

Final Report for BIAL Foundation grant 269/18:

Electrophysiological and genetic factors associated with hypnosis, suggestibility and hypnotic phenomenology

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Abstract

Background and Aim: The aim of the project was to investigate the neurobiology of suggestibility and the brain changes linked to hypnotic response.

The Leverhulme Trust funded in-depth behavioural assessment and magnetic resonance imaging of participants. The funding from the BIAL Foundation enhanced this by enabling the study of: 1) genetic variation potentially linked to suggestibility/hypnotic response, 2) The effects of hypnosis and perceived involuntariness on brain activity as measured with electroencephalography (EEG), 3) multimodal predictors of suggestibility.

Method: Severe disruption to the project was caused by the COVID-19 pandemic (laboratories were closed for an extended period). During this time, a systematic review of the associations between hypnotic suggestibility and specific genetic variants was undertaken. Once laboratories reopened and students returned to campus, data collection was prioritised. Within the project, 456 people completed online questionnaires to assess transliminality, absorption, dissociation and fantasy proneness, 328 participants were screened for suggestibility, 76 participants completed the behavioural tasks (e.g., assessment of suggestibility level using the Stanford Susceptibility to Hypnosis Scale - Form C, the Attentional Network Test, and the Mental Rotation task), 65 the resting state EEG, 64 the task-based EEG, 53 the genetic assessment, 62 the MRI scanning.

Results: The 1st output using the personality screening questionnaires and suggestibility screening data has been published open access in Acta Psychologica (Irving et al., 2024). This was the first study to assess the relationship between transliminality and suggestibility using a standardised suggestibility scale. The analyses revealed transliminality to be weakly correlated with the imaginative subjective response measure and the hypnotic suggestibility objective, subjective and involuntariness response measures.

The systematic review on the associations between genetic variants and hypnotic suggestibility identified 11 relevant research studies through the database searches. Out of these studies, the COMT gene was the most studied, but there was a lack of agreement in the findings across studies. Our genetic analysis was limited due to the low number of participants. Some participants have missing data due to the COVID restrictions that were in place and in a small number of others, genotype could not be determined from some samples. Our investigation of COMT (n = 48), revealed no significant difference in suggestibility level across genotype, however, there was an association with self-reported dissociation. DTNBP1 genotype was associated with suggestibility level.

The resting state EEG analyses, which assessed microstate prevalence, identified one of the microstates to occur more in those who were higher in suggestibility, whereas another microstate was related to both hypnotic depth and relaxation.

Conclusions: Transliminality might be expected to be closely related to suggestibility, but like the personality measures that have been previously investigated, transliminality explains only a small amount of variance in behavioural and subjective response to suggestion.

In relation to the potential genetic associations to hypnotic suggestibility, taking the findings of the systematic review into account, alongside those from our own analyses, to resolve controversy and speculation currently present in the literature, much larger research studies are needed in this area (potentially through collaborative efforts between research labs and teams).

Although our study flagged up a particular EEG microstate during the hypnosis condition that was linked to suggestibility and another linked to hypnotic depth, this finding only partially corresponds with the other previous microstate study, and further investigation is necessary.

In summary, this project has delivered an extremely well-characterised dataset for the study of suggestibility and hypnosis, and it will enable further investigation of the multimodal predictors of hypnotic suggestibility.

1. Introduction

Despite the numerous applications of hypnosis that are reported in the literature (e.g., treatment of irritable bowel syndrome, depression and anxiety, in addition to cognitive/perceptual alteration), much more can be learned about the psychological and neurobiological basis of suggestibility and response to hypnosis. One aim of this research project was to consider a range of potential predictors (e.g., personality attributes, behavioural capabilities, in addition to neuroanatomical, functional magnetic resonance imaging and genetic features) of hypnotic suggestibility. A further aim was to investigate the neural changes that are linked to response to hypnosis across different levels of suggestibility, and how specific self-reported phenomena (e.g., levels of absorption, dissociation or mental imagery) are linked to the brain changes.

