Effects of Restricted Environmental Stimulation on Optical Illusion Strength

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Abstract

Using restricted environmental stimulation (REST), researchers observed the effects of altered mental states, monocular vs. binocular cues, and orientation on perceptual processing. Participants were asked to partake in fifteen minutes of REST or normal resting. They then viewed the Hollow Mask Illusion which allowed the researchers to understand the reliance on top-down vs. bottom-up processing being utilized. Individuals that underwent REST were found to perceive the mask veridically significantly more. This suggests that participants relied mainly on past experiences and knowledge for their perception and interpretation of the mask when it was right-side up and when the participant used only one eye to view it. Findings suggest that REST can induce an altered mental state, although is it unclear exactly what this mental state is representative of, and how long it can last.

Effects of Restricted Environmental Stimulation on Optical Illusion Strength

Individuals who are prone to psychosis perceive the world differently. This altered perception is present even when the individual is not in a psychotic state (Silverstein, 2016). Psychosis is commonly seen in individuals with schizophrenia spectrum disorders, as well as those partaking in the use of psychoactive drugs (Notredame, Pins, Deneve, & Jardi, 2014). Individuals that undergo psychosis have been shown to have hallucinations, delusions, and other losses from reality that stem from altered perception. In order to study this altered state of perception, research shows that drug use could induce a similar state in otherwise healthy individuals (Taam et al., 2015; McKetin et al., 2006; Thomas, 1993; Mosholder et al., 2009). However, known side-effects of certain psychoactive drugs such as PCP, ketamine, and other hallucinogens have been shown to be dangerous, potentially even inducing a psychotic disorder, such as schizophrenia (Malhotra et al., 1997; Rosse et al., 1994; Javitt, 1987; Gururajan, 2012; Rubino, Zamberletti, & Parolaro, 2012; Bagot, Milin, & Kaminer, 2015). To be able to safely study a perceptual state similar to that of schizophrenia, an alternative method is needed. Restricted environmental stimulation (REST) has been shown to be a safe potential model for inducing such a state, allowing research into temporary conditions in the general public that would otherwise be necessary to study only in the psychiatric populations (Brownfield, 1965; Daniel & Mason, 2015; Mason & Brady, 2009; Lloyd, Lewis, Payne & Wilson, 2012).

Individuals who experience psychosis perceive the world differently and process stimuli differently (Notredame, Pins, Deneve, & Jardi, 2014; Tibber et al, 2013; Silverstein & Keane, 2011). There are two main streams of visual perception; top-down processing and bottom-up processing. Top-down processing occurs when prior knowledge and experiences are used to interpret a stimulus. It is often referred to as conceptually-driven processing because perception relies primarily on expectations, motivation, beliefs, ideas, and personal knowledge. Initial perceptual interpretations are made first by top-down processing that rely on patterns experienced prior in life. Top-down processing relies primarily on the prefrontal cortex for judgement (Cherry, 2018; Engel, Fries & Singer, 2001). On the other hand, bottom-up processing does not involve the use of prior worldly knowledge, but instead uses only the small details of the stimuli itself to help in the interpretation. It is referred to as data-driven processing because interpretation relies on detailed analysis of the stimuli. Visual data of the stimuli is sent to the visual cortex of the brain in bottom-up processing (Sincero, 2018).

Healthy individuals use both bottom-up and top-down processing in the interpretation of almost all stimuli. Usually top-down processing is involved in the initial estimation and identification of a stimulus. If it is not recognized immediately using situational and prior knowledge (top-down processing), bottom-up processing begins to examine the exact details of the stimuli and confirm its identification. (Von Stein, Chiang & Konig, 2000, Delorme, Rousselet, Mace & Fabre-Thorpe, 2004). The ventral stream of perception is slightly slower than the dorsal stream, which causes the detail-driven interpretation to occur slightly after the initial guess (Von Stein, Chiang & Konig, 2000). Communication between the frontal lobe and occipital lobe is imperative for the two forms of processing to be used collectively and transcranial communication allows for the most efficient and effective way of identifying a stimulus.

Individuals that experience psychosis are unable to use both bottom-up and top-down processing. These individuals have trouble combining the two streams of perception because of the dysconnectivity of their brains due to glutamate and dopamine receptor dysfunction (Olney & Farber, 1995; Coyle, 2006).

