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Investigating How Individual Differences in Selective Attention Relate to Schizotypy and Altered States of Consciousness

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Measures of altered states of consciousness (ASC) are useful for understanding anomalies within conscious experiences. Within psychedelic clinical trials, ASC have been associated with long-term positive treatment outcomes for numerous types of mental illnesses. Schizotypal Personality Scale (STA), a set of personality traits that can be related to psychedelic-induced ASC, is associated with potential changes in selective attention, such as being less bound to previously learned associations (i.e., reduced associative blocking). Given the similarity between schizotypy and psychedelic-induced ASC, we hypothesized that there may be attentional differences in individuals with past experiences of ASC. This study examined how differences in selective attention relate to past experiences of ASC and STA. In Study 1, participants completed a visual categorization task designed to elicit associative blocking, the STA, and the ASC scale. Results revealed slow learning feature–category associations in participants high in ASC and STA. Study 2 tested whether this deficit in performance was due to widened attention by implementing additional inference trials that measured incidental learning of feature–feature associations. Results from Study 2 confirmed that participants high in ASC and STA show deficits in learning categories, but this was not accounted for by wider selective attention per se. Our results suggest that flexible or widened attention may not be the locus of cognitive changes associated with past experiences of ASC. Rather, by showing reliable latency in an error-driven learning task, we add to a comprehensive understanding of the relationships between cognition and ASC.

Keywords: selective attention, psychedelics, altered states of consciousness, learning, categorization

Altered states of consciousness (ASC), states out of one's ordinary waking consciousness, have been of great interest in understanding both normal and abnormal conscious experiences. Measures of ASC have been used to gauge the mental alterations induced by different methods such as sensory deprivation, meditation, monochromatic sounds, and trance. More often though, measures of ASC have been used to gauge the intensity of psychoactive compounds (Griffiths et al., 2006; Hasler et al., 2009; Northoff et al., 2005). Measures of ASC, originally constructed by Dittrich (1975), are developed to measure the magnitude of experiencing oceanic boundlessness (unitive experience, self-transcendence, timelessness), dread of ego dissolution (self-dissolution accompanied by negative emotions, paranoia), and visionary restructuralization (visual and auditory hallucinations and synthesis). Interestingly, the magnitude of experiences, measured through ASC scales, has been found to "mediate long-term changes in mental health" (Roseman et al., 2018) within clinical trials investigating the therapeutic potential of psychedelics. Considering the

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Data and code for the present studies have been made publicly available at https://osf.io/9pmg7/?view_only=f8226d3734924bbabe834be896c89317 (Martis et al., 2023).
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long-term effects found in psychedelic clinical trials, subsequent differences in cognitive processes and behaviors may be associated with experiences of ASC. To determine a starting point for understanding how past experiences with ASC may impact cognition, we consider the disruptions of selective attention within schizophrenia-related traits that are putatively similar to those induced by psychedelic ASC (Aday et al., 2020; Carhart-Harris et al., 2016; Martin et al., 2014; Mason et al., 2008; Osmond & Smythies, 1952; Umbricht et al., 2003; Vollenweider et al., 1998).

Selective attention is a key faculty that supports people in differentiating relevant from irrelevant features of a scene or stimuli. Cues or features associated with an object or scene are believed to compete to attract attention. By being associatively coupled with the presence or absence of an outcome, cues can be learned as important and in turn attended to in future encounters. Cue competition underlies a wide range of associative learning phenomena such as overshadowing (Mackintosh, 1976), latent inhibition (Lubow, 1973), and associative blocking (Kamin, 1968), which is the focus of the present study. Selective attention may be an adaptive way to resolve cue competition because it allows people to focus on the most relevant cues for performing a task, although at the cost of potentially being unaware of new information in the environment that may also be useful for achieving a goal.

Several studies have found schizotypal personality traits are associated with differences in selective attention-related associative learning phenomena. Specifically, individuals high in schizotypy tend to have difficulties in inhibiting attentional tuning to irrelevant information in overshadowing, latent inhibition (Granger et al., 2012; Gray et al., 2002), and associative blocking tasks (Hemsley, 1993; Jones et al., 1997; Moran et al., 2003; Serra et al., 2001), suggesting the disorganization of cue competition processes. In associative blocking specifically, this reduced tendency to ignore irrelevant stimuli leads to improved overall performance (less blocking). In other cases, individuals higher in schizotypy may perform worse due to tendencies to perseverate on irrelevant stimuli when predictive ones are available. However, there remains debate about whether differences may be due to reinforcement sensitivity as opposed to selective attention per se (Pickett et al., 2017), and several studies have failed to replicate blocking and latent inhibition effects (Jones et al., 1992, 1997; Swerdlow et al., 1996).

Although less frequently studied in relation to schizotypy than associative learning, selective attention is also core to many other cognitive processes, such as category learning. Because category learning also depends on selective attention, it is possible that individuals higher in schizotypy may show similar patterns of effects in category learning tasks as in associative blocking. When categorizing a stimulus (e.g., when predicting whether an animal is a mammal or a bird), we need to attend to specific cues like whether the animal has nipples and hair (vs. feathers; Rehder & Hoffman, 2005). Cues that are not useful for distinguishing between categories may potentially be ignored or blocked. For example, learning to categorize birds and mammals based on whether they have hair or feathers may impact the ability to learn that the presence (or absence) of nipples can also facilitate categorization.

Category learning offers an opportunity to test how individual differences related to schizotypy and ASC may affect cognitive performance and memory (Deng & Sloutsky, 2016). Categories shape much of how people experience the world. Thus, investigating potential relationships between selective attention, schizotypy, and ASC could be one avenue for developing a mechanistic theory of how the adjustments of world views that have been found to accompany psychedelic drug usage (Timmermann et al., 2021) arise. Specifically, if greater past experience with ASC is related to changes in selective attention like those observed in individuals higher in schizotypy, changes to how people learn and think about categories could be one avenue by which ASC affects cognition more broadly. In this article, we examine how past experiences of ASC, and schizotypy, relate to individual differences in how people deploy selective attention in service of category learning.

The Present Investigation

Given the long-term benefits of psychedelic clinical trials and the similarities between psychedelic-induced states and schizophrenia-related states, we sought to investigate how measures of schizotypy (STA; Rawlings et al., 2001) and past experiences of ASC are related to individual differences in category learning performance for a task which requires participants to deploy selective attention processes to learn cues that were predictive of category membership.

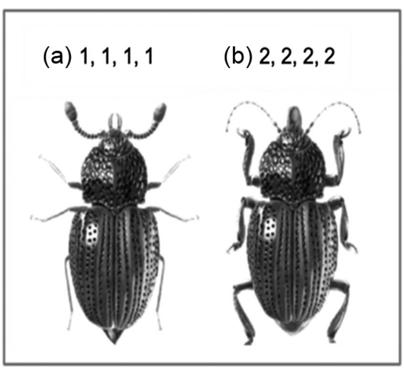
In Study 1, we tested whether individuals with frequent past experiences of ASC and those high in STA traits tend to have an increased probability of learning redundant associations, which would be consistent with disrupted blocking.

In Study 2, we extended this paradigm to test whether past experiences of ASC and STA were associated with differences in learning intercue associations by testing participants' ability to infer a missing cue when given other cues, with and without information about category membership. Disrupted blocking and stronger learning of interrelationships among cues or features would be indicative of flexible or widened attention present in these individuals. On the other hand, behaviors that suggest no learning of critical and or redundant features to category associations resulting in poor categorization and inference performance would be indicative of possible deficits in learned selective attention.

Study 1

Participants completed a category learning task where they had to employ selective attention to learn which features of a beetle, produced and adopted from Frances L. Fawcett (see Figure 1), predicted whether the beetle was a member of one of two possible categories (Hole 1 or Hole 2). The task had three key phases, two of which were the learning phases and the final of which was the test phase. In the Learning Phase 1, a single critical feature was predictive of category membership. For example, the set of legs on the beetle may be the critical feature dimension if thin legs predicted to be in Category 1 and the thick legs predicted to be in Category 2. In the Learning Phase 2, a redundant feature was added that was also perfectly predictive of category membership. For example, the antennae may now be an additional feature dimension predictive of category membership if thick antennae predict Category 1 and thin antennae predict Category 2. In this case now, thin legs and thick antennae are paired feature types predicting Category 1 and thick legs and thin antennae are paired feature types predicting Category 2.

Figure 1
Beetle Prototypes



Note. The numbers above the beetles indicate arbitrary numerical values associated with each of these dimensions. For example, in this figure, (a) 1 on the first dimension indicates thin legs and (b) 2 indicates thick legs. The other dimensions refer to tails, antennae, and pincers, respectively. Beetle images were modified from original artwork by Frances L. Fawcett. Copyright by Frances L. Fawcett. Adapted with permission.

After the two learning phases, a test phase was given in which some trials asked participants to categorize new beetles with missing critical or redundant features, and others where the paired critical and redundant features predicted different categories. We refer to these latter trial types as incongruent trials. These key trial types in the test phase would determine the type or direction of attention selectivity participants deployed toward given features and feature dimension pairs.

Someone who learns both critical and redundant features will show an above-chance tendency to choose a category associated with both feature dimensions. Someone who only learned the critical feature dimension will show an above-chance tendency to choose a category associated with the critical dimension but not the redundant. In contrast, someone who learned the redundant but not the critical would show an above-chance tendency to choose a category associated with the redundant feature dimension but not the critical during incongruent trials. Someone who does not learn the critical and redundant feature dimensions to be predictors of category membership will show a below-chance tendency to choose a category associated with either defining dimension. We hypothesized that participants high in ASC and STA will be less bound to originally learned (critical) associations permitting the learning of redundant associations and depicting instances of disrupted blocking.

Study 1: Method

Participants

Participants were recruited via Amazon's Mechanical Turk (MTurk) platform in the year 2020. Participants had no time limit for the task, and thus, participants with over 10 trials missing were excluded from the analysis due to the potential impact of missing data on our results. One hundred seventeen participants were included in the analyses. Participants were provided a consent form prior to beginning the study explaining the protection of privacy, a simple description of the study, the estimated duration (45 min) of the study, and contact information for if participants had any questions about the research. Participants were paid $2.00 to complete the study. Participants completed the study voluntarily and were able to withdraw at any time from the study. Demographic data were not available for this sample, but it was likely demographically similar to the sample in Study 2, as we utilized the same population and recruitment strategy.

The ethical considerations of the study were approved beforehand by the Human Research Protection Program at Texas Tech University, which serves as a liaison to the institutional review board.

Stimuli and Design

Beetles were used as the stimuli participants learned to categorize into one of two categories or "holes." Each beetle had four different feature dimensions that could be one of two variations—legs (skinny and stretched or thick and bent), tail (rounded or pointed), antennae (thick and bent upward or skinny and bent downward), and pincer (rounded or sharp; see Figure 1 for possible features). Each beetle image was 4.65 × 4.65 inches and centered in the screen. For each participant run, a randomly selected feature dimension was chosen to be the defining critical feature for categorization. On each trial of the learning phase, the words, "Which hole did this beetle come from? Press the '1' or '2' key" appeared 3 cm below the beetle image. Then, feedback was delivered, telling the participant whether they were right or wrong and the correct category.