One key limitation of a number of previous studies in the field is that groups of only high and low suggestible people have been recruited and assessed (which are termed “Highs” and “Lows” hereafter within this report). When comparing only Highs and Lows, it is impossible to determine whether the Highs, Lows, or both subgroups are atypical, compared with the majority of the

population (the Mediums) (see e.g., Lynn et al., 2007). Key objectives of this investigation were to examine how neurobiology differs across the entire suggestibility spectrum (by including Highs, Mediums and Lows), and to determine the effects on neural activity that a hypnotic induction has on people of varying levels of suggestibility.

1.1. Genetics

The initial evidence for a potential link between genetics and suggestibility came from twin studies. Morgan and colleagues (Morgan, 1973; Morgan et al., 1970) showed that higher correlations could be observed on the Stanford Hypnotic Susceptibility Scale, Form A (SHSS:A) for monozygotic twins ($r = .52$) compared with the dizygotic twins ($r = .17$). A different line of enquiry also pointed towards the possibility of a genetic link, with Piccione, Hilgard and Zimbardo (1989) showing that hypnotic suggestibility showed correlations of $r = .82$ and $r = .71$ between baseline and assessments performed 15 and 25 years later, respectively. Hypnotic suggestibility appears to remain relatively fixed over time, suggesting that genetics plays a key role.

One of our objectives was to collect DNA from our participants to enable genotyping for select single nucleotide polymorphisms (SNPs), to enable comparisons for each variant on key measures, such as suggestibility, attentional ability, and regional brain volume. Our analyses have initially focused on genes, for example, that have been linked to schizophrenia (and the expression of associated phenomenology, for example, the occurrence of hallucinations), that have been linked to the operation of hallucinatory drugs, and those which appear to be associated with cognitive processes, such as attention. We focused on COMT to assess which pattern of results in the existing literature might be replicated, in addition to 5-Hydroxytryptamine Receptor 2A (5-HTR2A), Dystrobrevin Binding Protein 1 (DTNBP1), and the solute carrier family 6 member 4 (SLC6A4; aka the serotonin transporter, 5-HTT or SERT) gene, specifically the serotonin-transporter-linked promoter region (5-HTTLPR).

Given the relatively small sample size that was the target of this investigation, another of our goals was to provide a DNA resource to enable collaboration with other research teams, especially given the extensive testing protocols and characterisation of our sample.

1.2 Brain activity

A number of studies have reported that Highs have higher levels of theta band activity (neural oscillatory activity at 4-8Hz) at rest (in the absence of a hypnotic procedure), and that increases in theta activity have also been linked to the administration of hypnotic inductions (for reviews see e.g., Barabasz & Barabasz, 2008; Jensen et al., 2015). Other data analysis techniques have also been applied, for example, connectivity analysis (e.g., Terhune et al., 2011), analysis of non-linear dynamics (e.g., Rho et al., 2021), and microstate analysis (e.g., Katayama et al., 2007). These approaches have yielded novel findings, but the results require replication. An additional objective of our study was to understand these types of changes in brain activity further by investigating the effects of a hypnotic induction by collecting both EEG data and fMRI data from the same group of participants. This was done in two separate test sessions (as opposed to simultaneous assessment). The EEG portion of the study also incorporated an intentional binding task. Intentional binding is when an intentional action and its outcome are perceived as occurring closer in time than when they actually did. When actions are experienced as being involuntary (after the provision of hypnotic suggestion), they have been reported to result in reduced intentional binding (Lush et al., 2017). This effect is of interest as it might provide a potential proxy marker of perceived involuntariness (e.g., the amount of outcome binding that might be evident).

1.3 The effect of the COVID-19 pandemic and the pivot to a systematic review

The COVID-19 pandemic severely disrupted the research project. During the pandemic, laboratory assessments could not be performed, as the University buildings were closed, and Government imposed lockdowns were in place. Given the extended period where there were difficulties in testing participants, with agreement from the BIAL Foundation, we adapted the proposed methodology from those outlined in the grant proposal, and worked on a systematic review of the literature on genetics and hypnotic suggestibility. Within the review we attempted to capture all of the available studies in the literature that have assessed the relationship between hypnotic suggestibility and at least one genetic variant.