Thus, individuals with schizophrenia will rely on one form of processing to govern their interpretation of the stimuli. Research suggests that individuals with psychosis spend significantly more time in bottom-up processing when interpreting stimuli (Dima, et al., 2009; Keane et al., 2013; Schneider et al., 2002 . In other words, individuals in a state of psychosis rely mostly on the exact details of a stimulus and very little on prior knowledge and experience in order to make an interpretation of the stimulus. For this reason, it has been shown that individuals experiencing psychosis will not be deceived by certain visual illusions which rely heavily on prior knowledge of the stimulus, such as the hollow mask illusion (King, Hodgekins, Chouinard, Chouinard & Sperandio, 2017; Silverstein & Keane, 2011; Kogata & Lidaka, 2018).

The hollow mask illusion shows differences in performance between individuals with psychosis and non-clinical controls (Dima et al, 2009). It uses a hollow mask that has been painted in a manner that makes it appear to be convex (popping out). The mask being used in this illusion is concave, where the nose, eyes, chin, cheeks, and forehead caved inwards. The coloring of the mask allows for a more realistic face-like appearance. The shading of the mask is illustrated in a way that makes it look like a light source is shining above it, in order to appear as faces do in real life with the sun always shinning above and casting a shadow, thus the mask appears to be popping out (convex). Interpretation of this illusion is only possible in a healthy mind because it takes advantage of top-down processing (Taylor, 1989). The brains of healthy individuals have become very efficient at finding the features of a face and identifying it. This ability grows mostly through top-down processing where one uses prior knowledge of faces to more efficiently identify them (Johnson, 2005). The ability to quickly identify faces is what makes the hollow mask illusion so strong in the healthy mind (Hill & Bruce, 1993). When presented with the hollow mask illusion, a healthy individual will spend more time seeing the mask as popping out because they are spending more time relying on top-down processing, or the prior knowledge of faces, to interpret the mask when it is face up (Papathomas & Bono, 2004). Individuals experiencing psychosis will spend more time seeing the mask veridical and they spend more time relying on bottom-up processes, using only the details of the mask to make their interpretation (Dima et al., 2009; Keane et al., 2013; Schneider et al., 2002). The difference in perception of the mask can be used to measure the processing of individuals and identify which form of processing is being relied on more.

REST is the process of taking away a range of senses from an individual. It can be done in a variety of ways with differing degrees depending on which senses are being deprived and to what extent. Altered states of perception like that of psychosis have been shown to be induced through REST (Daniel, 2017; Merabet et al., 2004; Brownfield, 1965; Daniel & Mason, 2015; Mason & Brady, 2009; Lloyd, Lewis, Payne & Wilson, 2012). REST has been shown to be a safe way to induce a state similar to psychosis, without inducing real psychosis and serves as a practical model for studying the mental state characteristic of schizophrenia.

This aim of this study is to investigate the processing of individuals induced to have a state similar to psychosis and how it may differ from that of healthy individuals not under such a condition. Using REST, individuals in this study will enter into a state of altered perception similar to what may be experienced by someone with schizophrenia, and then will be asked to interpret the hollow mask in order to understand which perceptual process they are relying on the most. Our main hypothesis is that individuals undergoing REST will see the hollow mask veridical, as concave, significantly more than individuals not participating in REST. Thus, we expect that those in an induced state of psychosis will perceive the information primarily through bottom-up processing. Our secondary hypothesis is that individuals undergoing REST will report significantly more hallucination-like experiences during the process. REST is still a relatively new technique for inducing a state similar to that of psychosis and needs to be studied further for it to become an accepted model of this induction. Using REST to examine perception of visual illusions is an area that has not yet been comprehensively explored. Common altered states of perception that occur in autism, schizophrenia, and drug use can also be further examined and studied by examining perceptions of certain visual illusions. The ability to induce a psychotic-like state similar to that of an individual with psychosis is imperative for a safe and effective experimentation. Understanding the mental processing of those with psychosis could aid in the treatment and medical awareness of those suffering from it.

