUTE TO BODY KNOWLEDGE PROCESSING : EVIDENCE FROM A CASE OF AUTOTOPAGNOSIA. *Brain*, *114*(1), 629-642. https://doi.org/10.1093/brain/114.1.629

Somer, E., Cardeña, E., Catelan, R. F., & Soffer-Dudek, N. (2021). Reality shifting : Psychological features of an emergent online daydreaming culture. *Current Psychology*. https://doi.org/10.1007/s12144-021-02439-3

Spagna, A., Hajhajate, D., Liu, J., & Bartolomeo, P. (2021). Visual mental imagery engages the left fusiform gyrus, but not the early visual cortex : A meta-analysis of neuroimaging evidence. *Neuroscience & Biobehavioral Reviews*, *122*, 201-217. https://doi.org/10.1016/j.neubiorev.2020.12.029

Spagna, A., Mackie, M.-A., & Fan, J. (2015). Supramodal executive control of attention. *Frontiers in Psychology*, *0*. https://doi.org/10.3389/fpsyg.2015.00065

Spanos, N. P. (1986). Hypnotic behavior : A social-psychological interpretation of amnesia, analgesia, and “trance logic”. *Behavioral and Brain Sciences*, *9*(3), 449-467. https://doi.org/10.1017/S0140525X00046537

Spanos, N. P., Brett, P. J., Menary, E. P., & Cross, W. P. (1987). A Measure of Attitudes toward Hypnosis : Relationships with Absorption and Hypnotic Susceptibility. *American Journal of Clinical Hypnosis*, *30*(2), 139-150. https://doi.org/10.1080/00029157.1987.10404174

Spanos, N. P., Cross, W. F., Menary, E., & Smith, J. (1988). Long term effects of cognitive-skill training for the enhancement of hypnotic susceptibility. *British Journal of Experimental & Clinical Hypnosis*, *5*(2), 73-78.

Spanos, N. P., & Flynn, D. M. (1989). Compliance, imaginal correlates and skill training. *British Journal of Experimental & Clinical Hypnosis*, *6*(1), 12-15.

Spanos, N. P., Flynn, D. M., & Gwynn, M. I. (1988). Contextual demands, negative hallucinations, and hidden observer responding : Three hidden observers observed. *British Journal of Experimental & Clinical Hypnosis*, *5*(1), 5-10.

Spanos, N. P., Gwynn, M. I., & Stam, H. J. (1983). Instructional demands and ratings of overt and hidden pain during hypnotic analgesia. *Journal of Abnormal Psychology*, *92*(4), 479-488. https://doi.org/10.1037/0021-843X.92.4.479

Spanos, N. P., & Hewitt, E. C. (1980). The hidden observer in hypnotic analgesia : Discovery or experimental creation? *Journal of Personality and Social Psychology*, *39*(6), 1201-1214. https://doi.org/10.1037/h0077730

Spanos, N. P., Stenstrom, R. J., & Johnston, J. C. (1988). Hypnosis, placebo, and suggestion in the treatment of warts. *Psychosomatic Medicine*, *50*(3), 245-260.

Spanos, N. P., Warnock, S., & de Groot, H. P. (1990). Cognitive skill training, confirming sensory stimuli, and responsiveness to suggestions in subjects unselected for hypnotizability. *Journal of Research in Personality*, *24*(2), 133-144. https://doi.org/10.1016/0092-6566(90)90012-U

Spence, C., & Deroy, O. (2013). Crossmodal Mental Imagery. In S. Lacey & R. Lawson (Éds.), *Multisensory Imagery* (p. 157-183). Springer. https://doi.org/10.1007/978-1-4614-5879-1_9

Spiegel, D. (1998). Using our heads : Effects of mental state and social influence on hypnosis. *Contemporary Hypnosis*, *15*(3), 175-177. https://doi.org/10.1002/ch.128

Sposito, A., Bolognini, N., Vallar, G., & Maravita, A. (2012). Extension of perceived arm length following tool-use : Clues to plasticity of body metrics. *Neuropsychologia*, *50*(9), 2187-2194. https://doi.org/10.1016/j.neuropsychologia.2012.05.022

Srzich, A. J., Byblow, W. D., Stinear, J. W., Cirillo, J., & Anson, J. G. (2016). Can motor imagery and hypnotic susceptibility explain Conversion Disorder with motor symptoms? *Neuropsychologia*, *89*, 287-298. https://doi.org/10.1016/j.neuropsychologia.2016.06.030

Stone, K., Bullock, F., Keizer, A., & Dijkerman, H. (2018, août). *The disappearing limb trick and the role of sensory suggestibility in illusion experience*. Neuropsychologia; Neuropsychologia. https://doi.org/10.1016/j.neuropsychologia.2018.07.012

Sutcliffe, S. J., & Gilhus, I. S. (2014). *New Age Spirituality : Rethinking Religion*. Routledge.