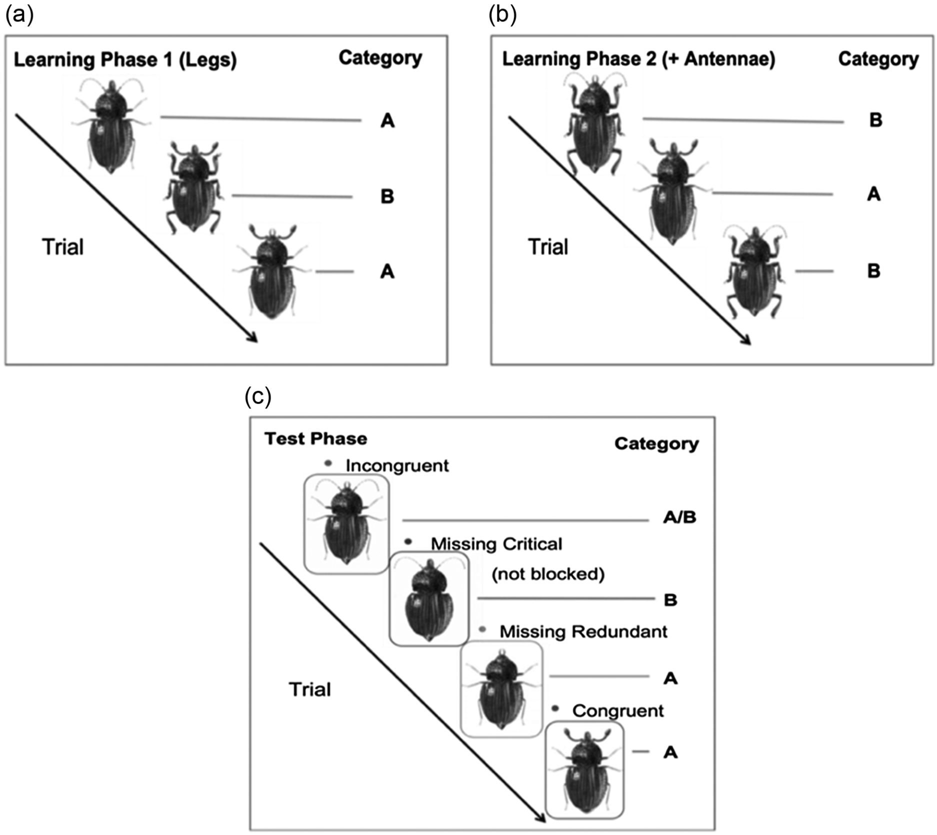
A three-phased categorization task with two learning phases and one test phase was used to investigate selective attention. Learning Phase 1 consisted of 16 beetle stimuli, reflecting all possible combinations of features. These stimuli were presented 3 times each in a randomized order (48 total categorization trials).

In Phase 2, an additional randomly selected redundant feature dimension was chosen from the remaining three feature dimensions (Figure 2b). Because all beetles in Phase 2 had to have consistent pairs of features, two feature dimensions (critical and redundant) are now perfectly predictive of category membership rather than just one (critical). Beetles which did not have a consistent pair of critical and redundant features were removed from Learning Phase 2, leaving eight beetles. To minimize participants' suspicion of there being fewer beetles, each of the eight beetles was presented 6 times to mirror the 48 trials in Learning Phase 1.

During the test phase, the original complete set of 18 beetles, plus novel beetles with missing feature dimensions, were presented. When a feature dimension was missing, it was valued as 0 (Figure 3). Images of beetles with missing features were the same size (4.46 × 4.46) with the same prompt appearing 3 cm below the stimulus, "Which hole did this beetle come from? Press the '1' or '2' key." However, feedback was not given after their responses. In the test phase, each possible variation of beetle with one of its feature dimensions missing was presented to the subject for categorization. The variations of missing feature dimensions presented in the test phase accumulated into four key trial types, which were of interest to investigate differences in learning feature–category associations and categorization behavior (Figure 2c). "Incongruent" trial types represented when the critical and redundant feature dimensions were associated with opposing category memberships, "missing critical" trial types represented when the critical feature dimension was not present on the beetle (e.g., missing leg dimension in Figure 3), "missing redundant" trial types represented when the redundant feature dimension was not present on the beetle, and "congruent" trial types represented when both critical and redundant feature dimensions were associated with the same category membership such as the LearningPhase 2 beetles.

Incongruent trials were designed to capture two categorization behavioral tendencies, namely the tendency to categorize in line with the critical feature or in line with the redundant features. Missing critical trials captured the behavioral tendency to categorize in line with the given redundant feature, representing an instance of disrupted blocking. Missing redundant trials captured the behavioral tendency to categorize in line with the critical feature. Congruent trials mirrored trials from Phase 2 where both critical and

Figure 2
Categorization Task Phases Example



Note. Phase is identified above each schematic. (a) In Phase 1, category membership is determined by legs (critical feature). (b) In Phase 2, the antennae is paired with the original critical feature (legs) and becomes a redundant feature. (c) In the test phase, four key trial types were recorded. Incongruent trials are when critical and redundant features are associated with opposite categories; the tendency to choose a category associated with one or the other was recorded. Missing critical trials, or the "not blocked" trials, recorded the tendency to choose a category associated with the redundant feature. Missing redundant trials recorded the tendency to choose a category associated with the critical feature. Congruent trials had both critical and redundant features pointing to the same category membership such as those presented in Learning Phase 2. Beetle images were modified from original artwork by Frances L. Fawcett. Copyright by Frances L. Fawcett. Adapted with permission.

redundant features were associated with the same category, capturing the behavioral tendency to categorize in line with the fundamental categorical rule.

Personality Trait Measures

ASC. ASC scales are often used to measure the magnitude of consciousness alteration in studies with many different induction methods. The most frequent use of ASC scales is to measure experiences induced by psychedelic substances during clinical trials. Studerus et al. (2010) psychometrically evaluated the original ASC questionnaire by Bodmer et al. (1994) and found that each of their original three factors was multidimensional and divided them into 11 new factors. This new factor structure produced slightly lower Cronbach's α though all were above 0.7. Studerus et al.'s (2010) 11-factor ASC scale included 42 items derived from the original 66-item ASC questionnaire by Bodmer et al. (1994; Table 1). The items were measured on a scale of 0–10, where 0 indicates *never have*

Figure 3
Beetle Missing a Feature Dimension

Note. This is an example of a beetle that is included in the test phase where any one of the four features dimensions can be missing. Here, the first feature dimension in chronological order, the legs, is missing, thus acquiring a value of 0 for its corresponding feature dimensions. Beetle images were modified from original artwork by Frances L. Fawcett. Copyright by Frances L. Fawcett. Adapted with permission.

experienced and 10 indicates *experienced often*. ASC is normally used as a gauge of phenomenal experience during psychedelic states, although it has not been used to determine the degree of past experiences. To better fit a trait and life experience-based measurement, rather than a post hoc experiential measurement, the items were rephrased (Table 1). For example, the original statements "I felt like a marionette" and "I experienced a touch of eternity" were rephrased to "At times I feel Like a marionette" and "I have experienced a touch of eternity." In the present study, the rephrased ASC had a McDonalds ω = 0.99, ω hierarchical = 0.87, ω total = 0.99, and a Cronbach's α = 0.99. Additionally, a latent variable exploratory factor analysis was performed post hoc for the rephrased ASC scale used for this study to determine the distinction of subfactors for analysis. The parallel analysis compares the eigenvalues obtained from the actual data with those obtained from a randomly generated data set. Eigenvalues from the actual data are then compared to the reference distribution, and only those eigenvalues that are greater than corresponding eigenvalues from the random data sets are retained to represent the number of factors or components to retain in the analysis. Despite the adopted ASC scale by Studerus et al. (2010) consisted of 11 lower order factors, a three-factor construct, including one pronounced factor and two minor ones, was found to be appropriate in the present study (see Table 2 for factor loadings). The present study supports the original construction of three key factors of the ASC scale as developed by Dittrich (1975). As indicated by the factor loadings, the majority of items on the ASC scale fit neatly into one factor, supporting the single overarching factor emphasized in the post hoc psychometric analysis and providing evidence for the potential use of the scale as a unidimensional measure.

Schizotypal Personality Scale. The four-factor Schizotypal Personality Scale (STA; Rawlings et al., 2001) is used to measure the magnitude of schizophrenia-related traits in participants. Previous research and discussion emphasize the similarities between ASC induced by psychoactive drugs and symptoms of schizophrenia. This scale was included in order to investigate potential relationships between 11-factor ASC and STA on the categorization task. The STA contains four factors labeled "magical thinking," "unusual perceptual experiences," "paranoid suspiciousness and isolation," and "social anxiety." Each of the 37 items was yes–no questions. In the present study, the STA showed high internal consistency with a McDonald's ω = 0.97, ω hierarchical = 0.63, ω total = 0.96, and a Cronbach's α = 0.95. An exploratory parallel analysis of the STA results suggested the presence of two factors which consisted of one overarching factor, as opposed to the four-factor model proposed by Rawlings et al. (2001; Table 3). Similar to the ASC factor loadings, the majority of STA items fit into one factor, supporting the use of the scale as a unidimensional measure for the present study.

Procedure

Before the learning phases, participants were told they will be presented with pictures of beetles and that each beetle comes from either "Hole 1 or 2." Participants were told the four features to pay attention to (legs, tail, antennae, and pincer) in order to begin categorizing. Participants were informed that there will be two learning phases where feedback ("correct" or "incorrect") will be provided after each trial. Before the learning phases began, one of these four features were randomly selected to be the critical feature for determining category membership of Hole 1 or 2. To choose which category the beetle belongs to, participants pressed the "1" key for Hole 1 and the "2" key for Hole 2. Participants were told to begin guessing categories in order to learn from correct/incorrect feedback responses.

