Schizotypal people stick longer to their first choices

Isabel Orenes*, Gorka Navarrete, David Beltrán and Carlos Santamaría

University of La Laguna

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*To whom correspondence should be addressed: Universidad de La Laguna. Departamento de Psicología Cognitiva. Campus Guajara, sn. 38205 La Laguna, Tenerife (Spain). Tel.: +34 922 317503; fax: +34922 317461

E-mail address: iorenes@ull.es
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Abstract
Many studies have reported that schizophrenic patients show a Bias Against Disconfirmatory Evidence (BADE). This cognitive bias has been related to the formation and maintenance of delusion. The aim of this paper was to study whether BADE was present in healthy people displaying psychometric schizotypy, and to compare a closure task, which has been used for schizophrenia, with a new chronometric paradigm. Results with the new paradigm showed that the high-schizotypy group maintained their initial hypotheses longer than the low-schizotypy group. This finding corroborated the similarities between schizophrenic disorder and schizotypal traits, in this case with respect to the BADE. Research of this kind could facilitate the study of cognition in the schizophrenic spectrum without the difficulties of working with schizophrenic patients for some tasks and the assessment and early intervention in at-risk populations.

Keywords: BADE; Delusion; Schizophrenia; Schizotypy; Assessment; Reaction time.
1. Introduction

People generally have a tendency to favor information that confirms their preconceptions and to maintain their beliefs even when faced with evidence to the contrary (see, for example, Johnson-Laird, 2006; Nickerson, 2008). A particular case of this tendency has been identified in schizophrenic patients and it is known as the Bias Against Disconfirmatory Evidence (BADE; Freeman et al., 2002; Garety et al., 1991; Garety and Freeman, 1999; Garety et al., 2001; Moritz and Woodward, 2006; Woodward et al., 2006a; Woodward et al., 2006b). These authors suggest that the formation and maintenance of delusion could be associated with this bias. Indeed, a BADE for delusional compared to non-delusional schizophrenic patients was observed (see, Woodward et al., 2006b).

The goal of this study was to explore whether healthy people in the schizophrenic spectrum with posited vulnerability to schizophrenia (high-schizotypal people) show a particular tendency to maintain beliefs against disconfirmatory evidence (BADE) as compared with low-schizotypal people.

Individuals with schizotypal characteristics share some of the perceptual and cognitive peculiarities described in schizophrenic patients though they do not experience severe perceptual distortions, paranoia, delusions or the psychotic episodes of schizophrenia (see, Questa et al., 2001). Amongst the shared cognitive peculiarities are: jumping to conclusions, false alarms with high confidence, deficit in theory of the mind and in semantic memory (Gray and Snowden, 2005; Kiang and Kutas, 2005; Langdon and Coltheart, 1999; Laws and Bhatt, 2005; Lipp et al., 1994; Sellen et al., 2005). Furthermore, there are indices of dopaminergic hyperactivity in schizotypy, which has long been argued to account for the positive symptoms in schizophrenia (see Meltzer and Stahl, 1976).
Because of these similarities, there is a body of opinion which considers that certain schizophrenic symptoms lie on a continuum with normal behavior, where the clinical condition would be one of the ends of that dimension (Chapman et al., 1995; Claridge, 1985, 1997; Claridge et al., 1996). The evaluation of schizotypy, by means of the application of a psychometric approach, has fundamental advantages. Firstly, it allows the study of some of the phenomena in the schizophrenic spectrum without the inherent limitations and difficulties of the participation of patients (general cognitive deficit, medication, etc.), and secondly, it allows the evaluation of the at-risk population for possible early intervention (e.g., Jones et al., 2000). As BADE is not confined to delusion-congruent scenarios it might reflect the enhancement of a general purpose cognitive-bias (not a specific consequence of mental illness) and should be present in a greater degree in high-schizotypal people than in low-schizotypal people.

As mentioned above, this study focused on one cognitive mechanism that could be related to delusion, BADE, which has been mainly evaluated with a closure task. This task is based on delusion-neutral scenarios: either written or pictured. The task in both cases consists of sequentially presented and increasingly disambiguated partial information. The BADE shows up when patients continued to endorse their initial decision even in the face of evidence that disconfirmed these beliefs. While the results with schizophrenic patients have been quite robust in showing this bias using the closure task with the written and pictures versions, there is only one study that has tested this bias in schizotypal people using the written version (Buchy et al., 2007); therefore, it is necessary to replicate this finding using a different experimental procedure.

