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SUGGESTIBILITY IS NOT CORRELATED WITH NORMAL PERCEPTUAL HALLUCINATIONS, BUT IS NEGATIVELY CORRELATED WITH PERCEPTUAL DISCRIMINATION

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Abstract. Non-veridical perception in the form of reporting the perception of objects actually not presented has been observed also in neurotypical subjects. This phenomenon of 'normal hallucinations' substantially depends on expectations formed by learned contextual cues and associations as priors and is interpreted as a result of the mechanisms of predictive coding. We explored whether perceptual associations formed experimentally by inter-stimulus associations are related to the suggestibility trait of the perceivers. No significant correlation was found between Gudjonsson's Suggestibility scale total scores and subjective clarity of the hallucinatory experiences. There was a small positive correlation between shift and the level of clarity of illusory experiences. Significant negative correlation was found between the level of suggestibility and correctness of perception of the actually present stimuli.

Keywords: suggestibility, hallucinations, expectation, perception, predictive coding

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Motto:
"Do you see yonder cloud that's almost in shape of a camel?
Polonius: By the mass, and 'tis like a camel, indeed.
Hamlet: Methinks it is like a weasel.
Polonius: It is backed like a weasel.
Hamlet: Or like a whale?
Polonius: Very like a whale."

— William Shakespeare, Hamlet

1. Introduction

The famous dialogue between Hamlet and Polonius nicely illustrates a typical way how perceptual reports are influenced by non-perceptual cognitive mechanisms. However, to know whether somebody indeed experiences something after having been biased by a suggestible talk or whether this is just a biased responding without any change in the responder's direct perception requires psychometric measurement of suggestibility as well as direct perception. Adherents to the predictive coding theory have listed many experimentally verified factors such as contextual expectations, priming, personality traits, neuropsychiatric vulnerabilities etc. that can predispose people to non-veridical perception (e.g., Clark 2013, de Lange et al. 2018; Fletcher and Frith 2009, Friston 2010, Palmer et al. 2017, Teufel and Fletcher 2020). The outcome of the perceptual process depends on the relative contribution of (a) prior information encoded in the cognitive system and (b) actual direct sensory evidence (de Lange et al. 2018, Fleming 2020, Gilbert and Li 2013, Sterzer et al. 2008, Teufel and Fletcher 2020). If the former overweighs the latter, experience is close to what was expected. In most cases with mentally healthy subjects, good enough perceiving conditions, typical circumstances and contexts, the expected and the real coincide. However, strong priors can also lead to non-veridical experience when the circumstances allow.

The sources of expectation-based bias can be categorized as higher or lower level factors capable of forming subjective perception (Clark 2013, Corlett et al. 2019, Fleming 2020, Lupyan 2015, Seriès and Seitz 2013, Summerfield and de Lange 2014, Tulver et al. 2019). Higher levels include beliefs, general conceptual knowledge stored in the cognitive system, probabilistic estimations etc. Typicality of situations also forms the learned contextual priors capable of misperception bias for example when real situations are not typical. Lower levels include structural constraints 'hardwired' in the perceptual system such that even higher-level knowledge speaking against the way the habitat is perceived cannot change the percept (e.g. illusory contours or motion extrapolation). The effects of cognitive and perceptual level priors on non-veridical perception have been well studied (e.g. Balcetis and Dunning 2006, de Lange et al. 2018, Gilbert and Li 2013, Lupyan 2017, O'Callaghan et al. 2017), including when mentally normal perceivers experience objects that are not actually presented (Aru and Bachmann 2017, Aru et al. 2018, Partos et al. 2016). We will call the latter cases 'normal hallucinations' (to distinguish from 'real hallucinations' for difference from clinical connotations). Effects of schizotypy and autism on hallucination proneness in (pre)clinical populations have been widely studied, with no full consensus on the precise mechanisms achieved as yet (Behrendt and Young 2004, Fletcher and Frith 2009, Karvelis et al. 2018, Lawson et l. 2014, Palmer et al. 2017, Pellicano and Burr 2012, Powers et al. 2017, Reed et al. 2008, van de Cruys et al. 2014, 2017). However, there is much less research on the *higher-level effects of stable personality traits* of neurotypical population on the propensity to experience actually formed expectation-based *normal* hallucinations. One of the aims of this exploratory study is to contribute to this shortcoming.

