Persistence of Hypotheses in Schizotypy: When Red Remains Orange for a While

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Abstract

The Bias Against Disconfirmatory Evidence (BADE) is the tendency to maintain a belief against opposite information and is one of the mechanisms that has been linked with the formation and maintenance of delusion in schizophrenia. The goal of this study was to assess this tendency in a nonclinical population with high schizotypy (classified according to SPQ, Spanish version). For this purpose, we devised a new and more sensitive measure than the traditional one; capable of measuring tiny traces of BADE in schizotypy. Two experiments were carried out to verify this. In Experiment 1, with a traditional instrument to measure the BADE in schizophrenia, we did not find significant difference between groups. In Experiment 2, BADE was measured with our new task. Reaction time (RT) analyses showed significant differences between high and low schizotypal participants. This result highlights the similarities between both, schizophrenic disorder and schizotypal trait, with respect to the presence of BADE. It also illustrates how suitable our instrument is to study this phenomenon in a nonclinical population.

Keywords: BADE; Delusion; Schizophrenia; Schizotypy; Assessment.

Introduction

"Don Quixote: Look there, friend Sancho Panza, where thirty or more monstrous giants rise up, all of whom I mean to engage in battle and slay, and with whose spoils we shall begin to make our fortunes

Sancho Panza: What we see there are not giants but windmills

Don Quixote: Those are giants, and if you are afraid, away with you out of here and betake yourself to prayer, while I engage them in fierce and unequal combat."

Miguel de Cervantes, 1605

Don Quixote ended up seriously wounded, not by giants but, as his server and friend warned him, by crashing against windmills. This literary example sets pretty well the topic of the present study: delusions, their maintenance against evidence, and their detection in non-clinical population. Delusion is the persistence of an erroneous belief, sometimes bizarre (e.g., the paranoia), which is false or implausible, that is, whose content does not reflect the reality to which it refers. Like other clinical manifestations in schizophrenia, delusion is also present in other clinical illnesses (e.g., neurological disorders, substance abuse, depression, Alzheimer's disease).

Positive symptoms (delusion and hallucination) in schizophrenia have been associated with a cognitive tendency to accept evidence that is consistent with patient's beliefs (Bias Against Confirmatory Evidence BACE), while ignoring it when inconsistent (BADE; Freeman et. al., 2002; Garety, Hemsley & Wessely, 1991; Garety & Freeman, 1999; Garety et al., 2001). Many studies have corroborated these tendencies in schizophrenic patients (Moritz & Woodward, 2006; Woodward et al., 2004; Woodward, Moritz & Chen, 2006). In the traditional tasks, drawings or sentences are sequentially presented and increasingly disambiguated towards plausible scenarios, and participants are asked to rate the plausibility of several interpretations for a particular scenario. The BADE shows up when the patients continued to endorse their initial beliefs, even in the face of evidence that disconfirmed these beliefs.

Healthy people displaying schizotypy show a large number of the cognitive biases described in schizophrenic patients but in a lower degree: Jumping to Conclusion, False Alarms with High Confidence, deficit in Theory of the Mind, and in Semantic Memory (Gray & Snowden, 2005; Kiang & Kutas, 2005; Langdon & Coltheart, 1999; Laws & Bhatt, 2005; Lipp, Siddle & Arnold, 1994; Sellen, Oaksford & Gray, 2005). Furthermore, there are some indices of abnormal Dopaminergic activity in schizotypy, which has longer been argued to account for the positive manifestations in schizophrenia (Cohen & Servan-Schreiber, 1992; Cohen, Braver & O´Reilly, 1996; Perlstein et al., 2001). Because of these similarities, some schizophrenic symptoms are now considered a continuum that can be evaluated and studied in schizotypy. From this point of view, the evaluation of schizotypy has fundamental advantages. First, it allows for the study of the same phenomena without the inherent limitations of the use of patients, and second, it permits evaluating the at-risk population to achieve an early intervention (Jones et al., 2000).