Consequently, the first aim of this study was to assess whether a nonclinical sample with a high schizotypy score would demonstrate a BADE using the picture-
based task (Experiment 1), which has been used for schizophrenic patients (Moritz and Woodward, 2006). The second goal was to test a new paradigm that presents a delusion-neutral color-changing scenario using a different unit of measure, the Reaction Time (RT) instead of plausibility judgments, for the same purpose (Experiment 2). The predicted outcome was that this new methodology would be more sensitive to subtle manifestations of BADE than the plausibility judgment, such as the BADE signs expected in a non-clinical population, and therefore more suitable for obtaining larger differences between low and high-schizotypal individuals. This hypothesis is based on a fundamental idea in cognitive science (that goes back to Donders’s (1869) pioneering work). Reaction time is sensitive to subtle variations between tasks where discrete measures are not discriminant enough. Thus, even if non-clinical participants were not inclined to maintain obviously erroneous judgments they may still show differences in RT. In doing so, BADE is understood to be a content-neutral cognitive bias that should be reflected in different tasks and with diverse methodologies. This assumption will be tested in the second experiment where the aim is to identify BADE using this new methodology which essentially measures the time taken to change a simple hypothesis when faced with evidence to the contrary. Besides, the chronometric measures included in this new task might enable future research to explore the cognitive mechanisms that support BADE with more precision.

2. Experiment 1: closure task in schizotypy

Moritz and Woodward (2006) described a bias against disconfirmatory evidence in schizophrenic patients using neutral pictures that were increasingly disambiguated – the closure task. The aim of the present experiment was to test whether the same tendency
would be detected with this task in a non-clinical sample with schizotypal traits. The performance of participants scoring high and low in the Schizotypal Personality Questionnaire (SPQ; Raine, 1991) was compared in a closure task which had more pictures in order to gain statistic power (14 instead of the 6 pictures used in Moritz and Woodward, 2006).

2.1. Method

2.1.1. Participants

Three hundred and seventy one undergraduates from the University of La Laguna completed the Schizotypal Personality Questionnaire (Spanish version of SPQ, Grasa et al., 2004). In accordance with previous studies (Buchy et al., 2007; Woodward et al., 2007), the students selected to form the high-schizotypy (n=30) and low-schizotypy groups (n=27) were those scoring over the 90th percentile and below the 10th percentile respectively. The 57 participants chosen were native speakers of Spanish (44 females; mean age: 21 years; S.D.=2.9; range: 18-40), and participated in the experiment in exchange for course credits.

2.1.2. Instrument

The SPQ is a 74-item yes-no self-report inventory consisting of nine subscales modeled on the 9 criteria of DSM-III-R schizotypal personality disorder (Raine, 1991), which are grouped around three factors: cognitive-perceptive (positive dimension), disorganization (disorganization dimension) and interpersonal (negative dimension). Total scores can therefore range from 0-74 with higher scores indicating a higher level
of schizotypy. The Spanish version of the scale presents high internal consistency (Cronbach alpha=0.90) and good construct and convergent validity (Grasa et al., 2004).

2.1.3. Material and procedure

The procedure followed here is the one described in the study of Moritz and Woodward (2006) with schizophrenic patients with a small modification explained below. Participants were given 14 experimental trials after two practice trials. Each trial was divided into eight stages, each showing a common object in decreasing degrees of fragmentation. New object features were added, in every stage, to the picture until the entire object was displayed at the final stage. In the illustrative example of Appendix 1a, one can see that only a curved shape, congruent with the mouth of a smiley face, is shown in the first stage of the chair item. More features were added to the picture in each stage until the last stage where the fully detailed chair appears. All objects were shown as simple black and white drawings (experimental trials: flower, pig, rocking chair, elephant, mermaid, windmill, raft, frog, guitar, girl, carriage, house, fish and bat; practice trials: dragon and castle). Instructions and trials were presented on a computer using the E-prime (1.0) software. Participants were asked to identify the object in each stage. The answer was open in half of the trials (self-generated trials), i.e., participants created their own interpretation at each stage and they were able to change their interpretations during the trial, while in the other half the participants chose one from the 6 or 9 alternatives provided at each stage (fixed trials; Appendices 1a and 1b illustrate each of these two types of trials, respectively). After identifying the object, participants had to rate the plausibility of the object-identification answer on a five point Likert scale (0=dismissed; 1=unlikely; 2=possible; 3=likely; 4=positive decision). When a decision (i.e., rating=4) was reached, the next trial began.
As stated above, a simplified version of Moritz and Woodward (2006) task was used where participants had to rate the plausibility of only their preferred interpretation (for fixed and self-generated trials). As the participants had to do the closure task (Experiment 1) and the chronometric task (see Experiment 2) in the same session, a single response per item was decided on to make the session more bearable.

2.1.4. Data analysis

Two indices were computed: BADE and BACE (Bias Against Confirmatory Evidence). While the BADE was calculated with the plausibility of incorrect interpretations, the BACE used the plausibility of correct interpretations, i.e., when the participants identified the object correctly. Both were obtained from differences in plausibility ratings between the mean at the first stage and the mean at later stages. As the perceived plausibility is higher in later stages, i.e., the participants show higher security as more information is presented, the differences of plausibility between the first stage with respect to the remaining stages must be negative, and consequently the indices are shown with negative numbers. Near-zero scores mean no changes in the participants’ interpretations through the stages. The BADE measure is computed as the minimal change in the participant’s plausibility ratings for incorrect interpretations throughout the stages while the BACE measure can be interpreted as the increase in the plausibility ratings in the same sequence for correct interpretations.