The other aim stems from the fact that in the majority of cases the expectation based misperception by normal subjects has been demonstrated in the experimental paradigms where either interpretation of ambiguous real objects was examined or real stimuli in the form of pure noise were used as the 'mold' from where illusory percepts emerged (e.g. Balcetis and Dunning 2006, Bruger et al. 1993, de Lange et al. 2018, Gilbert and Li 2013, Jakes and Hemsley 1986, Lupyan 2017, O'Callaghan et al. 2017, Partos et al. 2016, Rieth et al. 2011). Normal hallucinations in the conditions where they emerge on an empty background (Aru and Bachmann 2017, Aru et al. 2018, Vetik et al. 2020) have not been used in the context of the effects of higher-level personality related priors. We combine the above described two aims in a single study.

Looking for a more or less stable personality characteristic that is likely to influence normal hallucinations understandably leads to considering suggestibility. (For more information on this construct or trait see Gudjonsson 1984, 1992, 1997 and Terhune et al. 2017.) Suggestibility as a measurable trait almost by definition refers to how much a suggestion given by somebody is capable of changing someone else's behavior – for example behavior explicated in reporting own cognitive-perceptual experience after having been subjected to formation of perceptual expectations. There are direct and indirect suggestive influences of which both are typically applied by some means of instructions and questions (Pohl 2016, Polczyk and Pasek 2006). Suggestibility as assessed by Gudjonsson's GSS2 (1992, 1997) belongs to the indirect variety of suggestibility. It has been argued that suggestibility and suggestions positively correlate with hallucination proneness (Alganami et al. 2017, McGeown et al. 2012, Young et al. 1987). On the other hand, there is data allowing to doubt this association (e.g. Merckelbach and van de Ven 2001, Smith and Gudjonsson 1995). Moreover, even though the positive effect of suggestibility on hallucinations appears to be real, in many accounts it can be explained by reporting biases rather than change in vividness of direct experience (Alganami et al. 2017, Merckelbach and van de Ven 2001, Partos et al. 2016). We will examine how much the *subjective clarity* of the normal hallucinations which are based on experimentally formed expectation are related to Gudjonsson type suggestibility. We hypothesize that perceivers who rate their hallucinations as clearer have also higher level of suggestibility in general.

2. Methods

For our purposes, we used two instruments. First, for assessing the level of suggestibility, Gudjonsson's scale GSS2 (Gudjonsson 1997) was adopted. Second, for obtaining and measurement of normal hallucinations the method used earlier by Aru, Tulver and Bachmann (2018) was implemented.

2.1. GSS2

Gudjonsson Suggestibility Scale 2 (GSS2; Gudjonsson 1997) is based on a narrative paragraph describing a young boy who loses control of his bike. This narrative is read to the tested persons who are thereafter asked to report all that can be recalled about the story. 20 specific questions are asked, 15 of which are misleading and suggestive. After answering the questions, the person is told that (s)he made a number of errors (independent of whether errors have been made), and thus it is necessary to ask all the questions again. The scale allows four scores: (1) Yield 1 – the extent to which the tested give in to misleading questions. The range of possible scores is 0–15. (2) Yield 2 – the extent to which they give in to misleading questions after negative feedback (interrogative pressure). The range of possible scores is 0–15. (3) Shift – any change in response to all 20 questions after negative feedback. Shift scores may range from 0 to 20. (4) Total suggestibility = the sum of Yield 1 and Shift (the range of scores, 0–35. (The scale has not been formally validated in Estonia. We postulate that we use it as a proxy to quasi-experiment where data makes dependent variables and GSS2 text and questions are regarded as independent variables. We have back-translated the Estonian translation and accept *ad hoc* informal validity.)

2.2. Experiment

In the computer-controlled experiment a SUN CM751U CRT monitor with 1024×768 pixels resolution and 100 Hz refresh rate was used to display the stimuli. The experiment was programmed and run on VisionEgg. The viewing distance from the participants' eyes to the monitor was 80 cm. They were engaged in a dual task in the main block. In the dual-task setup (5 blocks, 96 trials in each, 480 trials altogether) one task was termed the 'main task' (recognize whether the presented face was male or female), the other task the 'auxiliary task' (25%, i.e. 120 trials – evaluate the subjective clarity of the square 'embracing' the face). In the 20% of the auxiliary task trials termed critical trials the square was not actually presented, and the face was depicted alone (24 critical trials).

Face images that were used as the main task stimuli were selected from the Radboud Faces Database (Langner et al. 2010). All facial images were transformed to grayscale and resized to fit an elliptical shape of uniform size (1.8 deg); the hairline was removed, leaving only the facial area visible. Face stimulus was surrounded by the lines of a square-shaped figure (4 deg) which formed the auxiliary task stimulus, depicted slightly darker than the background (see Fig. 1).