Participants then completed 48 trials of Learning Phase 1 (Figure 2a), followed by 48 trials of

Table 1
Rephrased ASC Items

Scale items	Scale items
1. At times I feel like a marionette	2. I have had the feeling of being connected to a superior power
3. I have enjoyed boundless pleasure	4. I have seen regular patterns in complete darkness or with closed eyes
5. Everything has seemed to unify into a oneness	6. Noises have seemed to influence what I saw
7. I have seen colors before me in total darkness with closed eyes	8. The shapes of things have seemed to change by sounds and noises
9. It has seemed to me as though I didn't have a body anymore	10. I have had difficulty making even the smallest decision
11. Sometimes everyday things gain a special meaning	12. Things around me have had a new strange meaning for me
13. I have been afraid that the state I was in could last forever	14. I have seen lights or flashes of light in total darkness or with closed eyes
15. It has seemed to me that my environment and I were one	16. I have had difficulty distinguishing important from unimportant things
17. I have experienced scenes rolling by in total darkness or with my eyes closed	18. I have experienced a touch of eternity
19. Conflicts and contradictions have seemed to dissolve before	20. I have felt afraid without being able to say exactly why
21. I have experienced everything terrifyingly distorted	22. I have experienced my surroundings as strange and weird
23. I have felt as though I was paralyzed	24. I have felt very profound
25. I have experienced past, present, and futureas oneness	26. Objects around me have engaged me emotionally much more than usual
27. I tend to feel threatened	28. I have had the feeling of being outside my body
29. I have felt as though I was floating	30. I have felt isolated from everything and everyone
31. I have felt the inability to complete a thought, my thought would repeatedly become disconnected	32. I have gained clarity into connections that puzzled me before
33. I have seen pictures from my past or fantasy extremely clearly	34. The colors of things have seemed to be changed by sounds and noises
35. I have had very original thoughts	36. I have had the feeling that I no longer had a will of my own
37. I have experienced a kind of awe	38. My imagination has been extremely vivid
39. I have experienced a profound peace in myself	40. I have the feeling something horrible would happen
41. I have experienced an all-embracing love	42. My experiences have had religious aspects

Note. ASC = altered states of consciousness.

Learning Phase 2 (Figure 2b) where the redundant feature was added as mentioned above. After completing both learning phases, participants transitioned into the test phase (Figure 2c) where they were told there will be no correct/incorrect feedback provided. Following the completion of the test phase, a message was presented congratulating participants for completing the categorization task and that they were now transitioning into two sets of questions. The first set (ASC scale) was described as being about events in one's life that they may or may not experience. The questions were answered on a 10-point Likert scale where 1 means *never have experienced* and 10 means *often experience*. Afterward, the STA was introduced and participants were asked to answer on a "yes" or "no" basis for each question. After the completion of the two scales, participants were provided a completion code to receive payment.

Study 1: Results

In Learning Phase 1, the average proportion of correct categorization was 0.76 ($SD = 0.20$). In Leaning Phase 2, participants had an average accuracy of 0.91 ($SD = 0.16$). Categorization accuracy between phases were analyzed with a paired-samples t test. Accuracy between the two learning phases were significantly different: $t(115) = 10.20$, $p < .001$; $d = 0.83$, suggesting that participants improved in the categorization task across the two trials. Table 4 provides the means and standard deviations of the key test phase trial types from both Studies 1 and 2.

Table 2
Item Factor Loadings for ASC

	Study 1			Study 2		
ASC items	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
Item 1	0.741	0.11	−0.13	0.87	−0.11	
Item 2		0.76		0.58	0.18	0.36
Item 3		0.72	0.18		0.69	0.20
Item 4		0.15	0.57	0.79		0.17
Item 5	0.12	0.81		0.48	0.38	0.17
Item 6	0.26	0.55		0.64	0.19	
Item 7			0.85	0.74		
Item 8	0.52	0.29		0.89		0.18
Item 9	0.76			0.92		0.10
Item 10	0.75	−0.22		0.76		−0.42
Item 11		0.82		0.35	0.51	
Item 12	0.34	0.55		0.65	0.34	
Item 13	0.73		0.18	0.75		−0.21
Item 14	0.17	0.23	0.65	0.81		
Item 15	0.25	0.65		0.26	0.66	0.14
Item 16	0.85			0.87		−0.18
Item 17	0.34	0.20	0.43	0.73	0.16	0.16
Item 18	0.40	0.55	−0.10	0.60	0.28	0.28
Item 19	0.31	0.55		0.53	0.39	
Item 20	0.79			0.70		−0.20
Item 21	0.86		−0.13	0.91		
Item 22	0.68	0.13		0.88		−0.14
Item 23	0.70			0.95		0.10
Item 24		0.74		0.33	0.58	
Item 25	0.35	0.59	−0.11	0.44	0.50	0.17
Item 26	0.42	0.45		0.65	0.32	
Item 27	0.86	−0.13		0.90		
Item 28	0.70	0.20		0.92		
Item 29	0.67	0.24		0.97		
Item 30	0.75		0.15	0.71	0.13	−0.34
Item 31	0.83		0.12	0.87		−0.16
Item 32		0.72	0.21	0.31	0.57	
Item 33	0.31	0.39	0.20	0.30	0.62	−0.13
Item 34	0.58	0.29		0.86		0.13
Item 35		0.36	0.33	−0.11	0.77	−0.36
Item 36	0.70	0.27	−0.10	0.85		
Item 37		0.60	0.27		0.79	−0.17
Item 38		0.42	0.40	0.13	0.72	−0.34
Item 39	−0.11	0.82	0.16	−0.10	0.88	0.18
Item 40	0.71		0.16	0.84		−0.19
Item 41		0.79	0.10		0.75	0.26
Item 42	0.18	0.60		0.31	0.49	0.32

Note. ASC = altered states of consciousness.

ASC

Correlation analyses were performed between ASC and categorization performance across the two learning phases to determine whether any categorization performance differences were related to past experiences of ASC. There was no statistically significant association between ASC rating in Phase 1 accuracy, $r(115) = -0.12$, $p = .18$. There was, however, a statistically significant negative correlation between ASC and Phase 2 accuracy, $r(115) = -0.27$, $p = .004$ (Figure 4).

Table 3
Item Factor Loadings for STA

	Study 1		Study 2	
STA items	Factor 1	Factor 2	Factor 1	Factor 2
Item 1	−0.16	0.75	0.86	
Item 2		0.49	0.68	
Item 3	0.59		0.34	0.32
Item 4	0.55	0.26	0.75	
Item 5	0.21	0.49	0.67	
Item 6	0.65	−0.13	−0.13	0.75
Item 7	0.63		0.10	0.41
Item 8	0.49			0.61
Item 9	0.33	0.31	0.39	0.33
Item 10	0.22	0.21	0.37	0.24
Item 11	0.49	0.30	0.44	0.31
Item 12	0.33	0.28	0.28	0.45
Item 13	−0.11	0.14	0.40	0.24
Item 14		0.19	0.42	0.31
Item 15	0.41		0.14	0.42
Item 16	0.44			0.62
Item 17	0.29		0.16	0.45
Item 18		0.62	0.80	
Item 19	0.25	0.46	0.69	
Item 20	0.49		0.30	0.40
Item 21	0.57		0.26	0.43
Item 22	0.56	−0.11	0.13	0.52
Item 23	0.47	0.16	0.33	0.28
Item 24	0.46		0.28	0.31
Item 25	0.47	0.13	0.64	0.16
Item 26		0.44	0.67	
Item 27	0.25	0.16	0.14	0.39
Item 28		0.62	0.70	
Item 29	0.34	0.23	0.26	0.31
Item 30		0.45	0.50	−0.14
Item 31	0.21	0.37	0.45	0.32
Item 32	0.33	0.43	0.67	
Item 33	0.46		0.17	0.37
Item 34		0.74	0.84	
Item 35	0.46	−0.11		0.51
Item 36	0.44	−0.18		0.50
Item 37	0.35		−0.18	0.63

Note. STA = Schizotypal Personality Scale.

Individual differences in selective attention may affect categorization performance. To determine how selective attention differences within the categorization tasks relate to ASC, we analyzed categorization performance across the different trial types (congruent, incongruent and chose critical, incongruent and chose redundant, missing critical and chose redundant, and missing redundant and chose critical). Rather than accuracy, the dependent variable we were interested in for the test phase was the likelihood of categorizing based on a given diagnostic feature or set of diagnostic features (critical and/or redundant).

There was a significant negative correlation between ASC and participants' tendency to choose the correct category on congruent trials (when critical and redundant features were associated with the same category), $r(115) = -0.47$, $p < .001$. This result is consistent with the possibility that people higher in ASC were less accurate at learning the feature–category associations overall. There was a significant negative correlation with ASC and participants' tendency to choose the category associated with the critical feature during incongruent trials (when critical and redundant features were associated with opposite categories), $r(115) = -0.31$, $p = .001$. This result suggested two possibilities: (a) slower learning of the critical feature or (b) some participants exhibited flexible selective attention toward the features, which led to more attentional sensitivity toward the redundant feature.

There was a significant negative correlation between ASC and participants' tendency to choose the category associated with the critical feature when the redundant feature was missing, $r(115) = -0.41$, $p < .001$, consistent with slower learning of the critical feature in individuals high in ASC. There was no significant correlation between ASC and participants' tendency to choose the category associated with the redundant feature when the critical feature was missing (not blocked trials), $r(115) = -0.007$, $p = .94$.

Finally, to test how the present results may vary across facets of the ASC scale, we conducted a series of correlation analyses where we iteratively retested correlations between category learning performance and ASC for each individual factor. The results suggest that all facets of ASC are associated with the same basic pattern as the overall scale (Table 5). However, this is not surprising given our parallel analysis revealing the presence of a single overarching factor. Moreover, through a series of multiple regression analyses between category membership and factor loading scores obtained from the parallel analysis, we found that two of the three factors were significantly and negatively associated with Phase 2 and congruent trial accuracy, choosing the category associated with the critical feature when the redundant feature was missing and during incongruent trials (see Table 6). Overall, the various approaches used to compare ASC ratings to categorization performance consistently reveal similar results, and the choice of treating the scale as a multiple or single-factor scale does not impact our overall conclusions.

Table 4
Means and Standard Deviations of Categorization Performance

Study	Trial type	Probability of choosing category associated with	*M*	*SD*
Study 1				
	Congruent trial	Critical or redundant	0.89	0.18
	Incongruent trial	Redundant	0.28	0.36
	Incongruent trial	Critical	0.72	0.36
	Missing redundant	Critical	0.82	0.25
	Missing critical	Redundant	0.61	0.25
Study 2				
	Congruent trial	Critical or redundant	0.86	0.35
	Incongruent trial	Redundant	0.20	0.31
	Incongruent trial	Critical	0.80	0.31
	Missing redundant	Critical	0.85	0.23
	Missing critical	Redundant	0.47	0.32

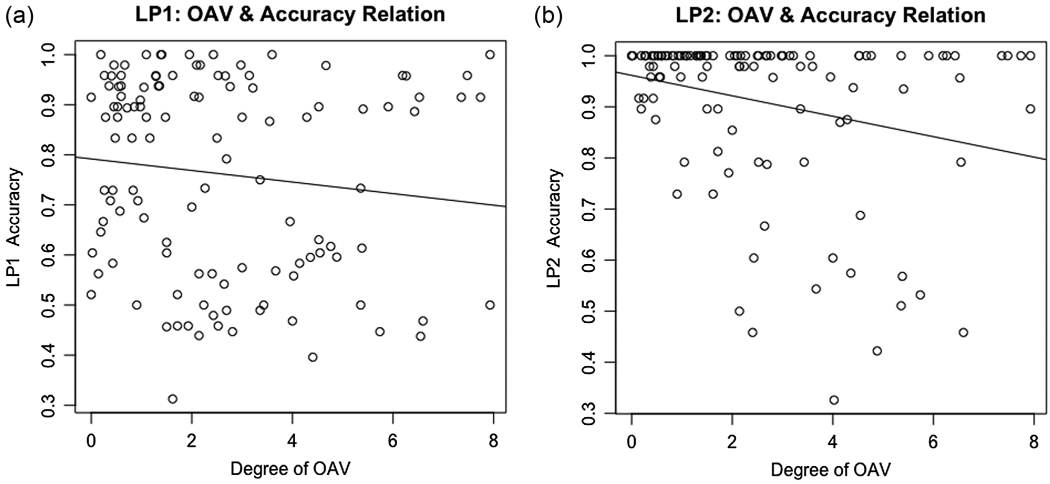
Study 2 inference trial type	Help or no help	*M*	*SD*
Inferring critical	Help	0.49	0.35
Inferring redundant	Help	0.63	0.30
Inferring critical	Without help	0.44	0.31
Inferring redundant	Without help	0.59	0.33