1.4. Research Aims

In summary, the aim of the project was to collect a detailed comprehensive dataset to enable investigation of the neurobiology associated with hypnotic suggestibility that would allow assessment of the neural response to hypnosis. The dataset would include in-depth behavioural assessments, resting state functional MRI with phenomenological reporting, structural MRI, resting state EEG with phenomenological reporting, event-related potentials relating to movements perceived at different levels of involuntariness, and DNA for targeted genetic assessment. A further aim of the project (created during the pandemic) was to carry out a systematic review of the literature on hypnotic suggestibility and genetic variability.

2. Methods

2.1. Participants

After being screened in-person with the Carlton University Responsiveness to Suggestion Scale (modified version), 328 participants provided usable data. All had completed the suggestibility screening without the use of hypnosis (testing imaginative suggestibility), whereas 243 completed the suggestibility screening both with and without hypnosis (to test hypnotic and imaginative suggestibility). Four-hundred and fifty-six participants completed a set of questionnaires that covered absorption, dissociation, fantasy proneness and transliminality*. The data of those people who completed both a suggestibility screening and the set of personality questionnaires were then merged. The first manuscript from this project uses that dataset and is now available (Irving et al., 2024). The dataset is stored on the Open Science Framework and is available [here](#).

Seventy-three people completed the Stanford Susceptibility to Hypnosis Scale – Form C (SSHS:C) (Weitzenhoffer & Hilgard, 1962) in the first laboratory session. Out of those people, 65 completed the rsEEG assessment, 63 completed the EEG intentional binding task and 53 DNA samples were available for the genetic analysis (2nd laboratory session). Of those people that completed the SSHS:C assessment, 61 then participated in the MRI component of the study (3rd laboratory session).

2.2. Instruments, Measures and Procedure

2.2.1. Threats to the completion of the project

COVID-19 severely disrupted data collection, due to the need for in-person laboratory sessions (for the EEG assessments and collection of the buccal swabs). As mentioned, the University laboratories

* In the latter stages of the project, a considerable amount of additional data was collected using the personality scales (with a slightly modified version of the transliminality questionnaire), and with an online adaptation of the CURSS (which was administered without the hypnotic induction, and that tested imaginative suggestibility only). The findings from the online CURSS, in association with the personality questionnaires have yet to be analysed and written up (and another round of data collection to expand that study was completed in March 2024).

were closed and national lockdowns were imposed. The laboratory closures and restrictions led to a lengthy delay in being able to carry out test procedures as planned. The University returned to face-to-face teaching as normal in late September 2022, and participant testing was then resumed.

2.2.1 Systematic review

The protocol for the review is pre-registered on the Open Science Foundation (and the protocol can be found here: <https://osf.io/qw6kt/>). Briefly, the procedures for the review followed the PRISMA (Page, McKenzie, et al., 2021; Page, Moher, et al., 2021) guidelines. The aim of the systematic review was to capture, evaluate and synthesise the evidence from all studies that investigated links between specific genetic variants and hypnotic suggestibility.

2.2.2. Genetic analysis:

Buccal swab sample collection and processing

Non-invasive DNA sampling of the participants was conducted using Isohelix 2K-2S Buccal swabs (Isohelix, Kent, UK). Two buccal DNA swab samples were collected from each subject, at least one hour after eating or drinking. The swabs were air-dried and stored in their collection tubes at -20°C. The extracted genomic DNA from the participant buccal swabs was obtained using two methods: Lucigen QuickExtract™ (LGC Biosearch Technologies, Middlesex UK), and Monarch® Genomic DNA purification kit (New England Biolabs, Hitchin, UK). One swab was used with each method.