On 75% of the trials in the dual-task condition the participants were tested on perception of the stimuli in the main task, yet they were told before the trials began that the auxiliary task is also relevant. No critical trials were included for the first 80 trials, to ensure that the participants were already used to the task (i.e. that they had built up an expectation about the stimulus screen).

Before the dual-task condition, participants were trained separately on both the main task of face perception and the auxiliary task of square evaluation condition. These practice trials served to ensure that participants were using the subjective visibility scale as intended. Concomitantly, individual contrast thresholds for the square stimuli were established: each subject performed 120 trials of the square detection task where the contrast was varied on-line between the six levels (part of these subliminal). As a result of this calibration two contrast levels were established – one leading to 75% correct detection and the other leading to 90% correct detection. An individualized invariant contrast value remaining within these limits was used in the main dual-task session for each subject. Upon completing the experiment, participants were debriefed about their experience and asked if they had noticed the missing stimuli.

2.3. Subjects

The initial sample consisted of 30 subjects (9 male, 21 female); mean age 37.7 (SD = 7.00, age range 23–49). All had normal/corrected vision. They were told that immediate memory and attention will be examined in the study. One subject was removed from the analysis because his GSS2 data represented an extreme outlier value (apparently due to some knowledge about the method) and the analyses were performed on data from 29 participants. (Current coronavirus situation prevented us from gathering more data from a larger sample to increase power because of direct contact restrictions by law imposed on our universities.)

2.4. Procedure

For all subjects, two procedures were run – GSS2 testing and visual perception experiment for normal hallucination testing. Each subject performed individually in the experimental room. The sample was randomly divided between two groups, 15 in each. One group did GSS2 first, immediately followed by the visual experiment. The order of tests for the other group was reversed.

Conducting the GSS2 was carried out according to the recommendations given by Gisli Gudjonsson (1992, 1997), with the only exception that delayed free recall was not used. Subjects were told that an oral text will be presented, to be listened to carefully and later on some tasks will be given related to the heard text. After the narrative was read aloud, participants were asked to produce a free written recall of the text. After free recall 20 questions were asked, including 15 misleading ones. After answers to questions the subjects received negative feedback in that they had made a number of mistakes (irrespective of the actual correctness of answers) and therefore they had to answer all questions again. Each testing took about 14 minutes.

In the visual experiment carried out in the dimly lit lab room, the task was explained and subjects performed (i) training trials for practice and contrast calibration and (ii) the main dual-task experiment (with face discrimination as the main task and square stimulus subjective contrast rating as the auxiliary task). A precise instruction for each specific task was displayed on the computer monitor before running the trials of that task. Each trial started with a fixation cross presented in the center of the grey screen for 1 s, followed by a stimulus (face-and-square) presented unpredictably to the left or right from the fixation for 100 ms. The facial stimulus depicted a male or female character with a neutral expression (1.8 deg); the auxiliary-task stimulus was a square-shaped figure (4 deg) surrounding the face. Lines forming the square were slightly darker than the background (see Fig. 1).

Stimuli were replaced by empty screen for 700 ms. The participants were instructed to keep fixation on the cross when initiating the stimulus presentation by pressing the spacebar on the computer keyboard. For responding for the main face gender discrimination task, keyboard keys had to be used as follows: S for male face and K for female face. For responding for the auxiliary square visibility (subjective clarity) rating task, Perceptual Awareness Scale (PAS) (Overgaard et al. 2006) was used. For this, one of the following responses had to be chosen so that: '1' corresponded to 'no experience of the stimulus', '2' corresponded to 'brief glimpse of the stimulus but could not recognize what it was', '3' corresponded to an 'almost clear impression of the stimulus', and '4' corresponded to a 'clear impression of the stimulus'.

On six critical trials where no square was presented participants were nevertheless asked to give a perceptual clarity rating. No critical trials were included in the first 80 trials. This was to ensure that subjects were already used to the task and had built up an expectation about the stimuli on the display.