STA

We repeated the same analyses as above with the STA scores. Correlation analyses were performed between STA and accuracy across the two learning phases. Results indicated that STA ratings were not significantly correlated with Phase 1 accuracy, $r(115) = -0.03$, $p = .78$, or with Phase 2 accuracy, $r(115) = -0.14$, $p = .14$. Further analysis correlating STA ratings with categorization choice between the different trial types (congruent, incongruent and chose critical, incongruent and chose redundant, not blocked, and critical learned) was conducted to determine any further differences in categorization behavior related to STA. There was a significant negative correlation between STA and participants' tendency to choose the correct category in congruent trials, $r(115) = -0.29$, $p = .001$. This suggests individuals high in STA had a decrement in accuracy after Phase 2 in comparison to individuals low in STA. There was no significant correlation between STA and participants' tendency to choose the category associated with the critical feature, $r(115) = -0.17$, $p = .06$, or redundant feature, $r(115) = 0.07$, $p = .06$, during incongruent trials. There was no significant correlation between STA and participants' tendency to choose the category associated with the redundant feature when the critical feature was missing (not blocked trials), $r(115) = -0.03$, $p = .73$. There was a significant negative correlation between STA and participants' tendency to choose the category associated with the critical feature when the redundant feature was missing, $r(115) = -0.29$, $p = .001$. This result is consistent with an accuracy decrement in individuals high in STA. ASC and STA were significantly correlated, $r(115) = 0.67$, $p < .001$.

As done with the ASC scale, we conducted a series of correlation analyses where we iteratively retested correlations between category learning performance and STA for each individual factor. The results suggest that all facets of STA are associated with the same basic pattern as the overall scale with the exception of the factor "Unusual Perceptual Experience," which was significantly negatively associated with choosing the category associated with the critical feature and positively associated with choosing the category associated with the redundant feature during incongruent trials (Table 7). Our parallel analysis revealed the presence of a single overarching factor so similar trends to those found with the analyses using the STA as a unidimensional measure is expected. Moreover, through a series of multiple regression analyses between category membership and factor loading scores obtained from the parallel analysis,

Figure 4
Regression Between Categorization Accuracy and ASC in Study 1



Note. (a) A scatterplot with a magnitude of ASC rating on the *x*-axis and Learning Phase 1 (LP1) accuracy on the *y*-axis, illustrating the majority of successful learning having low ratings of ASC. (b) A scatterplot with a magnitude of ASC rating on the *x*-axis and Learning Phase 2 (LP2) on the *y*-axis, illustrating the majority of successful learners having low ratings of past experiences of ASC. OAV = ASC = altered states of consciousness.

we found that only Factor 2 had associations with categorization behavior (see Table 8).

Study 1: Discussion

Results from Study 1 suggest that participants high in ASC take longer to learn a critical feature in a rule-based category learning task, as evidenced by the significant negative correlations between ASC scores and Phase 2 accuracy, congruent test phase performance, and the likelihood of categorizing based on the critical feature in trials where the critical was present but the redundant was missing. The addition of the redundant feature in Learning Phase 2 may have attracted the attention of those high in ASC, as a product of widened, rather than narrowed, attention, but at the expense of optimal categorization performance. Therefore, additional data are needed to establish whether these results simply reflect weaker learning performance in individuals high in ASC and STA or if it is related to competitive effects in selective attention. Based on the effects of ASC and STA on participants' categorization behavior, there are two possibilities: (a) Those high in ASC and STA may simply be worse at associative learning than those low in ASC and STA, causing poor category learning performance; (b) those high in ASC and STA deploy their attention differently and this mediates the differences in performance and category learning behavior observed in Study 1.

Study 2

In Study 2, we sought to determine whether those high in ASC show differences in categorization behavior due to poorer associative learning or because they are allocating their attention more widely across features in the task. To test these possibilities, we used the same basic category learning task as Study 1 but had participants complete additional feature inference trials (Figure 5) to assess whether higher ASC and STA are associated with learning the relationships among the critical and redundant features, consistent with wider selective attention, perhaps at the expense of learning the feature–category associations. Rehder and Hoffman (2005) found that selective attention in category learning develops continually across the learning phases. All stimulus dimensions are attended to early on in learning until their attention narrows to focus on relevant dimensions (Hoffman & Rehder, 2010). Following Rehder and Hoffman's (2005) findings, ASC and STA magnitude may be associated with a decrease in learning due to the continuous consideration of

Table 5
Simple Regression Analysis Between Trial Type and 11-Factor ASC

Study	Trial type	ASC 11-factor	Coefficient	p value	r^2
Study 1					
	Phase 1 accuracy				
		Anxiety	−0.01	.21	.01
		Blissful state	−0.01	.12	.02
		Changed meaning of percepts	−0.003	.67	.002
		Complex imagery	−0.005	.5	.003
		Disembodiment	−0.02	.05	.03
		Elementary imagery	−0.004	.50	.004
		Experience of unity	−0.01	.31	.01
		Impaired control and cognition	−0.01	.38	.01
		Insightfulness	−0.01	.37	.01
		Spiritual experience	−0.02	.01	.06
		Audiovisual synesthesia	−0.004	.50	.004
	Phase 2 accuracy				
		Anxiety	−0.02	.002	.08
		Blissful state	−0.01	.03	.04
		Changed meaning of percepts	−0.01	.05	.03
		Complex imagery	−0.01	.10	.02
		Disembodiment	−0.02	<.001	.12
		Elementary imagery	−0.0004	.40	.01
		Experience of unity	−0.01	.01	.05
		Impaired control and cognition	−0.02	.001	.08
		Insightfulness	−0.01	.07	.03
		Spiritual experience	−0.02	.00	.09
		Audiovisual synesthesia	−0.01	.03	.04
	Congruent trial accuracy				
		Anxiety	−0.04	<.001	.24
		Blissful state	−0.02	<.001	.12
		Changed meaning of percepts	−0.03	<.001	.12
		Complex imagery	−0.02	.002	.08
		Disembodiment	−0.04	<.001	.30
		Elementary imagery	−0.01	.03	.04
		Experience of unity	−0.03	<.001	.17
		Impaired control and cognition	−0.04	<.001	.22
		Insightfulness	−0.02	<.001	.10
		Spiritual experience	−0.03	<.001	.19
		Audiovisual synesthesia	−0.03	<.001	.19
	Incongruent chose critical				
		Anxiety	−0.05	<.001	.10
		Blissful state	−0.04	.002	.08
		Changed meaning of percepts	−0.04	.01	.06
		Complex imagery	−0.04	.003	.07
		Disembodiment	−0.06	<.001	.12
		Elementary imagery	−0.02	.08	.03
		Experience of unity	−0.04	.01	.07
		Impaired control and cognition	−0.05	.002	.08
		Insightfulness	−0.04	.01	.06
		Spiritual experience	−0.04	.002	.08
		Audiovisual synesthesia	−0.03	.01	.06
	Incongruent chose redundant				
		Anxiety	0.05	<.001	.10
		Blissful state	0.04	.002	.08
		Changed meaning of percepts	0.04	.01	.06
		Complex imagery	0.04	.003	.07
		Disembodiment	0.06	<.001	.12
		Elementary imagery	0.02	.08	.03
		Experience of unity	0.04	.01	.07
		Impaired control and cognition	0.05	.002	.08

(*table continues*)

Table 5 (*continued*)

Study	Trial type	ASC 11-factor	Coefficient	*p* value	r^2
		Insightfulness	0.04	.01	.06
		Spiritual experience	0.04	.002	.08
		Audiovisual synesthesia	0.03	.01	.06
	No redundant chose critical				
		Anxiety	−0.05	<.001	.22
		Blissful state	−0.02	.003	.08
		Changed meaning of percepts	−0.03	<.001	.10
		Complex imagery	−0.03	.001	.09
		Disembodiment	−0.05	<.001	.25
		Elementary imagery	−0.02	.04	.04
		Experience of unity	−0.03	<.001	.13
		Impaired control and cognition	−0.05	<.001	.18
		Insightfulness	−0.03	.001	.09
		Spiritual experience	−0.03	<.001	.11
		Audiovisual synesthesia	−0.04	<.001	.14
	No critical chose redundant				
		Anxiety	−0.002	.82	<.001
		Blissful state	0.004	.64	.002
		Changed meaning of percepts	0.001	.92	<.001
		Complex imagery	−0.0004	.96	<.001
		Disembodiment	−0.004	.73	.001
		Elementary imagery	0.003	.71	.001
		Experience of unity	−0.001	.90	<.001
		Impaired control and cognition	−0.01	.50	.004
		Insightfulness	0.004	.69	.001
		Spiritual experience	0.003	.70	.001
		Audiovisual synesthesia	−0.01	.45	.01
Study 2					
	Phase 1 accuracy				
		Anxiety	−0.02	.01	.05
		Blissful state	−0.02	<.001	.10
		Changed meaning of percepts	−0.02	.01	.06
		Complex imagery	−0.02	.001	.09
		Disembodiment	−0.02	.002	.08
		Elementary imagery	−0.01	.05	.03
		Experience of unity	−0.02	.001	.08
		Impaired control and cognition	−0.02	.002	.08
		Insightfulness	−0.02	.001	.09
		Spiritual experience	−0.03	<.001	.12
		Audiovisual synesthesia	−0.02	<.001	.09
	Phase 2 accuracy				
		Anxiety	−0.01	.01	.06
		Blissful state	−0.01	.13	.02
		Changed meaning of percepts	−0.01	.02	.05
		Complex imagery	−0.02	.004	.07
		Disembodiment	−0.01	.002	.07
		Elementary imagery	−0.01	.05	.03
		Experience of unity	−0.01	.002	.06
		Impaired control and cognition	−0.01	.01	.06
		Insightfulness	−0.01	.28	.01
		Spiritual experience	−0.01	.02	.04
		Audiovisual synesthesia	−0.02	<.001	.09
	Congruent trial accuracy				
		Anxiety	−0.03	<.001	.17
		Blissful state	−0.02	<.001	.08
		Changed meaning of percepts	−0.03	<.001	.20
		Complex imagery	−0.03	<.001	.16
		Disembodiment	−0.03	<.001	.24