SNP Genotyping

Variant genotyping of the genes of interest was conducted using the allele-specific quantitative PCR rhAMP™ SNP Genotyping system (Integrated DNA Technologies, Leuven, Belgium). The SNPs and their respective assays and control templates are detailed in Table 1.

Table 1. rhAMP™ SNP assay and control allele template designations

Gene Symbol	dbSNP ID (rsID)	Chromosome Position	rhAMP SNP Assay Design ID	gBlocks® Control Alleles Gene Fragment ID
<i>COMT</i>	rs4680	chr22 19963747 - 19963748	Hs.GT.rs4680.A.1	Hs.GT.rs4680.A.1.1
				Hs.GT.rs4680.A.1.2
<i>DTNBP1</i>	rs4236167	chr6 15533719 - 15533720	Hs.GT.rs4236167.T.1	Hs.GT.rs4236167.T.1.1
				Hs.GT.rs4236167.T.1.2
<i>HTR2A</i>	rs6313	chr13 46895804 - 46895805	CD.GT.GWQL2505.1	CD.GT.GWQL2505.1.1
				CD.GT.GWQL2505.1.2
<i>WWC1</i>	rs17070145	chr5 168418785 - 168418786	Hs.GT.rs17070145.T.1	Hs.GT.rs17070145.T.1.1
				Hs.GT.rs17070145.T.1.2

2.2.3. EEG:

An Electrical Geodesics Inc (EGI) NetAmps 200 amplifier was used for data collection, in combination with high-density Hydrocel 128 channel electrode nets. The impedance target was below 50 kΩ. Data was recorded using EGI Netstation 4.3.1 Software, running on an Apple Power Mac G5 (OS X v10.6.8). Sampling rate was set at 1000Hz.

Resting State EEG

Resting state, 3-minute-long eyes-closed recordings were made for three separate conditions: baseline, hypnosis and relaxation. The hypnotic induction included suggestions to enter hypnosis, to relax and to experience positive mental imagery. The relaxation condition contained very similar wording to the hypnosis condition, but in the script, the wording mentioning “hypnosis” was replaced with wording describing “relaxation”. Within the hypnosis condition prior to the de-induction, a post-hypnotic suggestion was provided (again via audio recording) that suggested that participants would experience finger movements as involuntary for a block of trials on the ERP task (see below), and this experience of involuntariness would be initiated when they heard an audio cue (bells chiming). Self-report data were obtained after each of the conditions, using Likert-scale ratings for depth of hypnosis, level of relaxation, absorption, dissociation, mental imagery and mind-wandering. The rsEEG data was preprocessed using a high pass filter of 1 Hz, a low pass filter of 30 Hz, resampling to 250Hz, bad channel removal, cleanline to remove line noise, ICA, ICLABEL to remove artefacts, interpolation, segmentation into 1 second epochs and automated rejection of epochs containing artefacts. The data were processed using The Microstate EELAB Toolbox (MST1.0) by Poulsen, Pedroni, Langer and Hansen (2018).

Event-related potential (ERP) task

An intentional binding task produced using the Psychophysics Toolbox (Brainard, 1997) for Matlab (The MathWorks Inc., 2018) was kindly shared by Lush and colleagues, and this was adapted for EEG. The paradigm was based on a Libet clock design (1983). The task was chosen to provide intentional binding scores for each participant that could potentially serve as an indicator of involuntariness and the success of the posthypnotic suggestion for this that was administered.

2.2.4 Personality Measures and Behavioural Tests

The initial set of assessments included: the Revised Transliminality Scale (Lange et al., 2000), the Tellegen Absorption Scale (Tellegen & Atkinson, 1974), Dissociative Experiences Scale (DES-II; Bernstein & Putnam, 1986; Carlson & Putnam, 1993), the Creative Experiences Questionnaire (CEQ; Merckelbach et al., 2001) and the Modified Carleton University Responsiveness to Suggestions Scale (CURSS; Comey & Kirsch, 1999); original by Spanos and colleagues (see e.g., Spanos, Radtke, Hodgins, Bertrand, et al., 1983; Spanos, Radtke, Hodgins, Stam, et al., 1983). Other assessments that formed part of the full test protocol included the Inventory Scale of Hypnotic Depth (Field, 1965) that was administered after the SHSS:C, the Attentional Network Task (Fan et al., 2002), the Working Memory: Visual Letter-Number Sequencing Task, and the Mental Rotation Task (www.millisecond.com), the Plymouth Sensory Imagery Questionnaire (Andrade et al., 2014), and the Phenomenology of Consciousness Inventory (Pekala, 1991) (administered after the rsEEG hypnosis condition).