In this study, we assessed the BADE in schizotypy, which has been related to the formation and maintenance of delusions. Ordinarily, a discrete measure has been used to test the BADE: the conscious judgment on the certainty that the participants have in their previous beliefs in the face of evidence that disconfirmed these beliefs.

Many studies have demonstrated that schizophrenic patients maintain incorrect initial responses with great confidence. However, this task may be inefficient in a nonclinical population since normal people are likely not to maintain beliefs that overtly contradict the evidence. For example, only a schizophrenic patient will maintain that mills are giants. Although Buchy et al (2007) evaluated whether this extends to a nonclinical sample scoring high on a schizotypy scale. The participants were sequentially presented with three sentences that increasingly disambiguated the true content of a delusion-neutral scenario and were asked to rate the plausibility of four interpretations for this scenario. Relative to low schizotypy participants, high schizotypy participants continued to endorse their initial beliefs, even in the face of evidence that disconfirmed these beliefs.

The Reaction Time has showed being a sensitive measure in Cognitive Science. For that reason, our purpose was to use the time taken by the participants to change their original beliefs according to external evidence as a fine-grained measure of the BADE, and found differences in that measure between high and low schizotypal people. Our new paradigm makes use of the same principle utilized in the traditional measures of the BADE. It starts with an ambiguous situation (an ambiguous color; e.g. one between blue and green) which gradually disambiguates. However, the participants are not asked to rate the plausibility of each interpretation but simply to indicate when the color changes from their original interpretation, if it is the case (e.g. the participants said the color was blue, they are asked to give a response as soon as they perceive it change into a different color). As a consequence, we obtain a constant and simpler measure (time to color change perception in milliseconds), which can be more sensitive to detect the BADE in nonclinical population.

In order to verify the utility of these two measurements (the classic measure based on judgments of confidence and the new task based on reaction-time), we carried out two experiments: in Experiment 1, we used the classic discrete measure, and in Experiment 2, the new continuous measure. The hypothesis was that the continuous measure would be more sensitive to detect the subtle BADE tendency present in schizotypal participants.

Experiment 1:Closure task in Schizotypy

The aim of the Experiment 1 was to test whether the high schizotypy group tended to maintain a hypothesis despite contradictory evidence (BADE) with a Closure task.

Method

Participants. From a total of 371 psychology students that were assessed with The Schizotypy Personality Questionnaire (SPQ; Raine, 1991) we chose a sample scoring over 90th percentile or below 10th percentile, dividing it into two groups: high-schizotypal participants (N=30) and low-schizotypal participants (N=27). 44 females and 13 males composed the sample. There was no statistical difference in sex between both groups ($\chi 2(1)=0.10$, $p=0.921$). The mean age was 21 (SD=2.9) years, range 18-40 years.

Instruments. The SPQ is a self-report questionnaire for the assessment of schizotypal personality disorder according to the DSM-III-R criteria (American Psychiatric Association, 1987). The internal consistency of the SPQ is 0.91 (the subscales mean is 0.74), and the test-retest reliability is 0.82 (Raine, 1991).

Closure task

We used a closure task (Moritz & Woodward, 2006), where a sequence of picture fragments was used instead of complex scenarios. For each trial, over a sequence of eight pictures, a common object (e.g., an elephant) was made increasingly visible (i.e., more features were added to the picture), and it was thus disambiguated. At each stage, interpretations of what the picture might depict were rated on a 5-point scale (dismissed, unlikely, possible, likely, positive decision). As soon as a decision was made, the trial ended.