(*table continues*)

Table 5 (*continued*)

Study	Trial type	ASC 11-factor	Coefficient	p value	r^2
		Elementary imagery	−0.03	<.001	.15
		Experience of unity	−0.03	<.001	.20
		Impaired control and cognition	−0.03	<.001	.20
		Insightfulness	−0.02	<.001	.07
		Spiritual experience	−0.03	<.001	.20
		Audiovisual synesthesia	−0.03	<.001	.24
	Incongruent chose critical				
		Anxiety	−0.02	.06	.03
		Blissful state	−0.03	.01	.05
		Changed meaning of percepts	−0.02	.11	.02
		Complex imagery	−0.02	.08	.03
		Disembodiment	−0.02	.02	.05
		Elementary imagery	−0.01	.18	.02
		Experience of unity	−0.03	.01	.05
		Impaired control and cognition	−0.02	.03	.04
		Insightfulness	−0.02	.04	.04
		Spiritual experience	−0.02	.04	.04
		Audiovisual synesthesia	−0.02	.02	.04
	Incongruent chose redundant				
		Anxiety	0.02	.06	.03
		Blissful state	0.03	.01	.05
		Changed meaning of percepts	0.02	.11	.02
		Complex imagery	0.02	.08	.03
		Disembodiment	0.02	.02	.05
		Elementary imagery	0.01	.18	.02
		Experience of unity	0.03	.01	.05
		Impaired control and cognition	0.02	.03	.04
		Insightfulness	0.02	.04	.04
		Spiritual experience	0.02	.04	.04
		Audiovisual synesthesia	0.02	.02	.04
	No redundant chose critical				
		Anxiety	−0.01	.09	.02
		Blissful state	−0.02	.02	.05
		Changed meaning of percepts	−0.02	.03	.04
		Complex imagery	−0.01	.05	.03
		Disembodiment	−0.01	.03	.04
		Elementary imagery	−0.01	.12	.02
		Experience of unity	−0.02	.01	.06
		Impaired control and cognition	−0.02	.03	.04
		Insightfulness	−0.02	.02	.05
		Spiritual experience	−0.02	.01	.06
		Audiovisual synesthesia	−0.02	.02	.05
	No critical chose redundant				
		Anxiety	−0.01	.27	.01
		Blissful state	−0.01	.45	.004
		Changed meaning of percepts	−0.02	.13	.02
		Complex imagery	−0.01	.27	.01
		Disembodiment	−0.01	.16	002
		Elementary imagery	−0.02	.06	.03
		Experience of unity	−0.01	.18	002
		Impaired control and cognition	−0.01	.29	.01
		Insightfulness	−0.01	.63	.002
		Spiritual experience	−0.01	.26	.01
		Audiovisual synesthesia	−0.01	.27	.01
	Inferred critical with help				
		Anxiety	−0.02	.13	.02
		Blissful state	−0.008	.53	.003
		changed meaning of percepts	−0.02	.07	.03
		Complex imagery	−0.02	.18	.02
		Disembodiment	−0.02	.05	.03

(*table continues*)

Table 5 (*continued*)

Study	Trial type	ASC 11-factor	Coefficient	*p* value	r^2
		Elementary imagery	−0.03	.001	.06
		Experience of unity	−0.02	.06	.03
		Impaired control and cognition	−0.02	.11	.02
		Insightfulness	−0.01	.29	.01
		Spiritual experience	−0.02	.14	.02
		Audiovisual synesthesia	−0.02	.05	.03
	Inferred redundant with help				
		Anxiety	−0.02	.09	.02
		Blissful state	−0.02	.08	.03
		Changed meaning of percepts	−0.02	.06	.03
		Complex imagery	−0.02	.05	.03
		Disembodiment	−0.02	.07	.03
		Elementary imagery	−0.02	.01	.05
		Experience of unity	−0.02	.11	.02
		Impaired control and cognition	−0.02	.07	.04
		Insightfulness	−0.01	.24	.01
		Spiritual experience	−0.01	.20	.01
		Audiovisual synesthesia	−0.02	.06	.03
	Inferred critical without help				
		Anxiety	−0.02	.12	.02
		Blissful state	−0.02	.10	.02
		Changed meaning of percepts	−0.03	.02	.05
		Complex imagery	−0.02	.07	.03
		Disembodiment	−0.02	.07	.03
		Elementary imagery	−0.02	.06	.03
		Experience of unity	−0.02	.15	.02
		Impaired control and cognition	−0.02	.07	.03
		Insightfulness	−0.02	.16	.02
		Spiritual experience	−0.01	.22	.01
		Audiovisual synesthesia	−0.02	.08	.03
	Inferred redundant without help				
		Anxiety	−0.02	.14	.02
		Blissful state	−0.02	.10	.02
		Changed meaning of percepts	−0.03	.02	.05
		Complex imagery	−0.02	.07	.03
		Disembodiment	−0.02	.07	.03
		Elementary imagery	−0.02	.06	.03
		Experience of unity	−0.02	.15	.09
		Impaired control and cognition	−0.02	.07	.03
		Insightfulness	−0.02	.16	.02
		Spiritual experience	−0.01	.22	.01
		Audiovisual synesthesia	−0.02	.08	.03

Note. ASC = altered states of consciousness.

more stimulus dimensions (and their associations) throughout learning. A performance difference between classification and inference trials could be a product of differences in sensitivity toward diagnostic versus prototypical features (Anderson et al., 2002; Chin-Parker & Ross, 2004). Inference trials may determine whether those high in ASC and STA scales are in fact taking more time attending to the entire array of feature dimensions of a given stimulus and thus are slower to learn the relationship between the critical feature and category membership. If individuals are able to infer the correct missing features given other features on the stimuli, this would suggest a widened attention throughout the learning phase is hindering categorization performance in the test phase. Although, if inference performance is not accurate, then it may be the case that those high in ASC and STA have an overall deficit in associative learning. The test phase in Study 2 allowed for participants who are learning feature–feature associations, as inferential learners would, to be identified, thus making it possible to assess whether the ASC effects

Table 6
Simple Regression Analysis Between Trial Type and Three-Factor ASC

Study	Trial type	ASC 3-factor	Coefficient	p value	r^2
Study 1					
	Phase 1 accuracy				
		Factor 1	−0.02	.26	.01
		Factor 2	−0.02	.19	.01
		Factor 3	−0.005	.8	.001
	Phase 2 accuracy				
		Factor 1	−0.05	.001	.09
		Factor 2	−0.04	.01	.05
		Factor 3	−0.002	.88	<.001
	Congruent trial accuracy				
		Factor 1	−0.09	<.001	.27
		Factor 2	−0.07	<.001	.16
		Factor 3	−0.02	.27	.01
	No critical chose redundant				
		Factor 1	−0.02	.52	.004
		Factor 2	0.01	.83	<.001
		Factor 3	0.03	.29	.01
	No redundant chose critical				
		Factor 1	−0.12	<.001	.23
		Factor 2	−0.08	<.001	.11
		Factor 3	−0.04	.14	.02
	Incongruent chose critical				
		Factor 1	−0.12	.001	.10
		Factor 2	−0.10	.004	.07
		Factor 3	−0.06	.08	.03
	Incongruent chose redundant				
		Factor 1	0.12	.001	.10
		Factor 2	0.10	.004	.07
		Factor 3	0.06	.08	.03
Study 2					
	Phase 1 accuracy				
		Factor 1	−0.06	.002	.08
		Factor 2	−0.07	<.001	.10
		Factor 3	−0.03	.21	.01
	Phase 2 accuracy				
		Factor 1	−0.05	.003	.08
		Factor 2	−0.03	.08	.03
		Factor 3	−0.03	.10	.02
	Congruent trial accuracy				
		Factor 1	−0.10	<.001	.24
		Factor 2	−0.07	<.001	.10
		Factor 3	−0.05	.01	.06
	No critical chose redundant				
		Factor 1	−0.04	.14	.02
		Factor 2	−0.02	.50	.004
		Factor 3	−0.03	.36	.01
	No redundant chose critical				
		Factor 1	−0.04	.03	.04
		Factor 2	−0.05	.02	.05
		Factor 3	−0.04	.09	.02
	Incongruent chose critical				
		Factor 1	−0.06	.03	.04
		Factor 2	−0.06	.04	.04
		Factor 3	−0.05	.12	.02
	Incongruent chose redundant				
		Factor 1	0.06	.03	.04
		Factor 2	0.06	.04	.04
		Factor 3	0.05	.12	.02

(*table continues*)

Table 6 (*continued*)

Study	Trial type	ASC 3-factor	Coefficient	*p* value	r^2
	Inferred critical with help				
		Factor 1	−0.07	.04	.03
		Factor 2	−0.03	.33	.01
		Factor 3	−0.04	.30	.01
	Inferred redundant with help				
		Factor 1	−0.06	.05	.03
		Factor 2	−0.04	.18	.02
		Factor 3	−0.01	.80	<.001
	Inferred critical without help				
		Factor 1	−0.06	.05	.03
		Factor 2	−0.03	.25	.01
		Factor 3	−0.01	.74	<.001
	Inferred redundant without help				
		Factor 1	−0.06	.06	.03
		Factor 2	−0.05	.14	.02
		Factor 3	−0.02	.63	.002

Note. ASC = altered states of consciousness.

observed in Study 1 were related to latency in learning or related to widened attention.

Study 2: Method

Participants

One hundred seventeen participants (50 female and 67 male) with a mean age of 40.35 years, and between the ages of 20 and 71, were recruited via Amazon Mturk in the year 2020. About 72% of the participants reported having at least a college degree, 18% had some college experience, and 10% completed some high school. The majority of the participants (79.4%) were White, 7% were Asian American, 6% were Hispanic, 4.2% were Black or African American, 1.8% were Native American or Alaskan Native, one participant chose “other,” and another participant chose not to specify their ethnicity. Participants were provided a consent form prior to beginning the study explaining how their privacy would be protected, a simple description of the study, an estimated duration of 45 min to complete the study, and contact information for if they had any questions about the study. Participants were paid $2.00 to complete the study. Participants completed the study voluntarily and were able to withdraw at any time from the study.

Materials and Measures

The same stimuli, instructions, and measures from Study 1 were used for Study 2, with the addition of the novel inference trials (Figure 5).

Procedure

Study 2 mirrored the procedure of Study 1 with the exception that critical and redundant features were fixed rather than randomly assigned as they were in Study 1. In Study 2, legs were always the critical feature and antennae was always the redundant feature. Both Learning Phases 1 and 2 had 32 categorization trials each.

To investigate whether widened attention played a role in the results of Study 1, feature–feature inference trials were added in the test phase. These new trial types asked participants to infer which feature value a beetle will have based on the presence of another feature, or coupled with the help of a category label. These latter trial types provided the category label, whereas trials of the former type did not present the category label. For example, participants were asked to infer which missing antennae (redundant feature) would belong to a beetle when the legs (critical feature) are given, on others, legs will be given and category membership is as well. Sixteen total inference trials were presented, eight had category membership provided and the other eight did not. These new trials allowed us to test whether participants have learned feature–feature and redundant feature–category associations, consistent with a flexible selective attention account. Like in Study 1, the categorization task was followed with ASC and STA scales.