Method

Participants

Participants were recruited from Albright College after the study was approved by the IRB. The majority of participants were young adults, ages 18-85 (M = 22, SD = 3.04). Data from 62 participants was initially collected however, 4 participants were excluded because of inaccurate quality control answers and recorded outliers, thereby leaving data from 58 participants (34 female) to be used for analysis. Participants from the Albright College Psychology Department were recruited through email to sign-up using their SONA (http://albright.sona-systems.com) accounts. Participants outside of the Albright College Psychology Department signed-up for the study via direct emailing from researchers and word of mouth. Those participants attending the Albright College Psychology Department were compensated with extra credit for their psychology courses, while all other participants were compensated with five dollars for their participation. All participants provided informed consent.

Materials

A monitor and tower were used to record all data. Illusion time was recorded using the iWorx handheld controller (model iWire; iWorx Systems Incorporated, Dover, NH). For programming, Labscribe3 software (BioSeb, Vitrolles, France) was used to collect illusion time data. A variety of established questionnaires were used to assess reliability of personality characteristics associated with schizophrenia, schizotypy, and delusional ideation. The Revised Hallucination Scale (RHS; Morrison, Wells & Nothard, 2000) was administered to assess the frequency that one experiences hallucinations. It is a 24-question survey scaled from “1- Never” to “4- Almost Always”. Answers corresponded with the number value from 1-4, and certain questions were reverse coded. All scores were added to yield an overall score for the RHS for each participant. Higher scores indicate more frequent hallucinations. The State-Trait Anxiety Inventory (STAI) Form Y-1 and Y-2 (Speilberger, Gorusch, Lushene, Vagg, & Jacobs, 1983), was given to measure state and trait anxiety. . The Y-1 form is a 20-question survey that used a scale from “1-Not at All” to “4-Very Much So”, and the Form Y-2 is a 20-question survey that used a scale from “1-Almost Never” to “4-Almost Always”. Answers corresponded with the number value from 1-4, and certain questions were reverse coded. All scores were added up for both forms to yield an overall score for STAI for each participant. Higher scores indicate higher anxiety. MSS-B (Kwapil, Gross, Raulin, Silvia, & Barrantes-Vidal) is a 40-question true or false survey that measures schitzotypy behavior. True corresponded with a score of 1, and false corresponded with a score of 0. All scores were added up to yield an overall score for positive schizotypy, negative schizotypy and disorganized schitzotypy behavior. Higher scores in each category indicate a higher schizptypy personality. The Cardiff Anomalous Perceptions Scale (CAPS; see appendix 1-5) is an 8-question survey also used to measure the extent and quality of hallucinatory experiences. The CAPS is a 32-question survey with a “Yes” or “No” answer option. An answer of “Yes” corresponds to a score of 1, and an answer of “No” corresponds with a score of 0. Scores were added up to give an overall score for CAPS. Higher scores indicate more frequency of anomalous perceptions. Each question had answers ranging from “1-Strongly Disagree” to “4-Strongly Agree”. Answers corresponded with the number value from 1-4, and certain questions were reverse coded. Scores were added up and yielded a total hallucination score as well as a total confound score. Higher scores indicated more vivid hallucination-like experiences and greater confounds present. These number scales were used to operationalize schizotypy behavior, likelihood to experience hallucinations, and other personal characteristic traits. A small survey was given to assess the hallucination-like experiences noticed by participants during the REST. 8 short questions were given about sights, sounds, or feelings that the participants experienced in the REST time. These scores were added up to give a total score for hallucination-like experiences felt during the REST. The higher the number, the greater amount of these experiences were felt.

Participants used SONA system (http://albright-.sona/systems.com) to sign-up for time slots. Surveymonkey (www.surveymonkey.com) was used to collect participant data from these scales.

A hollow mask that was painted in a realistic way was mounted onto a black piece of cardboard onto the wall. Black felt was used to cover the wall behind the mask. Black curtains were used on either side of the participants to focus their gaze on the mask. Lights were projected onto the mask from both sides of the curtains to increase the strength of the illusion. Participants used a chin rest to view the mask and sat on a chair in front of the curtains. For the REST, participants used swim goggles that were painted gray, a blowup air mattress, and noise-cancelling headphones.