3. Results

3.1 Suggestibility screening data and personality measures

Transliminality was found to be weakly correlated with the imaginative suggestibility subjective response measure ($r = 0.19$). Further to this, similarly weak correlations were found between transliminality and the hypnotic suggestibility response measures (objective, $r = 0.21$, subjective, $r = 0.23$, involuntariness, $r = 0.24$) (Irving et al., 2024). When considered alongside other personality traits (absorption, dissociation and fantasy proneness) that have been previously investigated in relation to suggestibility, multiple regression modelling (forward selection) showed that transliminality emerged as a sole predictor of the subjective imaginative suggestibility measure, and for the objective and subjective hypnotic suggestibility measures.

3.2 Systematic Review

The searches for the systematic review yielded 1018 records that after the removal of duplicates resulted in 588 remaining records. These were filtered by independent reviewers, who reached consensus that 19 full-texts should be reviewed for decisions about inclusion. A small number of additional reports were included that were known to the researchers and/or were identified through additional web searches. The most commonly analysed gene was COMT ($n = 8$), followed by the 5-HTT gene ($n = 2$). A number of other genes were analysed in single studies. These included OXTR, NOS3, OPRM1, FAAH, DRD3, DRD4, MAOA, and DAT. The findings of the COMT and 5-HTT studies within the literature provide mixed and incompatible findings. Regarding COMT, the first study reported that hypnotic suggestibility was higher in the Val/Met and Met/Met groups than in the Val/Val group (Ebstein et al., 1999; Lichtenberg et al., 2004; Lichtenberg et al., 2000), but found this relationship to be present in females only. Similarly, Raz et al. (2005) found those with the Val/Met variant to be higher in hypnotic suggestibility than the other variants. In direct opposition to these findings, however, Katonai et al (2017) and Szekely et al (2010) found higher suggestibility linked to Val/Val. Storozheva et al. (2018) found suggestibility to be higher in Met/Met, as did Rominger et al (2014) although they found the relationship to be present only in those with high attentional control. Bryant et al. (2013) and Presciuttini et al. (2014) found no significant relationship between COMT and hypnotic suggestibility.

3.3 Genetic analysis on current sample

COMT

Out of the usable samples, the number of people with each COMT genotype was as follows: A(Met)/A(Met) = 12, G(Val)/A(Met) = 24, G(Val)/G(Val) = 12. Assessing the difference in hypnotic suggestibility (as measured with the SHSS:C score) between the genetic subtypes, and using the Kruskal-Wallis test (due to deviation from normality), revealed no significant difference between the genotypes: $H(2) = .156$, $p = .925$ (FDR-corrected $p = 0.969$) (Figure 1a).

In relation to the phenomenological reports of level of dissociation during hypnosis, a significant difference was detected between the COMT variants: $H(2) = 6.062$, $p = .048$, where A/A (Met/Met) had the highest scores (median = 6, mean = 5.44, SD = 1.33), followed by G/A (Val/Met) (median = 5, mean = 4.91, SD = 1.69), and the lowest in dissociation was G/G (Val/Val) (median = 3, mean = 3.55, SD = 1.86) (see Figure 1b).