Table 7
Simple Regression Analysis Between Trial Type and Four-Factor STA

Study	Trial type	STA 4-factor	Coefficient	*p* value	r^2
Study 1					
	Phase 1 accuracy				
		Magical thinking	−0.01	.92	<.001
		Social anxiety	−0.06	.43	.01
		Unusual perceptual experience	−0.06	.42	.01
		Paranoid suspiciousness and isolation	−0.01	.92	<.001
	Phase 2 accuracy				
		Magical thinking	−0.08	.20	.01
		Social anxiety	−0.07	.28	.01
		Unusual perceptual experience	−0.12	.06	.03
		Paranoid suspiciousness and isolation	−0.08	.19	.01
	Congruent trial accuracy				
		Magical thinking	−0.24	.001	.09
		Social anxiety	−0.14	.05	.03
		Unusual perceptual experience	−0.20	.01	.07
		Paranoid suspiciousness and isolation	−0.25	.001	.09
	No critical chose redundant				
		Magical thinking	−0.03	.78	.001
		Social anxiety	0.08	.43	.01
		Unusual perceptual experience	−0.01	.89	<.001
		Paranoid suspiciousness and isolation	−0.06	.58	.003
	No redundant chose critical				
		Magical thinking	−0.33	.001	.09
		Social anxiety	−0.22	.02	.04
		Unusual perceptual experience	−0.29	.003	.08
		Paranoid suspiciousness and isolation	−0.31	.002	.08
	Incongruent chose critical				
		Magical thinking	−0.24	.11	.02
		Social anxiety	−0.23	.11	.02
		Unusual perceptual experience	−0.32	.03	.04
		Paranoid suspiciousness and isolation	−0.23	.12	.02
	Incongruent chose redundant				
		Magical thinking	0.24	.11	.02
		Social anxiety	0.23	.11	.02
		Unusual perceptual experience	0.32	.03	.04
		Paranoid suspiciousness and isolation	0.23	.12	.02
Study 2					
	Phase 1 accuracy				
		Magical thinking	−0.13	.05	.03
		Social anxiety	−0.12	.05	.03
		Unusual perceptual experience	−0.18	.002	.08
		Paranoid suspiciousness and isolation	−0.17	.01	.06
	Phase 2 accuracy				
		Magical thinking	−0.11	.04	.04
		Social anxiety	−0.09	.09	.02
		Unusual perceptual experience	−0.15	.001	.09
		Paranoid suspiciousness and isolation	−0.16	.003	.07
	Congruent trial accuracy				
		Magical thinking	−0.18	.01	.07
		Social anxiety	−0.08	.18	.02
		Unusual perceptual experience	−0.20	<.001	.10
		Paranoid suspiciousness and isolation	−0.24	<.001	.12
	No critical chose redundant				
		Magical thinking	−0.11	.26	.01
		Social anxiety	−0.09	.34	.01
		Unusual perceptual experience	−0.06	.52	.004
		Paranoid suspiciousness and isolation	−0.15	.13	.02

(*table continues*)

Table 7 (*continued*)

Study	Trial type	STA 4-factor	Coefficient	p value	r^2
	No redundant chose critical				
		Magical thinking	−0.02	.81	<.001
		Social anxiety	−0.01	.93	<.001
		Unusual perceptual experience	−0.09	.17	.02
		Paranoid suspiciousness and isolation	−0.05	.46	.01
	Incongruent chose critical				
		Magical thinking	−0.09	.35	.01
		Social anxiety	−0.10	.31	.01
		Unusual perceptual experience	−0.16	.07	.03
		Paranoid suspiciousness and isolation	−0.15	.12	.02
	Incongruent chose redundant				
		Magical thinking	0.09	.35	.01
		Social anxiety	0.10	.31	.01
		Unusual perceptual experience	0.16	.07	.03
		Paranoid suspiciousness and isolation	0.15	.12	.02
	Inferred critical with help				
		Magical thinking	−0.13	.25	.01
		Social anxiety	−0.13	.23	.01
		Unusual perceptual experience	−0.10	.33	.01
		Paranoid suspiciousness and isolation	−0.16	.14	.02
	Inferred redundant with help				
		Magical thinking	−0.16	.08	.03
		Social anxiety	−0.14	.13	.02
		Unusual perceptual experience	−0.15	.08	.03
		Paranoid suspiciousness and isolation	−0.17	.07	.03
	Inferred critical without help				
		Magical thinking	−0.16	.09	.03
		Social anxiety	−0.11	.23	.01
		Unusual perceptual experience	−0.05	.58	.003
		Paranoid suspiciousness and isolation	−0.17	.07	.03
	Inferred redundant without help				
		Magical thinking	−0.10	.35	.01
		Social anxiety	−0.16	.10	.02
		Unusual perceptual experience	−0.17	.07	.03
		Paranoid suspiciousness and isolation	−0.15	.16	.02

Note. STA = Schizotypal Personality Scale.

Study 2: Results

In Learning Phase 1, the average proportion of correct categorization was 0.75 ($SD = 0.20$). In Leaning Phase 2, participants had an average accuracy of 0.90 ($SD = 0.17$). Categorization accuracy between phases was analyzed with a paired-samples t test. Accuracy between the two phases was significantly different: $t(116) = 10.1$, $p < .001$; $d = 0.79$ (see Table 4 for means and standard deviations of key trials in Study 2).

ASC

Correlation analyses were performed between ASC rating and phase accuracy to determine whether any categorization performance differences related to past experiences of ASC. Unique to Study 2, there was a significant negative association between ASC rating in Phase 1 accuracy, $r(115) = -0.31$, $p < .001$. Consistent with Study 1, there was a significant negative association between ASC and Phase 2 accuracy, $r(115) = -0.25$, $p = .006$ (Figure 6).

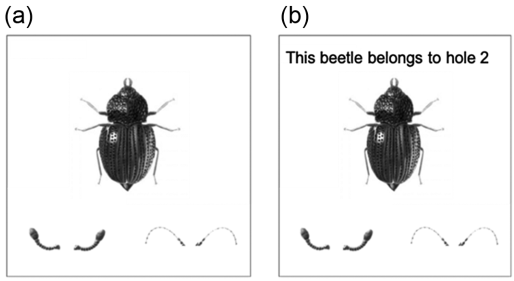
Further analyses testing for associations between ASC and different trial types (congruent, incongruent and chose critical, incongruent and chose redundant, not blocked, and critical learned) were conducted to determine whether people with past ASC experiences show variations in selective attention processes. There was a significant negative correlation between ASC scores and participants' tendency to choose the correct category on congruent trials (when critical and redundant features were associated with the same category), $r(115) = -0.46$, $p < .001$. This

Table 8
Simple Regression Analyses Between Trial Type and Two-Factor STA

Study	Trial type	STA two-factor	Coefficient	*p* value	r^2
Study 1					
	Phase 1 accuracy				
		Factor 1	−0.001	.97	<.001
		Factor 2	−0.004	.83	<.001
	Phase 2 accuracy				
		Factor 1	−0.01	.44	.01
		Factor 2	−0.04	.02	.05
	Congruent trial accuracy				
		Factor 1	−0.03	.08	.03
		Factor 2	−0.09	<.001	.22
	No critical chose redundant				
		Factor 1	−0.01	.82	<.001
		Factor 2	−0.03	.17	.02
	No redundant chose critical				
		Factor 1	−0.05	.05	.03
		Factor 2	−0.10	<.001	.14
	Incongruent chose critical				
		Factor 1	−0.05	.17	.02
		Factor 2	−0.07	.06	.03
	Incongruent chose redundant				
		Factor 1	0.05	.17	.02
		Factor 2	0.07	.06	.03
Study 2					
	Phase 1 accuracy				
		Factor 1	−0.07	<.001	.10
		Factor 2	−0.02	.38	.001
	Phase 2 accuracy				
		Factor 1	−0.06	<.001	.11
		Factor 2	−0.02	.24	.01
	Congruent trial accuracy				
		Factor 1	−0.09	<.001	.20
		Factor 2	−0.02	.31	.01
	No critical chose redundant				
		Factor 1	−0.03	.31	.01
		Factor 2	−0.05	.12	.02
	No redundant chose critical				
		Factor 1	−0.03	.14	.02
		Factor 2	0.01	.60	.002
	Incongruent chose critical				
		Factor 1	−0.07	.03	.04
		Factor 2	−0.01	.81	<.001
	Incongruent chose redundant				
		Factor 1	0.07	.03	.04
		Factor 2	0.01	.81	<.001
	Inferred critical with help				
		Factor 1	−0.04	.20	.01
		Factor 2	−0.04	.22	.01
	Inferred redundant with help				
		Factor 1	−0.04	.14	.02
		Factor 2	−0.05	.08	.03
	Inferred critical without help				
		Factor 1	−0.04	.14	.02
		Factor 2	−0.05	.08	.03
	Inferred redundant without help				
		Factor 1	−0.04	.21	.01
		Factor 2	−0.06	.08	.03

Note. STA = Schizotypal Personality Scale.

Figure 5
Inference Trial Example

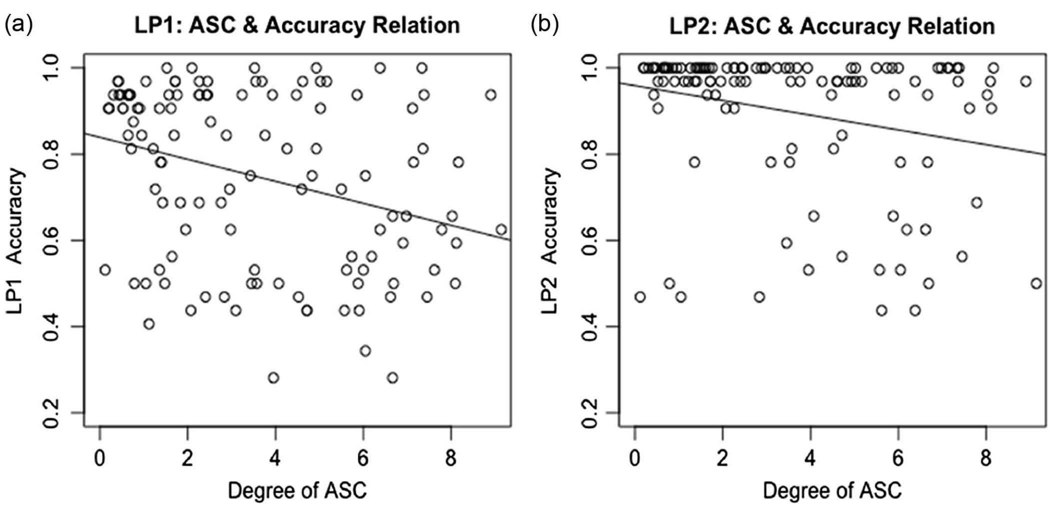


Note. Inference trials presented a beetle with either missing critical or redundant features. Rather than category classification, participants inferred the missing feature when presented with all the other features. In this case, the beetle is missing the antennae or redundant feature. Participants had to infer which type of antennae belongs to the beetle given its legs (critical feature). (a) It is an example of an inferencing task where only the critical feature is given to determine feature value (inference trial without help) and (b) It is an example where critical feature and category membership are given (inference trial with help). Beetle images were modified from original artwork by Frances L. Fawcett. Copyright by Frances L. Fawcett. Adapted with permission.

result is consistent with the possibility that people higher in ASC were less accurate at learning the feature–category associations overall. There was a significant negative correlation with ASC and participants' tendency to choose the category associated with the critical feature during incongruent trials (when both critical and redundant features were associated with opposite categories), $r(115) = -0.22$, $p = .02$. Replicating the findings of Study 1, this result suggests two possibilities: (a) It may be due to overall less learning of the critical feature or (b) potential flexible selective attention toward the features leading to more sensitivity toward the redundant feature. There was a significant negative correlation between ASC and participants' tendency to choose the category associated with the critical feature when the redundant feature was missing, $r(115) = -0.23$, $p < .015$, consistent with weak performance of learning critical feature and category association with participants high in ASC. There was no correlation between ASC and participants' tendency to choose the category associated with the redundant feature when the critical feature was missing (not blocked trials), $r(115) = -0.12$, $p = .18$, suggesting there was little to no learning of redundant feature–category associations.