Procedure

After giving informed consent, participants were randomly assigned to the control or the manipulation group. Participants in the manipulation group were given Ganzfeld goggle (gray, foggy swim goggles) and noise-cancelling headphones to wear. Participants in the control group were give clear swim goggles and headphones without noise-cancelling capabilities to wear. Both groups wore their headphones and goggles while lying face up on an air mattress for 15 minutes. During this time, all overhead lights were turned off, but four lamps to the left of the participant were left on. After 15 minutes of silence, all of the lights were turned back on and the participant was asked to sit up and complete a brief survey asking about the experiences they noticed while lying on the mattress. Upon finishing this survey, the participant was asked to participate in the Hollow Mask Illusion. After a short introduction and explanation of the task, the participant began looking at the mask and identifying whether they perceived it convexly or concavely. The participant was given a key pad with letters “A” through “D” on it. “A” corresponded to convex and “D” corresponded to concave. The participants were asked to use the keypad to indicate their perception of the mask, and this was recorded for later analysis. The time the participant viewed the mask popping out was calculated and used as our dependent variable. Participants saw the mask upside-down and right-side up, and with one eye open and two eyes open resulting in 4 overall conditions. The participant viewed the mask for two minutes in each condition, and the conditions were randomized to reduce order effects. The time the mask was viewed as popping out was calculated out of 120 seconds for each condition. A ratio was then calculated for each condition of the amount of time the participant viewed the mask as convex over the total amount of time viewing the mask. Lastly, participants were given debriefed on the aims of the study.

Results

To test our primary hypothesis that individuals would see the mask significantly more as convex after the REST condition compared to individuals that did not undergo REST, we ran a mixed measures 2(condition) x 2(number of eyes open) x 2 (orientation) ANOVA with orientation, number of eyes open, and manipulation as our three independent variables and time spent in the illusion (the ratio of time spent seeing the mask convexly) as our dependent variable. We found that there was a significant main effect of orientation, F(1,55) = 12.44, p < .005, η2 = .184. Individuals saw the mask as convex significantly more when the mask was right-side up (M = 0.61, SD = 0.364) versus upside-down (M = 0.45, SD = 0.381). There was also a main effect of number of eyes open, F(1, 55) = 40.01, p < .001, η2 = .422. Individuals saw the mask as convex significantly more when they had one eye open (M = 0.71, SD = 0.364) versus two eyes open (M = 0.355, SD = 0.381). There was no main effect of manipulation, F(1,55) = 0.02, p = .887, η2 = .000. There was a main interaction effect between eyes and manipulation, F(1,55) = 4.02, p = .05, η2 = .068, such that individuals undergoing REST were more likely to perceive the illusion in the one eye condition but less likely to perceive the illusion in the both eyes condition (see Figure 1). There was no interaction effect between the orientation condition and the eyes condition, nor between the orientation, eyes, and manipulation condition, F(1,55) = 1.48, p = .230, η2 = .026; F(1,55) = 0.40, p = .529, η2 = .007. To test our second hypothesis that individuals undergoing REST would perceive more hallucination-like experiences, we ran an independent t-test. Individuals that underwent REST (M = 12.29, SD = 3.47) reported significantly more hallucination-like experiences than individuals that underwent normal resting (M = 9.55, SD = 3.37), t(55) = 3.02, p < .005 (Fig 2)..

In order to test for the possible confound of order effect, we ran four one-way ANOVAs with the order of when the participant saw the mask right-side up and with one eye open as the independent variable, and the illusory time proportion (ratio of time spent seeing the mask convexly compared to concavely) as the dependent variable. There was no significant main effect of order on the proportion of illusory time for the right-side up and both eyes open condition, F(3,54) = 1.02, p = .391; the upside-down and both eyes open condition, F(3,54) = 1.14, p = .341; the right-side up and one eye open condition, F(3,54) = 1.62, p = .195; or the upside-down and one eye condition, F(3,54) = 1.56, p = .209.

To test for the possible confound caused by wearing glasses, we ran an independent t-test with wearing glasses as the independent variable and proportion of illusory time as the dependent variable. There was no overall significant difference in the total proportion of time spent perceiving the illusion over all conditions of the mask for participants that were wearing glasses (M = 0.52, SD = 0.22) versus participants that were not wearing glasses (M = 0.55, SD = 0.18), t(55) = 0.491, p = .626. For the strongest mask condition, there was also no significant difference in the proportion of time spent perceiving the illusion for the right-side up and one eye condition between participants that wore glasses (M = 0.74, SD = 0.33) and those that did not wear glasses (M = 0.81, SD = 0.31), t(55) = 0.822, p = .414. To check for physical confounds such as the participant being bored, uncomfortable, or not relaxed between condition groups, we ran an independent t-test. Scores for these areas were added together for each participant to yield one final confound score (higher scores corresponded with more confounds present). There was no significant difference in the total confound score between the REST group (M = 15.57, SD = 3.13) and the control group (M = 15.83, SD = 2.92); t(55) = 0.320, p = .750.