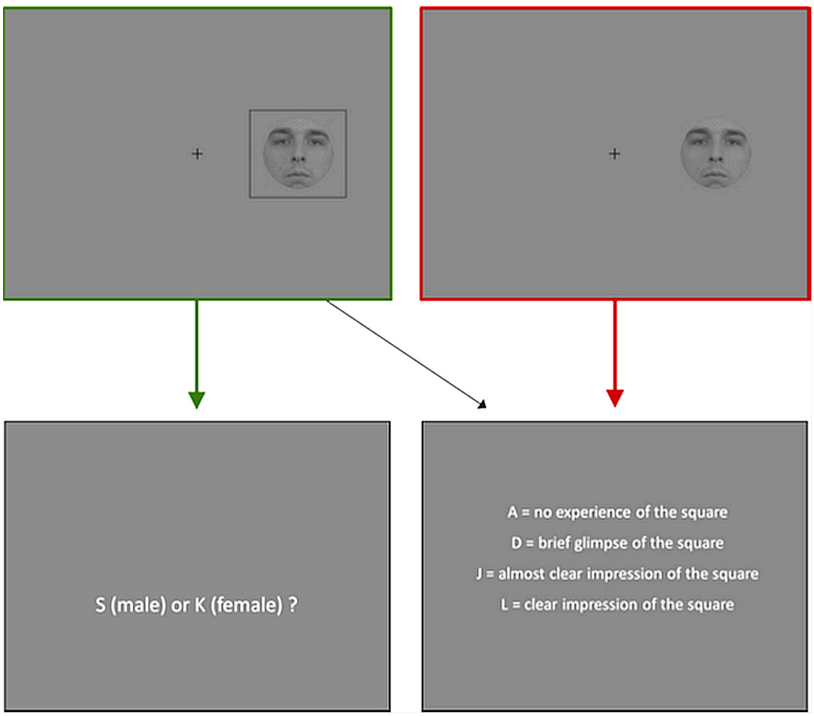

Figure 1. Illustration of the experimental paradigm for investigating normal hallucinations. The display on the top left (face surrounded by square) depicts the stimulus for the main task and the auxiliary task (shown in the bottom row): (i) indicate the gender of the face or (ii) rate the visibility of the square. In the single task condition (see methods) the tasks are practiced independently; in the main dual-task experiment the subject is prepared for both tasks. In the dual-task condition the face task was prompted on 75% of trials, thus focusing attention on face and less on the faint square stimulus. Importantly, in the critical trials (top right) no square was presented, but the subjects were nevertheless asked to rate the visibility (subjective clarity) of the absent square.

3. Results

Descriptive statistics for general evaluation of the results are drawn in Table 1. (For comparison, data for M from Gudjonsson (1997, as the source of Estonian practice with GSS2) is also shown in brackets after our respective M values.)

Table 1. Results of the GSS2 and visual perception experiment (N = 29)

	Mean	SD	Range
Immediate recall	20 (19.7)	5.04	14–31
Yield 1	2.9 (4.5)	5.33	0–10
Yield 2	5.33 (5.5)	3.85	0–12
Shift	4.97 (3.0)	3.93	0–13
Total suggestibility	7.87 (7.5)	5.65	0–21
Hallucination, proportion of critical trials	0.25	0.24	0–0.71
Correct discrimination of facial sex (proportion of trials)	0.69	0.08	0.49–0.84
Hallucination, mean clarity	1.44	0.49	1–2.67
Square-stimulus perception, mean clarity	2.88	0.67	1.86–3.86

As there were no notable differences between the results of two groups of subjects, data is handled as pooled together. Among the 29 participants only 7 (24%) responded in the critical trials (without the square) that they did not see the square. Clarity ratings of ten (34%) participants indicated that they perceived the in fact not presented square clearly at least once. No participant hallucinated in all critical trials. Mean clarity rating (i.e. clarity of the hallucinated experience) in the critical trials was 1.44 (SD = 0.49). On the other hand, mean clarity rating of the square stimuli when they were actually presented was 2.88 (SD = 0.67). These results show that (i) majority of subjects in our sample experience normal hallucinations and that (ii) subjective clarity of the illusory experiences is smaller than that of actually presented same stimuli. This also validates our experimental method for using it for assessing possible association of normal hallucinations with suggestibility.

The main question of interest was to test the hypothesis about the sample level increase of the expression of hallucinatory experiences (their clarity) with increase in suggestibility. However, we found no significant correlation between total suggestibility and clarity of hallucinations ($r = 0.24$, $p = 0.209$, ns) (see Figure 2). Yield1 relation with clarity of hallucinations was also not significant ($r = -0.18$, $p = 0.350$, ns). A marginally significant relation was found only between GSS2 shift indice and clarity of hallucinations ($r = 0.38$, $p < 0.04$). The central hypothesis of the study was not supported. Clarity of hallucinations was related neither to correctness of face gender discrimination ($r = -0.28$, $p = 0.15$) nor to the clarity of perception of the actually presented square stimuli ($r = 0.28$, $p = 0.14$, ns). Thus, normal hallucinations seem not to be dependent on general perceptual discrimination ability.