Tapal, A., Oren, E., Dar, R., & Eitam, B. (2017). The Sense of Agency Scale : A Measure of Consciously Perceived Control over One's Mind, Body, and the Immediate Environment. *Frontiers in Psychology*, *8*. https://doi.org/10.3389/fpsyg.2017.01552

Tart, C. T. (1986). *Waking Up : Overcoming the Obstacles to Human Potential*. New Science Library.

Tasso, A. F., & Perez, N. A. (2008). *Parsing everyday suggestibility : What does it tell us about hypnosis?*

Taves, A. (2009). *Religious Experience Reconsidered : A Building-Block Approach to the Study of Religion and Other Special Things*. Princeton University Press.

Taylor-Clarke, M., Jacobsen, P., & Haggard, P. (2004). Keeping the world a constant size : Object constancy in human touch. *Nature Neuroscience*, *7*(3), 219-220. https://doi.org/10.1038/nn1199

Tellegen, A. (1978). On Measures and Conceptions of Hypnosis. *American Journal of Clinical Hypnosis*, *21*(2-3), 219-237. https://doi.org/10.1080/00029157.1978.10403973

Terhune, D. B. (2015). Discrete response patterns in the upper range of hypnotic suggestibility : A latent profile analysis. *Consciousness and Cognition*, *33*, 334-341. https://doi.org/10.1016/j.concog.2015.01.018

Terhune, D. B., & Cardeña, E. (2016). Nuances and Uncertainties Regarding Hypnotic Inductions : Toward a Theoretically Informed Praxis. *American Journal of Clinical Hypnosis*, *59*(2), 155-174. https://doi.org/10.1080/00029157.2016.1201454

Terhune, D. B., & Cardeña, E. (2018, mars 2). *Dissociative Subtypes in Posttraumatic Stress Disorders and Hypnosis : Neurocognitive Parallels and Clinical ImplicationsTerhune & Cardena 15 CDPS.pdf*. https://research.gold.ac.uk/17051/1/Terhune%20%26%20Cardena%2015%20CDPS.pdf

Terhune, D. B., Cardeña, E., & Lindgren, M. (2011). Dissociative tendencies and individual differences in high hypnotic suggestibility. *Cognitive Neuropsychiatry*, *16*(2), 113-135. https://doi.org/10.1080/13546805.2010.503048

Terhune, D. B., Cleeremans, A., Raz, A., & Lynn, S. J. (2017a). Hypnosis and top-down regulation of consciousness. *Neuroscience & Biobehavioral Reviews*, *81*, 59-74. https://doi.org/10.1016/j.neubiorev.2017.02.002

Terhune, D. B., Cleeremans, A., Raz, A., & Lynn, S. J. (2017b). Hypnosis and top-down regulation of consciousness. *Neuroscience & Biobehavioral Reviews*, *81*, 59-74. https://doi.org/10.1016/j.neubiorev.2017.02.002

Terhune, D. B., & Hedman, L. R. A. (2017). Metacognition of agency is reduced in high hypnotic suggestibility. *Cognition*, *168*, 176-181. https://doi.org/10.1016/j.cognition.2017.06.026

Terhune, D. B., & Oakley, D. A. (2020). Hypnosis and imagination. In A. Abraham (Éd.), *The Cambridge Handbook of the Imagination* (p. 711-727). Cambridge University Press.

https://www.cambridge.org/core/books/cambridge-handbook-of-the-imagination/B4080A5A7D13689D97D73E916A8DDDA5

Terhune, D., & Cardeña, E. (2009). Out-of-body experiences in the context of hypnosis : Phenomenology, methodology, and neurophysiology. In *Psychological scientific perspectives on out-of-body and near-death experiences* (p. 89-104). Nova Science Publishers, Inc. http://lup.lub.lu.se/record/2373772

Thomas, N. J. T. (2014). Mental Imagery. In E. N. Zalta (Éd.), *The Stanford Encyclopedia of Philosophy* (Fall 2021). Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/archives/fall2021/entries/mental-imagery/

Thompson, T., Terhune, D. B., Oram, C., Sharangparni, J., Rouf, R., Solmi, M., Veronese, N., & Stubbs, B. (2019). The effectiveness of hypnosis for pain relief : A systematic review and meta-analysis of 85 controlled experimental trials. *Neuroscience & Biobehavioral Reviews, 99*, 298-310. https://doi.org/10.1016/j.neubiorev.2019.02.013

Tsakiris, M., Carpenter, L., James, D., & Fotopoulou, A. (2010). Hands only illusion : Multisensory integration elicits sense of ownership for body parts but not for non-corporeal objects. *Experimental Brain Research*, *204*(3), 343-352. https://doi.org/10.1007/s00221-009-2039-3

Tuthill, J. C., & Azim, E. (2018). Proprioception. *Current Biology*, *28*(5), R194-R203. https://doi.org/10.1016/j.cub.2018.01.064

Underhill, E. (1925). *Mystics of the Church* (Pennsylvania: Morehouse Publishing).