To test for the differences of the perception between men and women, we ran an independent t-test with gender as the independent variable and total proportion of illusory time as the dependent variable.

There was no significant difference in the total proportion of time perceiving the illusion between male ($M = 0.60$, $SD = 0.19$) and female ($M = 0.51$, $SD = 0.20$) participants, $t(56) = 1.526$, $p = .133$.

Discussion

Our primary hypothesis that individuals undergoing REST would see the hollow mask as concave significantly more, (i.e., they would perceive the information primarily through bottom-up processing) was not supported by our findings. Instead we found that individuals undergoing REST and individuals in our control group spent the same proportion of time viewing the mask as concave. Past research showed that individuals in a state of altered perception, similar to what may be experienced by someone with schizophrenia, were significantly less likely to be deceived by illusions such as the hollow mask illusion (Ash, Hughes & Papathomas, 2011; King, Hodgekins, Chouinard, Chouinard & Sperandio, 2017; Kogata & Lidaka, 2018). Our results did not support this finding for a few possible reasons. Perhaps our mask illusion was not strong enough to elicit the difference in perception between individuals in an altered state of perception and those in a normal state, or rather that the difference we did observe may not have been large enough to cause an effect in how participants perceived the mask. Research suggests that individuals with schizophrenia are less likely to see illusions only in strong illusions (King, Hodgekins, Chouinard, Chouinar & Sperandio, 2017). If our illusion was too weak, the difference in perception would not have been seen. Another possibility is that REST does not induce a state representative of the altered state of perception seen in individuals with Schizophrenia. Our REST could have potentially caused an altered mental state completely different to that of schizophrenia. Or perhaps the effects of the REST did not last long enough for them to have an effect on the hollow mask task. One way to avoid this confound could be to use a virtual reality (VR) system to induce the altered mental state and then immediately show the mask through the VR as well. More research will have to be done to understand the exact mental state induced by different forms of REST.

Our secondary hypothesis that individuals undergoing REST would experience more hallucination-like experiences than the individuals in the control group was supported by our results. REST has been shown to cause hallucination-like experiences in subjects (Suedfeld, Ballard, Baker-Brown & Borrie, 1986; Kjellgren, Lyden & Norlander, 2008). Many REST devices use flotation tanks to deprive individuals of their touch sensation (Kjellgren, Sundequist, Norlander & Archer, 2001), but we had participants lay on an air-mattress instead. Even with the difference in material, we still found that participants undergoing the REST reported significantly more hallucination-like experiences than controls. Finding such a difference shows that our REST was effective in inducing some sort of mental state change. The degree of this change, the amount of time this mental change lasts, and the exact details of the mental state induced are still unknown and need to be investigated further. Perhaps gathering open-ended descriptions from participants would have provided a better understanding of this induced state can be investigated.

We found that individuals were more likely to see the mask convexly when the mask was right-side up and when using only one eye, suggesting they rely more on top-down processing in these circumstances (Puce, Allison & McCarthy, 1999). One possibility for this relationship may be that using one eye decreases the efficiency of perception in the brain when interpreting the stimuli (Jones & Lee, 1981) thus making the brain rely more on experience (top-down processing) to make a final interpretation. Another reason for this finding may be that REST induced only a very weak mental state change that did not cause participants to rely fully on top-down processing. Instead, a weak state would cause the brain to perhaps become confused about what process it should rely on most, so the brain could potentially have to rely on the process that is getting the most information. When using two eyes, the visual cortex is providing adequate information to the brain, so when in confusion the brain may perhaps rely on this bottom-up process. However, when using one eye, the brain is not getting enough information to the visual cortex, so it may decide to use its prior knowledge to make the best interpretation. This rerouting would explain why participants would rely on top-down processing with one eye open and bottom-up processing when they used both eyes.