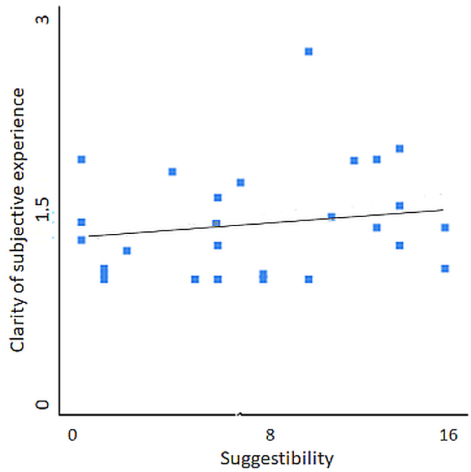

Figure 2. Scatter plot of Pearson's correlation showing association between GSS2 scores (measure of suggestibility) and mean clarity ratings of the hallucinated stimulus objects ($N = 29$; $r = 0.24$, ns).

On the other hand, a highly significant effect was found between total suggestibility and correctness of face gender discrimination ($r = -0.51$, $p = 0.004$). Subjects with higher suggestibility scores had generally lower ability to discriminate faces at the sample level.

4. Discussion

The hypothesized regularity that more suggestible individuals are also more prone to the effect of experimentally formed perceptual expectations on hallucination clarity did not receive experimental support. This is consistent with the view that a certain personality trait does not predispose someone to stronger or weaker expression of the effects of cognitive priors formed as a result of perceptual associative training. As the illusory experience of an actually not presented object must include involvement of more caudal brain mechanisms for perception and imagery, this also means that the higher level cognitive mechanisms in the rostral cortex that form a part of the suggestibility trait (Landry et al. 2017, Stuss and Knight 2013) do not exert or even cannot exert top-down modulation on how environmental objects are perceived in our case; this is in terms of vividness of experience. At the same time this allows to hypothesize that 'modules' constituting the neurobiological correlate of trait suggestibility need not be listed as higher level priors in the predictive coding theory of perception (Clark 2013, de Lange et al. 2018, Fletcher and Frith 2009, Friston 2010, Palmer et al. 2017, Teufel and Fletcher, 2020).

There was, however, a small effect of GSS2 shift on hallucination clarity although the total suggestibility did not have an effect. If to borrow from the domain of hypnotic suggestibility, it could be that interrogative suggestibility may have also different facets differently associated with the top-down mechanisms of perceptual system modulation (Terhune 2015). If this is true, further research will be needed to specifically study the partial effects of total suggestibility, yields, and shift, and this is with larger participant samples. Indeed, brain imaging data has shown that suggestions interpreted by frontal cortex can work back to the more caudal parts carrying the perceptual functions (McGeown et al. 2012, Oakley 2008, Terhune et al. 2017, Teufel and Fletcher 2020). This means that the main result of the present study may not provide any conclusive evidence, but could foster more differentiated further research distinguishing the roles of different putative sub-mechanisms involved in the brain architecture that forms the set of cognitive traits of personality.

Recently, some research has found that expectations do not alter early sensory processing and effects originate at the perceptual decision-making stage (Bang and Rahnev 2017, Rungratsameetaweemans et al. 2018). If this is so, we must explain why the quite commonly found expectation-caused normal hallucinations with their sensory-experiential content emerge at all. (In our study, most participants experienced these illusory percepts.) The paradoxical explanation that predictive coding is a theory only for non-veridical perception or perceptual decision-making without any bearing on real direct perception would be hard to digest.

Performing the GSS2 test involves metacognitive mechanisms as the subjects have to self-evaluate their memory and the extent to which one becomes subject to suggestive manipulation could be related to self-confidence. If this is so, then less confident subjects are expected to be more suggestible. This in turn means that confidence level should not predict normal hallucination level, provided that the results of the present study are to be taken into account. Recently we found evidence that propensity to normal hallucinations is not related to higher level metacognitive confidence (confidence in one's lower level metacognitive evaluations), but lower level metacognitive confidence about the correctness of one's perceptual discrimination negatively correlated with propensity for normal hallucinations (Vetik et al. 2020). Therefore, Gudjonsson's indirect suggestibility trait is likely to pertain to a different level of cognitive priors from those involved in expectation based mechanisms of perception.