Procedure and materials. Participants were given 14 experimental trials following a training block. All trials consisted of a sequence of eight stages, each showing a common object in decreasing degrees of fragmentation: new object features were added to each new picture until the entire object was displayed at the final stage. The objects were depicted as post-edited simple black-and-white drawings (experimental trials: float/raft, elephant, guitar, mill, mermaid, castle, etc.). Instructions and trials were presented on a computer running the software e-prime. The trials were run in fixed order with half of the trials being accompanied by cue interpretations (depending on the trial: 6–9 interpretations), which were assessed for plausibility until a decision was reached. Plausibility ratings had to be given on a five-point Lickert scale (1=dismissed, 2= unlikely, 3=possible, 4=likely, 5= positive decision). Once a decision (i.e., rating=5) was reached, the next trial (i.e., first fragment of new picture) was initiated. No feedback was provided about incorrect judgments. Only one of the interpretations eventually proved to be correct. In the remaining trials, no cue interpretations were provided, and the participants were instructed to create their own interpretations at each stage, which were subsequently rated for plausibility. If an interpretation was dismissed at any given stage (i.e., rating=0), it still had to be re-evaluated at all remaining stages. Again, the next trial was initiated once a decision was reached.

Results and discussion

The mean and standard deviation in the SPQ scale for the total population (N=361) was 23.48(9.84), for high schizotypy 42.08(5.62) and for low schizotypy 8.73(2.28).

The analyses did not yield any significant difference between high-schizotypal and low-schizotypal groups, either for BADE ($F(1,55)=0.790$; $p=0.378$; $d=0.238$) or BACE (($F(1,55)=0.004$; $p= 0.951$; $d=0.017$). However, a tendency for BADE existed in the high schizotypal group (-0.669(0.623)) compared to the low schizotypal group (-0.817(0.620)). Buchy et al., (2007) conducted an experiment with the same procedure using stories and they found differences between both groups with a tail. However, while a story may be given a more subjective interpretation, drawings can be interpreted more objectively. This results might reflect the lack of sensitivity of the task used to detect the BADE in this population.

Experiment 2:

Decision-Time Task in Schizotypy

The aim of the experiment 2 was to test whether the high schizotypy group tended to maintain a hypothesis despite contradictory information (BADE) with a new paradigm.

Method

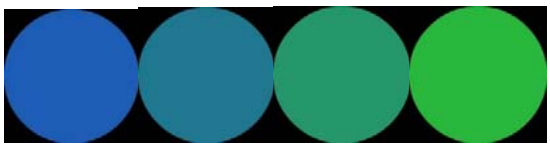
Participants. The participants were the same as in Experiment 1. Both experiments were conducted in the same session separated by a break.

Procedure and materials. A normative study was carried out in order to select the materials, i.e. sharp and ambiguous colors, which were presented to 57 new students from the same population. A total of 72 trials were presented to these participants, 18 trials were sharp colors and 54 ambiguous. Each trial showed a circle with two color names at the right and left of the figure. The participants' task was to choose the color of the circle, and then estimate the confidence of their responses in a Lickert scale from 1 to 5. The percentage of participants that selected the correct color was 99.33% for the sharp colors and 84.91% for the ambiguous colors; while the average of the confidence on the sharp colors was 4.05 and 4.68 on the ambiguous colors. Significant differences were found between the two types of colors in the percentage of accuracy (Wilcoxon: $z =-3.246$, $p = 0.001$) and in the confidence (Wilcoxon: $z =-2.735$, $p= 0.006$). The selection criterion for sharp and ambiguous colors was to maximize accuracy, while obtaining the biggest difference in confidence between both. Based on the results of the normative study, 6 sharp colors (yellow, blue, orange, red, green and purple) and their corresponding ambiguous were selected. Each color was paired with another, and we distinguished four different conditions: *Ambiguous-colors gradual-change, Sharp-color gradual-change, Sharp-color radical-change,* and *No-change*.

In *the Ambiguous-color gradual-change condition*, each color appeared twice in combination with another one (blue-green, blue-purple, green-yellow, yellow-orange, orange-red and red-purple). As the animation for each pair of colors started from both poles, we obtained a total of 12 items for this condition. The same pairs of colors were presented in *the Sharp-color gradual-change condition*, with the difference of using a sharp color to start the animation. Our key condition was *the Ambiguous-color gradual-change condition* because in that case the participants' initial decision could be perceived by themselves as a personal decision, and also because the traditional measures of BADE made use of ambiguous stimuli. However, we included *the Sharp-color gradual-change condition* to control if the ambiguity of the initial information used in the closure task was necessary for BADE to show up. We included *the sharp-color radical-change condition* as a control condition to check that the participants were detecting the changes. Each color was paired with another that allowed for the radical change (purple-yellow, red-green and blue-orange). Each pair began once by each pole resulting in 6 trials. All the previous conditions implied a change and that could lead to an automation of responses. For this reason, we created a *No-change condition*. There were 6 trials (purple, yellow, red, blue, green and orange), which remained the same color, but with different tones.