Further research could consider using true controls that only complete the Hallow Mask Illusion task and do not partake in REST or normal rest. A true control would test to see if there is any difference in perception between REST, laying down and being quiet, and just completing the Hollow Mask Illusion. Future work could also increase the time in REST to 25 or even 40 minutes (Turner & Fine, 1983), as 15 minutes may have not been long enough to allow the participants to view the mask before the effects wore off. By increasing the time in this state, one might be able to more accurately differentiate the mental state of those participants from the controls through a longer effect time and perhaps a more dramatic difference.

More research needs to be done to confirm these findings and to further understand the topic. Understanding the effects of perception in altered mental states could allow for a greater understanding of individuals with schizophrenia and other mental disorders. By understanding how these individuals perceive the world, it may help in the treatment and improved quality of life for these individuals. It is also important to understand the effects of REST on perceptual states, and to see if it is a valid model for the representation of the mental state observed in individuals with mental disorders such as schizophrenia. Through continued research in this field and the combination of using REST to observe perceptual changes in altered mental states, researchers can better understand the viewpoint and basis of behavior in these individuals who have altered mental states. Improvement in understanding the perception of individuals that undergo psychosis, such as those with schizophrenia, will greatly increase the ability of medical professionals to help these individuals improve their overall health and life outlook.

References

Ash, J., Hughes, J., Papathomas, T. (2011). A system to study 3D perception for diagnosing schizophrenia and assessing treatment results. 2011 IEEE 37th Annual Northeast Bioengineering Conference (NEBEC), Troy, NY, pp. 1-2.

Bagot, K., Milin, R. & Kaminer, Y. (2015) Adolescent initiation of cannabis use and early-onset psychosis, Substance Abuse, 36(4), 524-533.

Brownfield, C. A. (1965). Isolation: Clinical and experimental approaches. New York: Crown/Random House.

Cherry, K. (2018). Top-down processing and perception. Very Well Mind.

Coyle, J. (2006). Glutamate and Schizophrenia: Beyond the Dopamine hypothesis. Cellular and Molecular Neurobiology. 26(6), 363-382.

Daniel, C. (2017). Sensory deprivation as an experimental model of psychosis. Doctoral Thesis, University College London.

Daniel, C., and Mason, O. J. (2015). Predicting psychotic-like experiences during sensory deprivation. BioMed Res. Int.

Delorme, A., Rousselet, G., Mace, M., Fabre-Thorpe, M. (2004). Interaction of top-down and bottom-up processing in the fast visual analysis of natural scenes. Cognitive Brain Research. 19(2), 103-113.

Dima, D. et al. (2009). Understanding why patients with schizophrenia do not perceive the hollow mask illusion using dynamic casual modelling. NeuroImage. 45 (4). 1180-1186.

Engel, A., Fries, P., Singer, W. (2001). Dynamic predictions: Oscillations and synchrony in top-down processing. Nature Reviews Neuroscience. 2, 704-716.

Gururajan, A., Manning, E. E., Klug, M., & den Buuse, M. van. (2012). Drugs of abuse and increased risk of psychosis development. Australian andNew Zealand Journal of Psychiatry, 46(12), 1120–1135.

Happe, F. (1996). Studying weak central coherence at low levels: Children with autism do not succumb to visual illusions. A research note. The Journal of Child Psychology and Psychiatry, 37 (7), 873-877.

Hill, H. & Bruce, V. (1993). Independent effects of lighting, orientation, and stereopsis on the hollow-face illusion. Perception.

Javitt, D. (1987). Negative schizophrenic symptomatology and the PCP model of schizophrenia. The Hillside Journal of Clinical Psychiatry, 9(1), 12-35.

Johnson, M. (2005). Subcortical face processing. Nature Reviews: Neuroscience, 6, 766-774.

Jones, R. K., & Lee, D. N. (1981). Why two eyes are better than one: The two views of binocular vision. Journal of Experimental Psychology: Human Perception and Performance, 7(1), 30-40.

King, D., Hodgekins, J., Chouinard, P, Chouinard, V., Sperandio, I. (2017). A review of abnormalities in the perception of visual illusions in schizophrenia. Psychon Bull Rev, 24(3), 734-751.

Kjellgren, A., Lyden, F., Norlander, T. (2008). Sensory isolation in flotation tanks: Altered states of consciousness and effects on well-being. The Qualitative Report, 13 (4), 636-656.

Kjellgren, A., Sundequist, U., Norlander, T., Archer, T. (2001). Effects of flotation-REST on muscle tension pain. Pain Research and Management, 6(4), 181-189.