To determine if widened attention is prevalent in participants with past experiences of ASC, a multilevel logistic regression model was used to predict trial inference trial performances (dependent

Figure 6
Regression Between Categorization Accuracy and ASC Rating in Study 2



Note. (a) A scatterplot with a magnitude of ASC rating on the *x*-axis and Learning Phase 1 (LP1) accuracy on the *y*-axis, illustrating the majority of successful learning having low ratings of past experiences of ASC. (b) A scatterplot with a magnitude of ASC rating on the *x*-axis and Learning Phase 2 (LP2) on the *y*-axis, illustrating the majority of successful learners having low ratings of past experiences of ASC. ASC = altered states of consciousness.

Table 9

Correlations Between the Probability of Representing Disrupted Blocking and Correctly Performing Inference Trials

Disrupted blocking and inference trial type	Help or no help	Correlation	Pearson's r
Inferring redundant	Help	0.35	<0.001
Inferring critical	Help	0.57	<0.001
Inferring redundant	No help	0.24	0.01
Inferring critical	No help	0.65	<0.001

variable) with ASC scores (independent variable). None of the coefficients from the inference trial types, inferring the redundant feature with help ($b = -0.01$, $SE = 0.01$, $p = .24$), inferring the critical feature with help ($b = 0.01$, $SE = 0.01$, $p = .38$), inferring the redundant feature without help ($b = -0.02$, $SE = 0.01$, $p = .072$), and inferring the critical feature without help ($b = 0.0002$, $SE = 0.01$, $p = .99$), were significant. Results from the multilevel logistic regression suggest there was no significant effect of ASC on the ability to infer both critical and redundant missing feature trials with and without help.

In a series of simple regressions, Study 2 replicated the results of Study 1, which found a relationship between the ASC scale and categorization behavior (Table 5). Most of the subfactors of the ASC scale showed negative correlations with Phases 1, 2, and congruent trial accuracy, as well as accuracy in choosing the category associated with the critical feature during incongruent trials and when the redundant feature was missing. Notably, the current regressions yielded novel findings, revealing significant associations between specific ASC subfactors and inference trials. Elementary imagery was significantly negatively associated with inferring the critical and redundant feature with help, while changed meaning of percepts was significantly negatively associated with inferring the critical and redundant feature without help. To further explore the relationship between the three factors identified from the parallel analysis and categorization behavior, additional simple regressions were conducted (Table 6). The findings were consistent with those from Study 1 with the inclusion of a significant negative association between Factors 1 and 2 and Phase 1 accuracy. For the inference trials, the results indicated that the only significant association was a negative one between Factor 1 and the ability to infer the critical feature with help.

STA

The analysis above was repeated with STA scores. Correlation analyses were performed between STA and phase accuracy to determine any related categorization performance differences. Results indicated that there was a significant negative correlation between STA rating in Phase 1, $r(115) = -0.24$, $p = .01$, and Phase 2 accuracy, $r(115) = -0.25$, $p = .006$.

Further analysis correlating STA ratings and categorization choice between the different trial types (congruent, incongruent and chose critical, incongruent and chose redundant, not blocked, and critical learned) was conducted to determine whether any further differences in categorization behavior are associated with STA. There was a significant negative correlation between STA and participants' tendency to choose the correct category in congruent trials, $r(115) = -0.31$, $p < .001$. This result suggests individuals high in STA had a decrement in accuracy after Phase 2 in comparison to individuals low in STA. There was no significant correlation between STA and participants' tendency to choose the category associated with the critical feature, $r(115) = -0.14$, $p = .14$, or the redundant feature, $r(115) = 0.14$, $p = .14$, during incongruent trials. There was no significant correlation between STA and participants' tendency to choose the category associated with the redundant feature when the critical feature was missing (not blocked trials), $r(115) = -0.12$, $p = .19$. There was no significant correlation between STA and participants' tendency to choose the category associated with the critical feature when the redundant feature was missing, $r(115) = -0.06$, $p = .52$.

To determine if widened attention is prevalent in participants high in measures of STA, a multilevel logistic regression model was used to predict inference trial performance (dependent variable) with STA scores (independent variable). None of the coefficients from the inference trial types were statistically significant: inferring the redundant feature with help (b = 0.05, SE = 0.12, p = .63), inferring the critical feature with help (b = −0.15, SE = 0.12, p = .22), inferring the redundant feature without help (b = 0.09, SE = 0.12, p = .44), and inferring the critical feature without help (b = −0.08, SE = 0.12, p = .49) were significant. Results from the multilevel logistic regression suggest there was no significant effect of STA on the ability to infer both critical and redundant missing feature trials with and without help.

Results from a series of simple regressions investigating the factors of the STA and categorization behavior replicated our findings when using the STA as a unidimensional construct (Table 7). Specifically, the majority of factors were significantly and negatively associated with Phases 1, 2, and congruent trial accuracy. In addition, we found no significant associations between the factors and inference trials. As done in Study 1, we conducted simple regressions between the categorization behavior and the two-factor loadings specified from our parallel analysis (Table 8). The results showed Factor 1, rather than Factor 2 from Study 1, to have a significant negative association with Phases 1, 2, and congruent trial accuracy. Furthermore, unlike in Study 1, we found a significantly negative association between choosing the category associated with the critical feature, and a significantly positive association with choosing the category associated with the redundant feature, in incongruent trials. Despite the difference in which factor had a significant role between the studies, the results from the factor regressions are similar to those found with the original single STA factor model within Study 2. This similarity is not surprising given that the factor solution from the parallel analysis supports a single overarching construct of the STA.

Further Analysis

Results support the hypothesis that people high in ASC and STA perform worse in the categorization and inference tasks due to poorer learning of feature–category and feature–feature associations, without the mediation of widened attention. Further correlation analyses were conducted between categorization and inference trial performance to determine if task type correlates with one another. For example, it may be the case that there were no significant associations between the scales and inference performance because of a mediating effect from categorization performance or the learning of feature–category associations. An overall low performance in learning feature–category associations may explain low inference ability. In order to correctly perform the inference trials, participants should pay attention to multiple features of the stimulus to learn feature–feature associations. The attention toward multiple feature dimensions may either hinder the performance of feature–category association or enable the ability to categorize off of more than just the critical feature but also the redundant, presenting disrupted blocking as was the interest in Study 1. Again, there was no association between ASC and STA with disrupted blocking in Study 1 and ASC and STA with inference trials. It may be the case no associations were found because of a mediating relationship between inference and disrupted blocking in categorization trials.

Phase 1 accuracy had no significant correlations with inferring the critical feature with help, $r(115) = -0.12$, p = .2, or without help, $r(115) = -0.08$, p = .36, or the redundant feature with help, $r(115)$ = 0.06, p = .53. This result is a bit surprising given Phase 1 is when participants just began to learn the feature–category associations and the inference trials are in the test phase after learning has been completed. Aligned with the possibility that inference performance is mediated by learning of feature–category associations, we found a significant positive association between both Phase 1, $r(115) = 0.21$, p = .03, and Phase 2, $r(115)$ = 0.28, p = .002, accuracy with probability of inferring the redundant value without help. This suggests that despite narrowing attention toward the diagnostic critical feature early in learning, participants who are better at learning the category membership tend to also learn the association of critical and redundant features (feature–feature) even though the redundant feature is presented later in learning, contrary to the idea that significant decreases in errors orient a learner's attention to becoming more narrowed as found by Rehder and Hoffman (2005).

Similar to Phase 1, Phase 2 accuracy had no association with the ability to infer the critical feature with help, $r(115) = -0.1$, p = .27, redundant feature with help, $r(115)$ = 0.04, p = .69, and the critical feature without help, $r(115)$ = −0.08, p = .39. Although, replicating Phase 1, Phase 2 accuracy had a significant association with ability to infer the redundant feature when there was no help, $r(115)$ = 0.28, p = .002, consistent with the hypothesis that inference performance was mediated by categorization ability. A significant association was found between the ability to infer the redundant feature without help and congruent trial accuracy, $r(115) = 0.27$, $p = .003$, which is also consistent with this hypothesis. These associations show that the better one learns the feature–category association, the better they are at inferring the missing redundant feature when no help is provided. In line with the prediction that disrupted blocking should enable better performance in inference trials, significant positive associations were found between the likelihood of categorizing off of redundant feature when the critical feature is missing (not blocked) and being able to infer the correct feature value in all inference trial types (Table 9).

Overall, these results support the idea that disrupted blocking leads to better learning of feature–feature associations and thus better performance in inference trials. Although, results do not suggest that participants high in ASC or STA are more likely to have disrupted blocking as opposed to simply learning the tasks at a slower rate.

Discussion

Findings from clinical studies using psychedelics for therapeutic treatments show long-lasting benefits, suggesting there may be changes in personality and cognition that last beyond the experience of ASC. In addition, selective attention differences found in people high in schizotypal trait measures and the similarity of schizotypal traits to symptoms of psychedelic-induced states suggest the possibility of similar selective attention behaviors found in individuals post ASC experience. The present study investigated selective attention differences associated with ASC and schizotypy personality (STA) traits using a category learning task that was designed to elicit selective attention effects like associative blocking. Results from Study 1 showed that individuals high in ASC and STA had a deficit in learning feature–category associations which led to poorer performance in the categorization task and did not show any evidence of reduced associative blocking. Study 2 aimed to further test whether these differences in learning were due to widened or increased flexibility in selective attention by testing participants on learned feature–feature associations with a feature inference task. Results revealed higher ASC and STA are associated with lower accuracy in performing the feature–feature inference task as well. These results therefore suggest that those high in ASC and STA potentially do possess cognitive differences which may limit their learning of feature–category associations, but not due to widened or flexible attention per se. Further analysis suggested that reduced learning of feature–category associations present participants higher in ASC and STA may have contributed to the lack of disrupted blocking being present and the inability to accurately perform inference trials. Overall, ASC and STA were associated with a lower ability to learn new categorical associations. These results may reflect reduced selective attention abilities in ASC and STA as apossible cause of the lower learning ability but are not consistent with the predicted wider or more flexible selective attention capabilities.