The DTNBP1 genotype was significantly associated with SHSS:C score: $H(2) = 6.173$, $p = .0457$ (but not when corrected for multiple comparisons using FDR, $p = 0.632$) (see Figure 1c). The highest suggestibility score was evident for genotype C/C ($n = 11$, median = 9, mean = 7.55, SD = 3.01), followed by C/T ($n = 20$, median 6, mean = 5.85, SD = 2.08), followed by T/T ($n = 11$, median = 5, mean = 4.91, SD = 2.30). Post-hoc testing (Nemenyi) showed that C/C was significantly different compared to T/T ($p = .040$).

The other genes investigated (HTR2A and KIBRA) did not show any relationship to suggestibility or the phenomenological ratings reported during the resting-state hypnosis, relaxation or baseline periods (as assessed during fMRI).

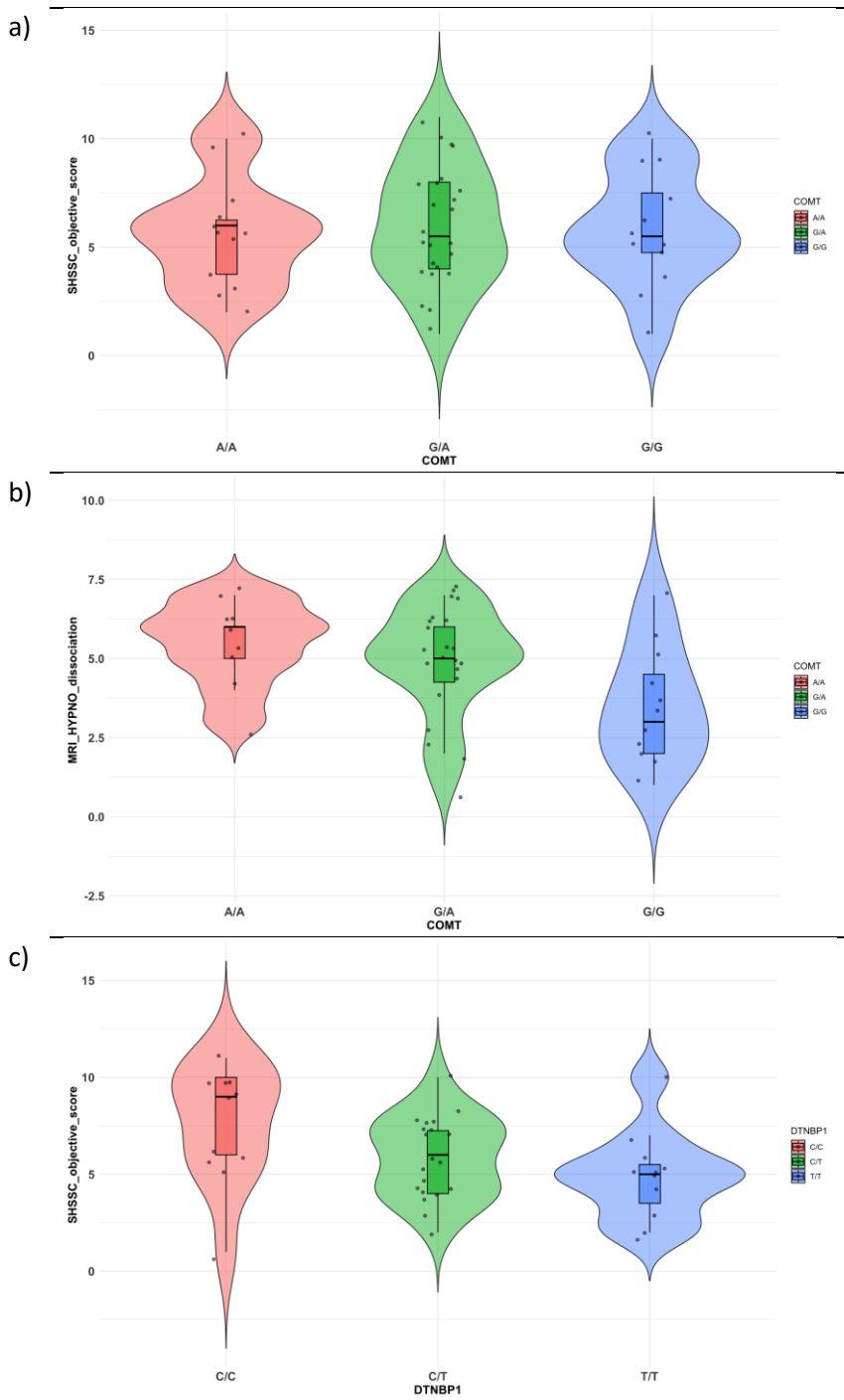


Figure 1: Violin plots to show a) hypnotic suggestibility scores (SHSS:C) grouped by COMT genotype, b) mean dissociation self-report score grouped by COMT genotype, c) hypnotic suggestibility scores grouped by DTNBP1 genotype.

3.4. EEG

The analysis of the resting state EEG data (over the periods of baseline, relaxation and hypnosis) resulted in 6-microstate prototypes (see Figure 2), which match those previously described in the literature (e.g., Custo et al., 2017; Michel & Koenig, 2018). The first 4 have similar topographies to the microstates reported in a previous microstate study of the effects of hypnosis reported by

Katayama et al. (2007), and two additional microstate prototypes (numbers 5 and 6) were identified.

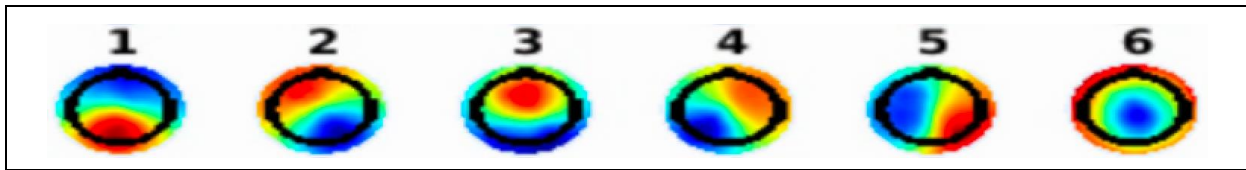