The absence of a robust general effect of suggestibility on illusion-producing perceptual mechanisms is in contrast with the significant negative correlation between this trait and correctness of face gender discrimination. Hallucination proneness and perceptual ability in case of perception of actually presented stimuli seem to be independent. The present data do not allow to know what factors may mediate the effect of worse direct stimulus discriminability by the more suggestible individuals (at the group level). General visual ability of the participants was controlled by individually calibrating the stimuli contrast and by pre-testing their *visus* beforehand (only subjects with normal or corrected-to-normal vision participated). If, according to the predictive coding theory (Clark 2013; de Lange et al. 2018, Fletcher and Frith 2009, Friston 2010, Palmer et al. 2017, Teufel and Fletcher 2020), perception is the result of relative impact of priors and sensory evidence then less reliable direct perception would predict more expressed hallucinations. Yet the worse perceptual discrimination ability was not accompanied by an increase in hallucination clarity. It seems that in order to explain the association of higher suggestibility with less precise real perception we need to consider situational variables and/or attentional effects.

If we would assume that more suggestible subjects, due to some personality characteristic, pay less attention to the task then the drop in perceptual discrimination is easy to understand. However, then it needs to be explained why less attention does not have an effect on normal hallucinations. As there was no relation between total suggestibility and hallucination clarity then we have to conclude that these hallucinations do not depend on how carefully a subject pays attention to the stimulation expected to be perceived (as the main task). This seems likely because earlier research has also found no effects of attention on normal hallucinations (Aru et al. 2018). As the hallucinated objects are actually absent in the vicinity of the really presented objects, there is no need to divide attention between these two objects. The top-down generated, expectation based illusory objects emerge automatically.

Another possible factor capable of harming veridical perception is anxiety. By hypothesizing that more suggestible individuals are also less self-confident individuals we can believe that their state or trait anxiety is relatively higher and attention therefore less focused and less distraction-free. This would explain the negative correlation between suggestibility and perceptual discrimination. Consistently with this interpretation, in an earlier work using a similar face gender discrimination task we found strong detrimental effect of STAI/anxiety score on stimulus discrimination ($p < 0.005$) (Tulver et al. 2017).

There are limitations of the present exploratory study which need to be pointed out. First, the sample size is not very large and a weak effect with Gudjonsson shift facet suggests that with a large sample some significant effects could be found. Even having said this, it is quite clear from the results of the present experiment that the effect of suggestibility on normal hallucination vividness, even if it exists, cannot be robust. On the other hand, as there are subcomponents to interrogative suggestibility then we must not abandon the possibility that specific facets of suggestibility have different effects on normal hallucinations. The lack of scrutiny on this issue makes another limitation of this exploratory study. Both these limitations must be overcome in respective future research.

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References

Alganami, F., F.Varese, G. F. Wagstaff, and R. P. Bentall (2017) "Suggestibility and signal detection performance in hallucination-prone students". *Cognitive Neuropsychiatry* 22, 2 159–174.

Aru, J. and T. Bachmann (2017) "Expectation creates something out of nothing: the role of attention in iconic memory reconsidered". *Consciousness and Cognition* 53, 203–210.

Aru, J., K. Tulver, and T. Bachmann (2018) "It's all in your head: expectations create illusory perception in a dual-task setup". *Consciousness and Cognition* 65, 197–208.

Balcetis, E. and D. Dunning (2006) "See what you want to see: motivational influences on visual perception". *Journal of Personality and Social Psychology* 91, 4, 612–625.

Bang, J. W. and D. Rahnev (2017) "Stimulus expectation alters decision criterion but not sensory signal in perceptual decision making". *Scientific Reports* 7, 17072.

Behrendt, R. and C. Young (2004) "Hallucinations in schizophrenia, sensory impairment, and brain disease: a unifying model". *Behavioral and Brain Sciences* 24, 771–830.

Brugger, P., M. Regard, T. Landis, N. Cook, D. Krebs, and J. Neiderberger (1993) "'Meaningful' patterns in visual noise: effects of lateral stimulation and the observer's belief in ESP". *Psychopathology* 26, 261–265.

Clark, A. (2013) "Whatever next? Predictive brains, situated agents, and the future of cognitive science". *Behavioral and Brain Sciences* 36, 3, 181–204.