General Discussion

Over time, a learner develops an understanding of the world, or a perception, which will assist them in further actions. This transition from being primed by external stimuli influences the higher level, top-down processes of the learner to make later predictions of the world or in this case predictions of beetle-category membership. ASC experiences, and the symptoms which may follow, could be affecting the ability or the transition of this bottom-up priming to become a rule promoted by top-down processes, explaining deficits in the ability to learn new category structures. Consistent with a possible deficit in top-down processing in individuals high in ASC, Soulières et al. (2011) suggested that autistic populations, who show a similar effect of slower category learning, may require extended exposure to a rule before it can be incorporated by top-down processes. This raises the question of whether the present results are influenced by top-down processing difficulties per se and in turn reflect a need for extended exposure to the learning phases for those higher in ASC and STA to be able to redirect their attention toward the categorization rule. If participants had longer learning phases, we may have seen typical categorization accuracy or a stronger presence of disrupted blocking and the ability to perform inference trials in individuals with high ratings of ASC and STA. Interestingly, this weakening of top-down processing may be a critical attribute of the ASC experience, as explained further by the relaxed beliefs under psychedelics model of psychedelic states, which we expand upon further in the Implications section.

It may be the case that studies finding disrupted blocking in individuals with higher STA ratings utilize tasks that do not require as much active problem solving as the category learning task in the present study. Consequently, a general deficit in selective attention leads to instances of disrupted blocking in previous studies, but not in the present case where the task requires selective attention to determine a rule for categorization and more top-down cognitive control in maintaining this rule across trials. For example, Paniukov and Davis (2018) found that different selective attention tasks, matching, and categorizing require different abilities in top-down selective attention processes. For instance, matching tasks, akin to the Wisconsin Card Sorting Task (Grant & Berg, 1948), do not require as much top-down selective attention as category learning tasks like the one used in this study. Likewise, simpler associative learning paradigms, like those used in past studies on STA, may be more likely to show disrupted blocking because they do not require as much top-down cognitive control in order to learn either initial or redundant associations.

One possibility for resolving the apparent variability in results across studies is for future research to begin studying differences in attentional control more broadly rather than selective attention per se. For example, it is possible that tasks that allow more passive learning of relationship stimuli or allow participants to construct their own categories may show more benefits, rather than deficits of ASC. Specifically, the free classification task used by Smith and Kemler (1977) may be worth testing in participants with varying degrees of past experience of ASC. Smith and Kemler's (1977) free classification task asks participants to rate the resemblance of two out of three stimuli presented with varying shape and color properties but does not impose a particular structure or rule on participants, thus allowing for a more constructive, and less top-down, use of attention. This task may avoid the potential top-down rule maintenance requirements of the present learning paradigm and provide an opportunity for ASC or STA to leverage more creativity in their solutions to the task.

Implications

It is important to consider that poor categorization performance observed in individuals higher in STA and ASC here does not necessarily result from poorer cognitive functioning or disordered thinking. An inability to efficiently learn new categories may show benefits when considered from a cognitive flexibility perspective. That is, even though lower associative learning rates may lead to reduced accuracy in the present context, it is not always useful to form rules as fast as possible. For example, a slower approach to learning and developing associations may allow an individual to avoid being bound to the diagnostic rules constructing the associative categories and could be beneficial for flexibility of perceptions or malleability of habitual top-down processes (Plebanek & Sloutsky, 2017). In a paradoxical sense, the process of categorizing is necessary for investigation, representation, and so forth, but one may find benefit in being conscientious about whether they are quick to label and fixate within the category's conceptions or stereotypes. When considering these examples, it is a bit more intuitive to conceive of the benefits and potential of a "deficit" in learning new categories.

For the Science of Psychedelics

Given the role of ASC scales play in measuring the phenomenological effects of psychedelic drugs, an open question is how the present results may translate to studies using such drugs to understand consciousness or cognition. Long-lasting effects being recorded after a single acute administration (Vargas et al., 2021) provoke the idea that there may be long-term changes in cognitions, which may elongate mental states from the psychedelic experience promoting psychological well-being. Thus, it may be useful to view the ASC experience as analogous to a personality trait measurement. Supporting the plausibility of ASC transitioning into a trait-based concept, a recent study by Thomas and Barušs (2022) found that participants who underwent an 18-week self-development course expressed more difficulties with socialization and, relevant to this study, cognitive-based tasks mediated by ASC ratings.

One avenue for future research is to look into the neurobiological relationships underlying the present effect. Some brain regions that are known to be involved in category learning also exhibit changes in activation related to distinct psychedelic phenomenology, namely the ventral lateral prefrontal cortex (vlPFC). The vlPFC is involved both in category learning and in psychedelic experiences. In categorization, vlPFC is involved when people learn tasks that do not require or benefit from extensive top-down processing (see Zeithamova et al., 2019, for a review on brain mechanisms of concept learning). Similarly, in psychedelic studies, vlPFC-related activation has been found to be associated with increased attribution of meaning to previously meaningless music (Preller et al., 2017). Putting these results together suggests that perhaps individuals high in ASC use more bottom-up strategies in category learning, which in the present case, may lead to slower learning and focusing on irrelevant features, instead of the faster, deliberate tuning of attention to relevant features that those lower in ASC may use. This hypothesis is consistent with the relaxed beliefs under psychedelics model of psychedelic states that argues one fundamental factor of how normal cognition is impacted by psychedelic states is via a relaxing of top-down processing in favor of increased bottom-up information flow (Carhart-Harris & Friston, 2019). An understudied question is the downstream cognitive consequences of psychedelic usage. Investigating selective attention in well-controlled experimental designs with participants under psychedelic states and postexperience will assist in understanding the subjective experience one will endeavor and potentially leverage the states for promoting a cathartic experience.

For Psychology of Consciousness

Psychiatrist and existential philosopher Karl Jaspers described a moment where it is possible to transcend ones being, thus deviating from one's developed pathology. As an existentialist, he focused on the experience of the event, the emotions, sensations, thoughts, the subjectivity. Limit situations (*Grenzsituation*) as Jaspers calls them are important for the cathartic experience; and to understand the subjectivity of such an experience may potentially assist in promoting and guiding it. Science of the mind has evolved since Jaspers' time and now developed fields such as cognitive psychology and cognitive neuroscience have focused on structuring validated methods for measuring (or observing) the processes within the mind. Psychedelics have introduced the ability to investigate such out of the ordinary experiences such as those Karl Jaspers describes to be transforming. The present study approaches this aim by investigating potential differences in attentional and sensory integrating processes that may be related to past experiences of ASC. The alteration of one's typical attentional processes provokes the question of how it may benefit individuals seeking a psychedelic assisted therapy as treatment for an array of mental illnesses, again, as a way to deviate from ones developed pathology as Jaspers would describe.

Limitations

All participants volunteered from an online portal (MTurk), which raises the possibility that our sample population may have different cognitive dispositions relative to the general population or to patient populations that have been used in previous studies on ASC, STA, and schizophrenia. The majority of the participants had some college or completed all of a college degree, which is somewhat higher educational attainment relative to the general population. MTurk is also not as frequently used by people who have existing full-time jobs outside of academic positions. This may have affected performance on the task and limited the generalizability of the findings to the general public. Additionally, the sampled population may differ substantially from typical studies interested in STA and thus we do not know if a more clinically oriented population may present different effects.

Due to the majority of our sample being middle aged, our sample may not be representative of the frequency of cognitive divergencies related to ASC in the general population. It may be the case that younger adults are more likely to seek out ASC experience, thus limiting our representation of individuals who tend to have such experiential phenomena in everyday life. Alternatively, perhaps middle-aged participants are more likely to have experienced more cumulative instances of ASC than younger participants. Future studies should seek to determine the generality of the current findings both within a sample that is more representative of the general population and a more clinically oriented population that may have suspected high ratings of STA. Finally, our use of the ASC scale was focused on past experiences in daily life, rather than the specific event of undergoing a psychedelic experience, and thus the results may differ for a sample that actively took the psychedelics.

While this study has provided valuable insights into the relationship between cognitive divergencies and ASC, there are limitations to the sample population used in this study, which may have influenced the results. It is also possible that the participants in the present study did not differentiate among the subfactors of the scales as much as in previous studies and instead provided evidence for a single larger factor related to ASC and schizotypal traits. Therefore, it is important to further investigate the differential item functioning in the ASC and STA scales to determine whether the differences in the factors found in this study are due to differences in the populations used. The investigation of differential item functioning can help to identify any potential sources of bias in the scales and allow for more accurate measurement of the constructs of interest across different populations (Langer et al., 2008), including clinical populations and individuals who have undergone a psychedelic experience. This investigation can also provide a further understanding of the differences in factors of the scales found in this study and inform future research in this area.

Differences in task demands between the present study and previous literature also have the potential to contribute to differences in blocking behavior between studies. While beetles have been commonly used as stimuli in the categorization literature, including in previous studies conducted by Davis et al. (2012) and Paniukov and Davis (2018), individual feelings of disgust toward these images may potentially confound the results of the present study. Schienle et al. (2003) have found a potential association between feelings of disgust and symptoms of schizophrenia, which may impact attentional orientation toward the task and promote learning latency, as observed in our study. Notably, no studies have investigated the relationships between disgust and ASC. As a limitation of our study, we did not measure participants' affective responses toward the beetle stimuli and thus cannot rule out the possibility of this confounding factor. To address this limitation, future studies may consider using more affectively neutral stimuli or measuring individual differences in the disgust response as a covariate in data analysis.

Conclusions

In conclusion, we found cognitive differences present in individuals with past experiences of ASC, which affect their ability to learn to selectively attend to rule-relevant features in a category learning task. Specifically, although we initially expected wider attention and thus broader learning of the different associations between stimulus features in individuals with past experiences of ASC, we found that these individuals simply did not learn the primary task associations as well as individuals lower in ASC. Future research should test the generality of these effects by employing tasks similar to the ones used in this study, and those which do not require such sustained attention, like more passive or creative attention tasks. These results should also be explored in clinical settings with subjects who are actively taking psychedelics to see if our results generalize to active ASC or simply past experiences of them. If mechanisms that potentially promote the experiences and long-lasting benefits from psychedelic clinical trials can be identified, researchers may be able to translate these mechanisms to better design a subjective experience for a patient and further to understand how experiencing variations of our habitually primed top-down selves can induce a situation of transformation closer to acquiring autonomy.

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