Figure 2. Microstate prototypes (n = 6) identified using the baseline, relaxation and hypnosis condition data.

The correlation analyses revealed that SHSS:C suggestibility was associated with the occurrence ($r = .28$, uncorr $p = .036$, FDR corr $p = .124$), average duration of occurrence ($r = .28$, uncorr $p = .036$, FDR corr $p = .122$) and percentage of total duration of the epoch ($r = .28$, uncorr $p = .036$, FDR corr $p = .122$) of microstate 4, as measured during the hypnosis condition. When using the SHSS:C score for only those items that were experienced as more involuntary (score ≥ 3), SHSS:C suggestibility was associated with the occurrence ($r = .37$, uncorr $p = .005$, FDR corr $p = .028$), average duration of occurrence ($r = .34$, uncorr $p = .01$, FDR corr $p = .045$) and percentage of total epoch duration ($r = .35$, uncorr $p = .006$, FDR corr $p = .033$) of microstate 4, as measured during the hypnosis condition. On the other hand, deeper hypnosis during the hypnosis condition was associated with microstate 5 occurrence ($r = .37$, uncorr $p = .004$, FDR corr $p = .024$), average duration ($r = .27$, uncorr $p = .040$, FDR corr $p = .135$), and percentage of total epoch duration ($r = .34$, uncorr $p = .009$, FDR corr $p = .042$). Microstate 5 during the hypnosis condition was also linked to reported relaxation (occurrence, $r = .5$, uncorr $p < .001$, FDR corr $p < .001$; average duration, $r = .29$, uncorr $p = .029$, FDR corr $p = .104$; percentage of total epoch duration, $r = .47$, uncorr $p < .001$, FDR corr $p = .002$).