Kogata, T. & Lidaka, T. (2018). A review of impaired visual processing and the daily visual world in patients with schizophrenia. Nagoya J Med Sci, 80 (3), 317-328.

Malhotra, A., Pinals, D., Adler, C., Elman, I., Clifton, A., Pickar, D. & Breier, A. (1997). Ketamine-induced exacerbation of psychotic symptoms and cognitive impairment in neuroleptic-free schizophrenics. Neuropsychopharmacology, 17, 141-150.

Mason, O. J., and Brady, F. (2009). The psychotomimetic effects of short-term sensory deprivation. J. Nerv. Ment. Dis. 197, 783–785.

McKetin, R. , McLaren, J. , Lubman, D. I. and Hides, L. (2006), The prevalence of psychotic symptoms among methamphetamine users. Addiction, 101, 1473-1478.

Merabet, L., Maguire, D., Warde, A., Alterescu, K., Stickgold, R., Pascual-Leone, A. (2004) Visual hallucinations during prolonged blindfolding in sighted subjects. Journal of Neuro-Opthalmology. 24(2): 109 – 113.

Mosholder, A., Gelperin, K., Hammad, T., Phelan, K., Johann-Liang, R. (2009). Hallucinations and other psychotic symptoms associated with the use of attention-deficit/hyperactivity disorder drugs in children. Pediatrics, 123(2), 611-616.

Notredame, C., Pins, D., Deneve, S., Jardri, R. (2014). What visual illusions teach us about schizophrenia. Front. Integr. Neurosci.

Olney, J., Farber, N. (1995). Glutamate receptor dysfunction and schizophrenia. Arch Gen

Psychiatry. 52(12), 998-1007.

Papathomas, T. V., and Bono, L. M. (2004). Experiments with a hollow mask and a reverspective: Top-down influences in the inversion effect for 3-D stimuli. Perception, 33, 1129-1138.

Puce, A., Allison, T., McCarthy, G. (1999). Electrophysiological studies of human face perception. III: Effects of top-down processing on face-specific potentials, Cerebral Cortex, 9 (5), 445–458.

Rosse, R., Collins, J., Fay-McCarthy, M., Alim, T., Wyatt, R. & Deutsch, S. I. (1994). Phenomenologic comparison of the idiopathic psychosis of schizophrenia and drug-induced cocaine and phencyclidine psychoses: A retrospective study. Clinical Neuropharmacology, 17(4), 359-369.

Rubino, T., Zamberletti, E., & Parolaro, D. (2012). Adolescent exposure to cannabis as a risk factor for psychiatric disorders. Journal of Psychopharmacology, 26(1), 177–188.

Silverstein, S. M., and Keane, B. P. (2011). Vision science and schizophrenia research: toward a re-view of the disorder editors' introduction to special section. Schizophr. Bull. 37, 681–689.

Sincero, S. (2018). Top-down vs. bottom-up processing. Explorable.

Suedfeld, P., Ballard, E., Baker-Brown, G., & Borrie, R. (1986). Flow of consciousness in restricted environmental stimulation. Imagination, Cognition and Personality, 5(3), 219–230.

Taam, M., de Boissieu, P., Taam, R., Breton, A., Trenque, T. (2015). Drug-induced hallucination: A case/non case study in the French pharmacovigilance database. Eur. J. Psychiat., 29.

Taylor, S. E. (1989). Positive illusions: Creative self-deception and the healthy mind. New York: Basic Books.

Thomas, H. (1993). Psychiatric Symptoms in Cannabis Users. British Journal of Psychiatry, 163(2), 141-149.

Tibber, M. S., Anderson, E. J., Bobin, T., Antonova, E., Seabright, A., Wright, B., et al. (2013). Visual surround suppression in schizophrenia. Front. Psychol. 4, 88.

Turner, J., Fine, T. (1983). Effects of relaxation associated with brief restricted environmental stimulation therapy (REST) on plasma cortisol, ACTH, and LH. Biofeedback and SelfRegulation. 8(1), 115-126.

Von Stein, A., Chiang, C., König, P. (2000). Top-down processing mediated by interareal synchronization. Proceedings of the National Academy of Sciences, 97 (26), 14748-14753.