Corlett, P. R., G. Horga, P. C. Fletcher, B. Alderson-Day, K. Schmack, and A. R. Powers III (2019) "Hallucinations and strong priors". *Trends in Cognitive Sciences* 23, 2, 114–127.

de Lange, F. P., M. Heilbron, and P. Kok (2018) "How do expectations shape perception?". *Trends in Cognitive Sciences* 22, 9, 764–779.

Fleming, S. M. (2020) "Awareness as inference in a higher-order state space". *Neuroscience of Consciousness* 2020, 1, niz020.

Fletcher, P. C. and C. D. Frith (2009) "Perceiving is believing: a Bayesian approach to explaining the positive symptoms of schizophrenia". *Nature Reviews Neuroscience* 10, 1, 48.

Friston, K. (2010) “The free-energy principle: a unified brain theory?”. *Nature Reviews Neuroscience* 11, 127–138.

Gilbert, C. D. and W. Li (2013) “Top-down influences on visual processing”. *Nature Reviews Neuroscience* 14, 5, 350.

Gudjonsson, G. H. (1984) “A new scale of interrogative suggestibility”. *Personality and Individual Differences* 5, 3, 303–314.

Gudjonsson, G. H. (1992) “Interrogative suggestibility: factor analysis of the Gudjonsson Suggestibility Scale (GSS 2)”. *Personality and Individual Differences* 13, 4, 479–481.

Gudjonsson, G. (1997) *Gudjonssons Suggestibility Scale II manual*. London: Psychology Press.

Jakes, S. and D. R. Hemsley (1986) “Individual differences in reaction to brief exposure to unpatterned visual stimulation”. *Personality and Individual Differences* 7, 121–123.

Karvelis, P., A. R Seitz., S. M. Lawrie, and P Seriès (2018) “Autistic traits, but not schizotypy, predict increased weighting of sensory information in Bayesian visual integration”. *eLife* 7, e34115.

Landry, M., M. Lifshitz, and A. Raz (2017) “Brain correlates of hypnosis: a systematic review and meta-analytic exploration”. *Neuroscience & Biobehavioral Reviews* 81, 75–98.

Langner, O., R. Dotsch, G. Bijlstra, D. H. Wigboldus, S. T. Hawk, and A. D. Van Knippenberg (2010) “Presentation and validation of the Radboud Faces Database”. *Cognition and Emotion* 24, 8, 1377–1388.

Lawson, R. P., G. Rees, and K. J. Friston (2014) “An aberrant precision account of autism”. *Frontiers in Human Neuroscience* 8, 302.

Lupyan, G. (2015) “Cognitive penetrability of perception in the age of prediction: predictive systems are penetrable systems”. *Review of Philosophy and Psychology* 6, 4, 547–569.

Lupyan, G. (2017) “Objective effects of knowledge on visual perception”. *Journal of Experimental Psychology: Human Perception and Performance* 43, 4, 794.

Mazzoni, G., E. Rotriquenz, C. Carvalho, M. Vannucci, K. Roberts, and I. Kirsch (2009) “Suggested visual hallucinations in and out of hypnosis”. *Consciousness and Cognition* 18, 2, 494–499.

McGeown, W. J., A. Venneri, I. Kirsch, L. Nocetti, K. Roberts, L. Foan, and G. Mazzoni (2012) “Suggested visual hallucination without hypnosis enhances activity in visual areas of the brain”. *Consciousness and Cognition* 2, 1, 100–116.

Merckelbach, H. and V. van de Ven (2001) “Another White Christmas: fantasy proneness and reports of ‘hallucinatory experiences’ in undergraduate students”. *Journal of Behavior Therapy and Experimental Psychiatry* 32, 3, 137–144.

Oakley, D. A. (2008) “Hypnosis, trance and suggestion: Evidence from neuroimaging”. In M. Nash and A. Barnier, eds. *The Oxford handbook of hypnosis: theory, research, and practice*, 365–392. Oxford: Oxford University Press.

O’Callaghan, C., K. Kveraga, J. M. Shine, R. B. Adams, Jr, and M. Bar (2017) “Predictions penetrate perception: converging insights from brain, behaviour and disorder”. *Consciousness and Cognition* 47, 63–74.

Overgaard, M., J. Rote, K. Mouridsen, and T. Z. Ramsøy (2006) “Is conscious perception gradual or dichotomous? A comparison of report methodologies during a visual task”. *Consciousness and Cognition* 15, 4, 700–708.

Palmer, C. J., R. P. Lawson, and J. Hohwy (2017) “Bayesian approaches to autism: towards volatility, action, and behavior”. *Psychological Bulletin* 143, 5, 521.