4. Discussion

4.1 Personality correlates of suggestibility

The suggestibility screening data enabled analyses to be carried out, to test for the first time to our knowledge, whether transliminality could predict hypnotic suggestibility. Findings showed that transliminality was only a weak predictor of hypnotic suggestibility (on the objective, subjective and involuntariness measures) (Irving et al., 2024). Transliminality did however outperform (in terms of prediction of variance) other commonly assessed personality traits when predicting hypnotic suggestibility (objective and subjective measures). The results suggest that transliminality, which has been described as relating to the ease that information flows back and forth from consciousness (Thalbourne & Houran, 2000), and the scale for which, draws on items used to assess magical ideation, mystical experience, fantasy proneness, absorption, hyperaesthesia, appears to be a weakly predisposing factor for hypnotic suggestibility, but in the prediction of suggestibility there is still a large amount of unexplained variance, some of which is very likely explained by genetic composition, or factors such as expectancy and response without the use of hypnosis (see e.g., Braffman & Kirsch, 2001; Kirsch & Braffman, 2001).

4.2 Systematic review of genetic associations with hypnotic suggestibility

The systematic review showed that, although the number of studies on the genetics of hypnotic suggestibility has been accumulating, these studies have yielded a number of mixed findings (e.g., for the COMT studies, the genotype with the highest suggestibility differs considerably across studies and in some cases a relationship is detected only in a subset of the overall sample, or when considering, in combination, another factor). Larger studies are needed, and it appears that

advance planning and collaboration of research groups worldwide would be beneficial, to carry out well-powered studies (adopting at least a minimal uniform data-collection protocol) that could account for other potentially interacting factors (e.g., participant sex, levels of anxiety during testing, or levels of attentional control). With a highly complex trait like hypnotic suggestibility it is also likely that there are multiple genes involved that interact and only large-scale studies will enable investigation of these factors.

4.2 Genetic associations (Analyses from the current study)

No significant difference was seen in suggestibility level (SHSS:C) according to COMT genotype. Numerically slightly higher mean hypnotic suggestibility scores were found for the A/G (Val/Met) genotype, but when the median scores were assessed, it was A/A (Met/Met) that had the highest scores. Given the clear lack of any significant differences between groups and the overlap between groups, the results of our study are most consistent with those of Bryant et al. (2013) and Presciuttini et al. (2014), who also found no difference between suggestibility scores in their participants in relation to COMT genotype.

The group with the A/A (Met/Met) genotype, which is associated with lower efficiency of the COMT gene, less degradation of dopamine and more cortical dopamine availability (Lachman et al., 1996), reported significantly higher levels of dissociation during the hypnosis condition than the G/G (Val/Val) group.

4.3 EEG resting state analyses

Increased occurrence and duration of microstate 4 was associated with higher hypnotic suggestibility score (in particular when scoring on only items where response was perceived as involuntary). Increased occurrence and duration of this microstate prototype was linked to deeper reported hypnosis in the study by Katayama et al. (2007). Katayama et al. did not identify/select microstate 5 as a prototype in their study, whereas we did, finding its occurrence and duration, during the hypnosis condition, to be linked to greater depth of hypnosis and relaxation. Clearly, further study on microstates, hypnosis and suggestibility is needed (in particular, which prototypes are most relevant to hypnosis and suggestibility, and what is their functional significance?).

5. Conclusion

In summary, we thank the BIAL Foundation for supporting this research project. The funds have enabled us to develop a highly comprehensive and detailed multimodal dataset: Providing suggestibility screening of additional participants and the inclusion of EEG and genetic assessments into the project. We now have a very well characterised set of participants to advance knowledge on suggestibility and response to hypnosis. The dataset contains personality and behavioural assessments, EEG data, MRI data (both functional and structural) and genetic assessments. There is an extensive publication plan to utilise the available datatypes and the combinations of these.

6. Recommendations

Key recommendations are that much larger collaborative efforts are needed to help to understand the genetic underpinnings of hypnotic suggestibility, and a larger consideration of SNPs and gene (and demographic/trait) interactions is necessary. The same is true for neuroimaging studies in this field, and collaborative efforts would enable much larger datasets to be collected and combined, hopefully increasing reliability and confidence in findings, and enabling greater transferability.

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