Vaitl, D., Birbaumer, N., Gruzelier, J., Jamieson, G. A., Kotchoubey, B., Kübler, A., Lehmann, D., Miltner, W. H. R., Ott, U., Pütz, P., Sammer, G., Strauch, I., Strehl, U., Wackermann, J., & Weiss, T. (2005). Psychobiology of Altered States of Consciousness. *Psychological Bulletin, 131*(1), 98-127. https://doi.org/10.1037/0033-2909.131.1.98

Valentine, K. E., Milling, L. S., Clark, L. J., & Moriarty, C. L. (2019). The Efficacy of Hypnosis as a Treatment for Anxiety : A Meta-Analysis. *International Journal of Clinical and Experimental Hypnosis*, *67*(3), 336-363. https://doi.org/10.1080/00207144.2019.1613863

Vallar, G., & Ronchi, R. (2009). Somatoparaphrenia : A body delusion. A review of the neuropsychological literature. *Experimental Brain Research*, *192*(3), 533-551. https://doi.org/10.1007/s00221-008-1562-y

van Elk, M., & Aleman, A. (2017). Brain mechanisms in religion and spirituality : An integrative predictive processing framework. *Neuroscience & Biobehavioral Reviews*, *73*, 359-378. https://doi.org/10.1016/j.neubiorev.2016.12.031

Varga, K., Németh, Z., & Szekely, A. (2011). Lack of correlation between hypnotic susceptibility and various components of attention. *Consciousness and Cognition*, *20*(4), 1872-1881. https://doi.org/10.1016/j.concog.2011.09.008

Vartier, J. (1971). *Allan Kardec : La naissance du spiritisme*. Hachette.

Veissière, S. (2016). Varieties of tulpa experiences : The hypnotic nature of human sociality, personhood, and interphenomenality. In *Hypnosis and meditation : Towards an integrative science of conscious planes* (p. 55-74). Oxford University Press.

Vignemont, F. de, & Massin, O. (2013). *Touch*. 00.

Vignemont, F. (2018). *Mind the body : An exploration of bodily self-awareness*. Oxford University Press.

Wagstaff, G. F. (1977). An experimental study of compliance and post-hypnotic amnesia. *British Journal of Social and Clinical Psychology*, *16*(3), 225-228. https://doi.org/10.1111/j.2044-8260.1977.tb00222.x

Wagstaff, G. F. (2004). High hypnotizability in a sociocognitive framework. In *The highly hypnotizable person* (p. 85-114). Routledge.

Wagstaff, G. F., Cole, J. C., & Brunas-Wagstaff, J. (2008). Measuring Hypnotizability : The Case for Self-Report Depth Scales and Normative Data for the Long Stanford Scale. *International Journal of Clinical and Experimental Hypnosis*, *56*(2), 119-142. https://doi.org/10.1080/00207140701849452

Wallace, B. (1986). Latency and Frequency Reports to the Necker Cube Illusion : Effects of Hypnotic Susceptibility and Mental Arithmetic. *The Journal of General Psychology*, *113*(2), 187-194. https://doi.org/10.1080/00221309.1986.9710555

Wallace, B., & Garrett, J. (1973). Hypnotic susceptibility and autokinetic movement frequency. *Perceptual and Motor Skills*, *36*(3, Pt. 2), 1054-1054. https://doi.org/10.2466/pms.1973.36.3c.1054

Wallace, B., Garrett, J. B., & Anstadt, S. P. (1974). Hypnotic Susceptibility, Suggestion, and Reports of Autokinetic Movement. *The American Journal of Psychology*, *87*(1/2), 117-123. https://doi.org/10.2307/1422005

Wallace, B., Knight, T. A., & Garrett, J. B. (1976). Hypnotic susceptibility and frequency reports to illusory stimuli. *Journal of Abnormal Psychology*, *85*(6), 558-563. https://doi.org/10.1037/0021-843X.85.6.558