Partos, T. R., S. J. Cropper, and D. Rawlings (2016) "You don't see what I see: individual differences in the perception of meaning from visual stimuli". *PloS one* 11, 3, e0150615.

Pellicano, E. D. and Burr (2012) "When the world becomes too real: a Bayesian explanation of autistic perception". *Trends in Cognitive Sciences* 16, 10, 504–510.

Pohl, R. F., ed. (2016) *Cognitive illusions: intriguing phenomena in judgement, thinking and memory*. London: Psychology Press.

Polczyk, R. and T. Pasek (2006) "Types of suggestibility: relationships among compliance, indirect, and direct suggestibility". *International Journal of Clinical and Experimental Hypnosis* 54, 4, 392–415.

Powers, A. R., C. Mathys, and P. R. Corlett (2017) "Pavlovian conditioning – induced hallucinations result from overweighting of perceptual priors". *Science* 357, 6351, 596–600.

Rungratsameetaweemans, N., S. Itthipuripat, A. Salazar, and J. T. Serences (2018) "Expectations do not alter early sensory processing during perceptual decision-making". *The Journal of Neuroscience* 38, 24, 5632–5648.

Reed, P., D. Wakefield, J. Harris, J. Parry, M. Cella, and E. Tsakanikos (2008) "Seeing non-existent events: effects of environmental conditions, schizotypal symptoms, and sub-clinical characteristics". *Journal of Behavior Therapy* 39, 276–291.

Rieth, C. A., K. Lee, J. Lui, J. Tian, and D. E. Huber (2011) "Faces in the mist: illusory face and letter detection". *i-Perception* 2, 5, 458–476.

Seriès, P. and A. Seitz (2013) "Learning what to expect (in visual perception)". *Frontiers in Human Neuroscience* 7, 668.

Smith, P. and G. Gudjonsson (1995) "The relationship of mental disorder to suggestibility and confabulation among forensic inpatients". *Journal of Forensic Psychiatry* 6, 3, 499–515.

Sterzer, P., C. Frith, and P. Petrovic (2008) "Believing is seeing: expectations alter visual awareness". *Current Biology* 18, 16, R697–R698.

Stuss, D. T. and R. T. Knight (2013) *Principles of frontal lobe function*. Section V. Oxford University Press.

Summerfield, C. and F. P. de Lange (2014) "Expectation in perceptual decision making: neural and computational mechanisms". *Nature Reviews Neuroscience* 15, 745–756.

Terhune, D. B. (2015) "Discrete response patterns in the upper range of hypnotic suggestibility: a latent profile analysis". *Consciousness and Cognition* 33, 334–341.

Terhune, D. B., A. Cleeremans, A. Raz, and S. J. Lynn (2017) "Hypnosis and top-down regulation of consciousness". *Neuroscience & Biobehavioral Reviews* 81, 59–74.

Teufel, C. and P. C. Fletcher (2020) "Forms of prediction in the nervous system". *Nature Reviews Neuroscience* 21, 231–242.

Tulver, K., I. Allemann, and T. Bachmann (2017) "Trait anxiety is correlated with the correct categorization of faces, but not reaction times, in a spatial attention task". In *European Conference on Visual Perception.* 27–31 August 2017*: Abstract Book*, 173. Berlin, Germany.

Tulver, K., J. Aru, R. Rutiku, and T. Bachmann (2019) "Individual differences in the effects of priors on perception: a multi-paradigm approach". *Cognition* 187, 167–177.

Van de Cruys, S., K. Evers, R. Van der Hallen, L. Van Eylen, B. Boets, L. De-Wit, and J. Wagemans (2014) "Precise minds in uncertain worlds: predictive coding in autism". *Psychological Review* 121, 4, 649.

Van de Cruys, S., S. Vanmarcke, I. Van de Put, and J. Wagemans (2017) "The use of prior knowledge for perceptual inference is preserved in ASD". *Clinical Psychological Science* 6, 3, 382–393.
Vetik, S., K. Tulver, D. Lints, and T. Bachmann (2020) "Among the two kinds of metacognitive evaluation, only one is predictive of illusory object perception". *Perception* 49, 10, 1043–1056.
Young, H. F., R. P. Bentall, P. D. Slade, and M. E. Dewey (1987) "The role of brief instructions and suggestibility in the elicitation of auditory and visual hallucinations in normal and psychiatric subjects". *Journal of Nervous and Mental Disease 175*, 1, 41–48.