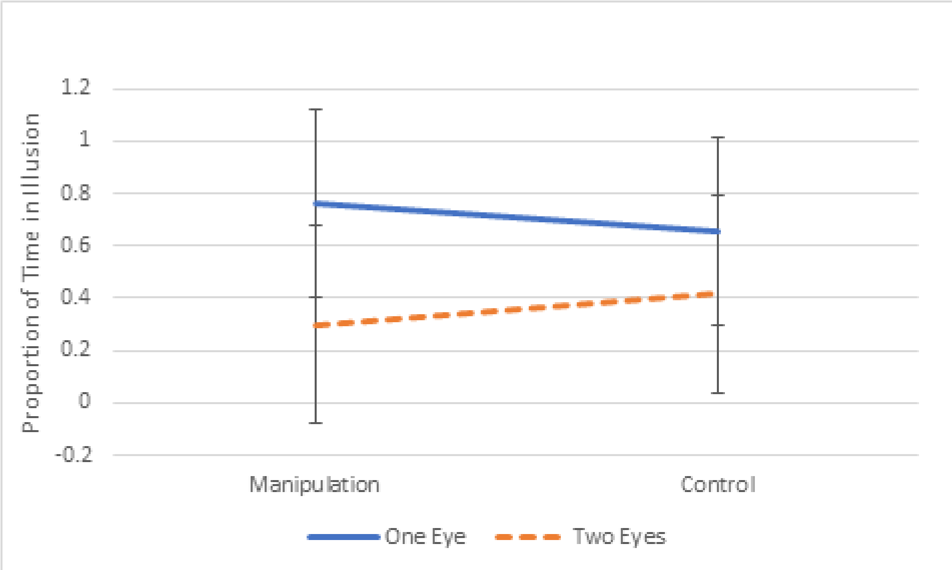

Figure 1. Mean difference values with standard deviations of the proportion of time participants perceived the mask as convex (as opposed to concave) while viewing the mask after either manipulation (REST) or control (no REST) with either one eye open (blue line) or two eyes open (orange line). Individuals saw the mask as convex (in illusion) significantly more with one eye open. There was also an interaction effect between condition and number of eyes open. In the manipulation condition, there was a greater difference in the proportion of time participants saw the mask as convex vs. concave between one eye and two eyes open, in that a greater amount of time was spent in the illusion during one eye open conditions. In the control condition, the difference in proportion of time spent in the illusion (seeing the mask as convex) is not as pronounced between the one and two eyes open conditions.

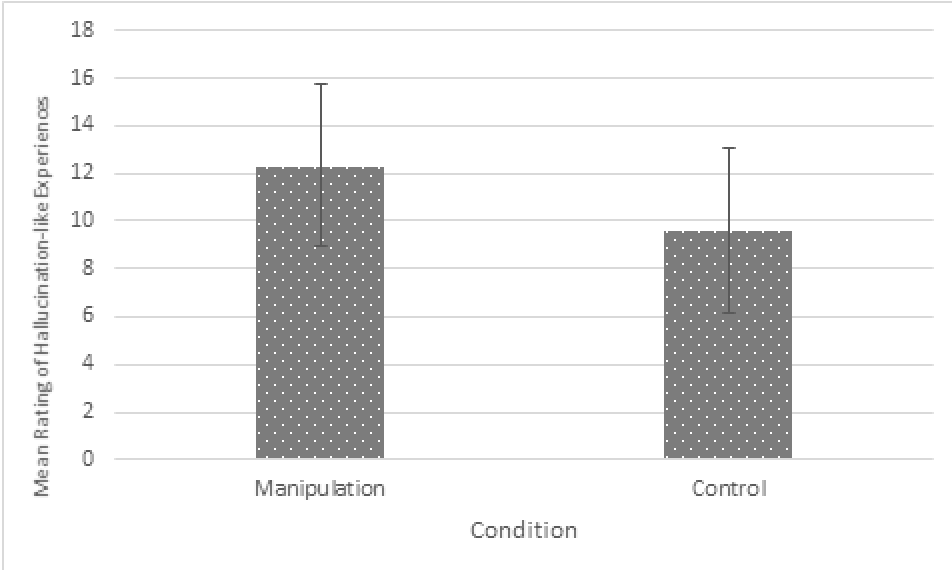

Figure 2. Mean rating of hallucination-like experiences noticed by participants while in the REST or normal rest conditions. Individuals in the manipulation group experienced significantly more hallucination-like experiences than the control group.