Walsh, E., Guilmette, D. N., Longo, M. R., Moore, J. W., Oakley, D. A., Halligan, P. W., Mehta, M. A., & Deeley, Q. (2015a). Are You Suggesting That's My Hand? The Relation Between Hypnotic Suggestibility and the Rubber Hand Illusion. *Perception*, *44*(6), 709-723. https://doi.org/10.1177/0301006615594266

Walsh, E., Guilmette, D. N., Longo, M. R., Moore, J. W., Oakley, D. A., Halligan, P. W., Mehta, M. A., & Deeley, Q. (2015b). Are You Suggesting That's My Hand? The Relation Between Hypnotic Suggestibility and the Rubber Hand Illusion. *Perception*, *44*(6), 709-723. https://doi.org/10.1177/0301006615594266

Wegner, D. M., & Sparrow, B. (2007). The puzzle of coaction. In *Distributed cognition and the will : Individual volition in social context* (MIT Press, p. 17-37).

Weitzenhoffer, A. M. (1994). Eriksonian myths. In *Ericksonian Methods : The Essence Of The Story*. Routledge.

Weitzenhoffer, A. M. (2000). *The Practice of Hypnotism* (Wiley). https://www.wiley.com/en-us/The+Practice+of+Hypnotism%2C+2nd+Edition-p-9780471297901

Weitzenhoffer, A. M., & Hilgard, E. R. (1959). *Stanford Hypnotic Susceptibility Scales, Form A and B*.

Weitzenhoffer, A. M., & Hilgard, E. R. (1962). *STANFORD HYPNOTIC SUSCEPTIBILITY SCALE, FORM C*. 56.

White, R. W. (1941). A preface to the theory of hypnotism. *The Journal of Abnormal and Social Psychology*, *36*(4), 477-505. https://doi.org/10.1037/h0053844

Whitwell, R. L., Goodale, M. A., Merritt, K. E., & Enns, J. T. (2018). The Sander parallelogram illusion dissociates action and perception despite control for the litany of past confounds. *Cortex*, *98*, 163-176. https://doi.org/10.1016/j.cortex.2017.09.013

Wicken, M., Keogh, R., & Pearson, J. (2021). The critical role of mental imagery in human emotion : Insights from fear-based imagery and aphantasia. *Proceedings of the Royal Society B: Biological Sciences*, *288*(1946), 20210267. https://doi.org/10.1098/rspb.2021.0267

Wickless, C., & Kirsch, I. (1989). *Effects of verbal and experiential expectancy manipulations on hypnotic susceptibility*. http://psycnet.apa.org/record/1990-06682-001

Wieder, L., Brown, R., Thompson, T., & Terhune, D. B. (2021). Suggestibility in functional neurological disorder : A meta-analysis. *Journal of Neurology, Neurosurgery & Psychiatry*, *92*(2), 150-157. https://doi.org/10.1136/jnnp-2020-323706

Wieder, L., & Terhune, D. B. (2019). Trauma and anxious attachment influence the relationship between suggestibility and dissociation : A moderated-moderation analysis. *Cognitive Neuropsychiatry*, *24*(3), 191-207. https://doi.org/10.1080/13546805.2019.1606705

Williams, S. E., Guillot, A., Di Rienzo, F., & Cumming, J. (2015). Comparing self-report and mental chronometry measures of motor imagery ability. *European Journal of Sport Science*, *15*(8), 703-711. https://doi.org/10.1080/17461391.2015.1051133

Woody, E., & Szechtman, H. (2000a). Hypnotic hallucinations and yedasentience. *Contemporary Hypnosis*, *17*(1), 26-31.

Woody, E., & Szechtman, H. (2000b). Hypnotic hallucinations : Towards a biology of epistemology. *Contemporary Hypnosis*, *17*(1), 4-14. https://doi.org/10.1002/ch.186

Woody, E., & Szechtman, H. (2011). Using hypnosis to develop and test models of psychopathology. *The Journal of Mind-Body Regulation, 1*(1), Article 1.

Woody, E. Z., & Barnier, A. J. (2008). Hypnosis scales for the twenty-first century : What do we need and how should we use them. *The Oxford handbook of hypnosis: Theory, research, and practice*, 255-282.

Woody, E. Z., Barnier, A. J., & McConkey, K. M. (2005). *Multiple Hypnotizabilities : Differentiating the Building Blocks of Hypnotic Response*. /paper/Part-1-%3A-Psychometric-Analysis-of-the-Combined-SHSS-Woody-Barnier/97e0a3d4b51ba6974d0b5d8ec9f103e2fb63e97c

Woody, E. Z., & Sadler, P. (2008). *Dissociation theories*. Oxford University Press New York.