The whole task consisted of 36 experimental trials preceded by the training block. Each trial had two parts. First, a circle and two names of possible colors on its right and left appeared on screen and participants had to choose the color of the circle by pressing the corresponding key in the keyboard. After choosing the color, the circle remained up to 10 seconds on the screen. Throughout this time, the subject's task was to press the key only if the color changed (Figure 1).

Task 1: What colour is the circle?



Task 2: Press only if the colour changes

Figure 1: Decision-Time Task. People saw the first figure and they chose the color, then a film started to change the colour and people had to press when colour changed.

Results and discussion

Numerous studies have shown that the schizophrenic patients and high-schizotypal participants are slower in several tasks (see, Lipp, Siddle & Arnold, 1994). For this reason, we analyzed the reaction time for response 1, where the participants had to respond as quickly as possible to the initial color presented. This can be taken as an independent measure of speed. Three subjects were eliminated because they erred in more than one third of the items (two from the high-schizotypal group and one from the low-schizotypal group). The results showed no significant difference between the groups (all F's <1). However, we used this previous measure as a covariate for further analyses.

Regarding response 2, we examined the length of time the participants maintained their first hypothesis for each color (see Figure 2). In *the sharp-color radical-change condition*, there were no significant differences between low-schizotypy (5291(743) ms.) and high-schizotypy (5490(400) ms.) groups, F (1,53) = 1.615, p = 0.209, d = 0.348. In *the sharp-color gradual-change condition*, the average of the low schizotypy group was 5962(657) ms. and 6285(810) ms. for the high schizotypy. The difference was marginally significant, F (1,53) = 2.961, p = 0.091, d = 0.440. Finally, for *the ambiguous-color gradual-change condition*, the average of the low-schizotypy group was 5003(681) ms., and 5451(604) ms. for the high-schizotypy group. As we predicted, the high-schizotypal participants took longer to change their initial hypotheses than the low-schizotypal participants in this condition, F(1,53)=6.801, p=0.012, d=0.70. In general, the high-schizotypy participants tended to maintain their hypotheses longer in all conditions (even though we have controlled for speed differences with the covariate). We found significant differences between groups in t*he ambiguous-color gradual-change condition*, and a nearly significant tendency in *the sharp-color gradual-change condition*. Two possible accounts for the difference being more apparent with the ambiguous starting color are: first, an ambiguous situation could facilitate the persistence of the initial hypothesis as it can be felt by the participant as a personal decision, and this circumstance might have make them harder to inhibit this first belief. Second, the ambiguous stimuli changed more quickly than the sharp stimuli, giving not enough time for inhibition to occur in high-schizotypal participants.

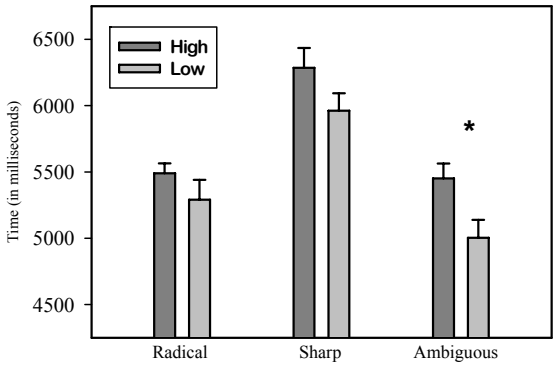


Figure 2: Mean Reaction Times for the Change of Hypothesis in the three conditions. Asterisk indicates significant differences (p<.05) between the two groups.