Woody, E. Z., & Szechtman, H. (2007). To see feelingly : Emotion, motivation and hypnosis. In *Hypnosis and conscious states : The cognitive neuroscience perspective* (p. 241-256).

Wreszinski, W. (1909). *Die Medizin der alter Agypter : Der grosse medizinische Papyrus des Berliner Museums (Pap. Berl. 3038)* (JC Hinrichs).

Wu, T., Chen, C., Spagna, A., Wu, X., Mackie, M.-A., Russell-Giller, S., Xu, P., Luo, Y., Liu, X., Hof, P. R., & Fan, J. (2020). The functional anatomy of cognitive control : A domain-general brain network for uncertainty processing. *Journal of Comparative Neurology*, *528*(8), 1265-1292. https://doi.org/10.1002/cne.24804

Yamamiya, Y., Cash, T. F., Melnyk, S. E., Posavac, H. D., & Posavac, S. S. (2005). Women's exposure to thin-and-beautiful media images : Body image effects of media-ideal internalization and impact-reduction interventions. *Body Image*, *2*(1), 74-80. https://doi.org/10.1016/j.bodyim.2004.11.001

Yeates, L. B. (2018). James Braid (V) : Chemical and hypnotic anaesthesia, psycho-physiology, and Braid’s final theories. *Australian Journal of Clinical Hypnotherapy & Hypnosis*, *40*(2), 112-167. https://doi.org/10.3316/informit.326505573983891

Zagzebski, L. T. (2012). *Epistemic Authority : A Theory of Trust, Authority, and Autonomy in Belief*. Oxford University Press.

Zech, N., Hansen, E., Bernardy, K., & Häuser, W. (2017). Efficacy, acceptability and safety of guided imagery/hypnosis in fibromyalgia—A systematic review and meta-analysis of randomized controlled trials. *European Journal of Pain (London, England)*, *21*(2), 217-227. https://doi.org/10.1002/ejp.933

Zeev-Wolf, M., Goldstein, A., Bonne, O., & Abramowitz, E. G. (2016). Hypnotically induced somatosensory alterations : Toward a neurophysiological understanding of hypnotic anaesthesia. *Neuropsychologia*, *87*, 182-191. https://doi.org/10.1016/j.neuropsychologia.2016.05.020

Zeig, J. K. (1994). *Ericksonian Methods : The Essence of the Story*. Psychology Press.

Zivney, O., & Lynn, S. J. (1996). Carleton Skill Training Program hypnotizability gains generalize to a novel setting. *Annual Meeting of the American Psychological Associaton*.

Zopf, R., Truong, S., Finkbeiner, M., Friedman, J., & Williams, M. A. (2011). Viewing and feeling touch modulates hand position for reaching. *Neuropsychologia*, *49*(5), 1287-1293. https://doi.org/10.1016/j.neuropsychologia.2011.02.012

RÉSUMÉ

Près d'un siècle de recherche scientifique sur l'hypnose a révélé que celle-ci peut avoir des effets spectaculaires sur la perception, la cognition et le comportement. Après une brève revue historique, nous argumentons contre une vision unitaire de l’hypnose. Ainsi, nous avons restreint notre investigation à une unique suggestion hypnotique : la modulation des représentations de la taille du corps. Notre travail expérimental révèle que la suggestion hypnotique est un outil fiable et robuste pour moduler ces représentations, comme le révèlent les mesures perceptuelles et implicites. Au-delà du rôle des facteurs contextuels et des traits individuels, nous soulignons l’importance de l'imagerie mentale et du monitoring de source. Dans cette optique, l'imagerie confondue avec la perception appuie les attentes contextuelles, façonnant ainsi les représentations corporelles de bas niveau.

MOTS CLÉS

Hypnose, suggestion, image corporelle, schéma corporel, imagerie mentale, monitoring de source

ABSTRACT

Almost a century of modern scientific inquiry into hypnosis has revealed that it can have dramatic effects on perception, cognition, and behaviour. After a brief historical review, we argue against hypnosis being a unitary phenomenon. Therefore, we restricted our scope to a single hypnotic suggestion, namely modulating body-size representations. Our experimental work revealed that hypnotic suggestion is a reliable and robust tool for modulating these representations both according to self-reports and implicit measurements. We interpret these effects as the result of classic situational and trait factors, and we highlight the important role of imagery and source monitoring. In this view, imagery taken for perception supports contextually cued expectancies, shaping primitive bodily representations

KEYWORDS

Hypnosis, suggestion, body image, body schema, imagery, source monitoring