General discussion

The goal of the present study was to explore one of the possible cognitive pillars of schizophrenic delusion. A well established finding in this field is that schizophrenic patients are reluctant to change their previous hypotheses in the face of contrary evidence. If this bias is reflecting the functioning of a general cognitive mechanism (such as lack of inhibition of previous information), it would be possible to find some slight traces of it in non-clinical population with a predisposition to schizophrenia. In this case we used psychometric schizotypal participants and presented a new paradigm that proved itself sensitive enough to capture the phenomenon in that population.

For this purpose we checked if BADE was present in the schizotypy population and compared the sensitivity of the discrete traditional measure and the new paradigm we introduced in this non-clinical population. The lack of robust results supporting the presence of BADE in schizotypia might have been interpreted as if this cognitive bias were exclusive of clinical schizophrenia. However, it seems that the problem with the traditional instruments was not the absence of BADE but their lack of sensitivity to detect small traces of this bias. The new instrument should help us advance in the study of the delusion avoiding the difficulties posed by the schizophrenic patients.

We ran two experiments. In Experiment 1 we used a traditional instrument for measuring the BADE in schizophrenics and failed to find any significant difference between high and low schizotypy participants, while the tendency went in the predicted direction. The difference between Buchy's study and ours could be explained by the difference in material (stories vs. drawings). In Experiment 2, we tried to maximize precision with a much more sensitive chronometric measure, and with the advantages of non-continuous responses and a very simple stimuli –colored circles–, we found significant differences between high and low schizotypy groups. The same participants

carried out both experiments but we only found differences in experiment 2. It is obvious then that the TR measure is more adequate to find differences in a non-clinical population. In general, the high-schizotypal participants presented a tendency to maintain the initial hypothesis on all conditions, but we found significant differences between groups only in *the ambiguous-color gradual-change condition.* The closure task always presents the ambiguous stimulus and they are related with a personal interpretation and bigger resistance to change.

As this is the first work with this paradigm, further replications are needed to substantiate the results, not only with high-schizotypal participants, but also with other psychological disorders and schizophrenia. However, the results are promising and our paradigm, as it is based upon a simple judgment, calls for basic cognitive mechanisms and can be used for further analysis of the nature of delusion. One of the future research lines could be the study of inhibition in high schizotypal participants. Schizophrenic patients present a Dopaminergic-activity deficit related to the inhibition and maintenance of information in working memory (Cohen & Servan-Schreiber, 1992; Cohen, Braver & O´Reilly, 1996; Perlstein et al., 2001). In particular, it seems they have difficulties inhibiting the active information, which interferes with the processing of the new incoming information (See Computational Models in schizophrenia about how dopamine could be underlying the schizophrenia symptoms, Rolls et. al., 2008). Also, Kiang & Kutas, (2005) used a priming task and found that high-schizotypal participants were unable to maintain the prime in working memory, so that it exerted no influence over the target. In their experiment, high-schizotypal participants tended to react equally fast to three conditions, with the prime and target related, indirectly related or non-related. In contrast, the low-schizotypal group showed differences in the processing between related and unrelated targets.

In fact, the inability to inhibit and maintain information in working memory has been observed in a plethora of tasks, including some in the social field as that of the Theory of Mind (Langdon & Coltheart, 1999) where these authors found that the high schizotypy group took more time to distinguish between what the subject and a second observer are seeing than the low schizotypy group, which seems to reflect a difficulty to inhibit their own point of view of the situation.

In sum, we have designed a new paradigm which could be more sensitive to measure the BADE in a non-clinical population. We found the presence of the BADE in people with high schizotypy, a mechanism that could be related to delusion. This result corroborates numerous studies about the concept of health and illness, which could be seen as a continuous. It might facilitate the study of schizophrenia and numerous symptoms with non-clinical population and without the problems that patients present (general cognitive deficits, medication), and also, it might allow evaluating the at-risk population to achieve an early intervention (Jones et al., 2000).

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