2.2. Results and discussion
The mean and standard deviation in the SPQ scale was 42.08 (5.62) for high schizotypal and 8.73(2.28) for low schizotypy groups. High and low groups did not differ reliably on gender ($\chi^2 (1)=0.10$, $p=0.921$).

One participant was excluded before the analyses for not answering most of the trials. As Trial Type did not yield any significant interaction with Group when entered as an additional within-subject factor, all subsequent analyses collapsed ratings from self-generated and fixed trials (see Fig. 1). There was no difference in either the plausibility ratings at the initial stage or in the number of interpretations that the groups gave before their decision (see Table 1). Therefore, no differences were found in jumping to conclusions between both groups (Moritz and Woodward, 2006).

**Table 1.** Descriptive results

<table>
<thead>
<tr>
<th></th>
<th>High schizotypy</th>
<th>Low schizotypy</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Initial Plausibility (stage 1) for fixed trials</td>
<td>1.445</td>
<td>1.167</td>
<td>$F (1,55)=1.801; p=0.185$</td>
</tr>
<tr>
<td>Mean Initial Plausibility (stage 1) for self-generated trials</td>
<td>1.019</td>
<td>0.836</td>
<td>$F (1,55)=0.862; p=0.357$</td>
</tr>
<tr>
<td>Number of different answers for fixed trials</td>
<td>2.591</td>
<td>2.878</td>
<td>$F (1,55)=3.989; p=0.051$</td>
</tr>
<tr>
<td>Number of different answers for self-generated trials</td>
<td>4.021</td>
<td>3.941</td>
<td>$F (1,55)=0.142; p=0.708$</td>
</tr>
</tbody>
</table>

As expected, no significant differences in BACE index were found between high and low-schizotypy groups: mean scores were -1.695 (0.999) and -1.679 (0.934), $F (1, 55) = 0.004$, $p = 0.951$. The absence of difference in the non-clinical sample is consistent with that to be expected from the literature with a clinical population.
Fig. 1: Change scores from the initial stage to subsequent stages of plausibility over choice and created trials for correct answers (BACE, right figure) and incorrect answers (BADE, left figure). Data shown up to the stage 5 because most participants made their decision at this stage.

However, the one-way ANOVA on the BADE index also failed to show a significant difference between high- and low-schizotypy groups, with mean scores of -0.669 (0.623) and -0.817 (0.620), $F(1,55) = 0.790, p = 0.378$. In contrast to what was expected, the high schizotypal participants did not show a bias against disconfirmatory evidence. This result seems to be at odds with the previous association of schizotypy with BADE, which was also established using a plausibility judgment task (Buchy et al., 2007). There are, however, differences between the Buchy study and the present experiment that might account for the inconsistency. The most important factor is the format of materials (written versus pictured). It seems reasonable to assume that the interpretation of a story from a text could be a more complex scenario than the interpretation of a picture. The first version would also be interpreted as being more subjective and variable than the shape of well-known objects. Although a reliable difference between both groups was not found, the high group tended to maintain their first choice more than the low group, i.e., the BADE index (-0.669) was nearer 0. This tendency suggests that the picture-based version of the closure task might not be sensitive enough to detect small traces of this cognitive bias.
3. Experiment 2. The decision-time task in schizotypy

The aim of the Experiment 2 was to extend the idea of BADE as a basic cognitive bias by testing it via a sensitive chronometric measure. The time taken by the participants to change an initial decision on the color of a circle presented to them, while the color gradually changed was measured in this paradigm. This time was taken as a measure of the persistence of their initial decision against evidence. This measure differs from the classical closure task in that it does not entail a metacognitive decision of plausibility, but a direct and continuous measure of the time taken to change the participant’s initial selection. The predicted outcome was that the RT paradigm would be more sensitive, and consequently, more likely to detect the BADE in schizotypal participants.

3.1. Method

3.1.1. Participants

Participants in Experiment 2 were the same as those in Experiment 1. Both experiments were performed in the same session, with a break between them.

3.1.2. Material and procedure

A normative study was carried out to select the materials. Our goal was to obtain both sharp (non-ambiguous) and ambiguous colors. Fifty-seven university students different to those forming the experimental sample were shown 72 color trials: 18 sharp and 54 ambiguous colors. We used primary and unambiguous colors (e.g. blue or green) as sharp colors. The ambiguous colors are those that are located between two sharp colors, so that a person could name them as belonging to two distinct categories (e.g. turquoise...
as it is somewhere in between blue and green). A circle appeared, in each trial, on the screen with the names of two possible colors to the right and left of the figure. The participant’s task was to name the color of the circles and to estimate the degree of confidence in their choices using a Likert scale from 1 to 5. The percentage of correct identifications was 99.33% for sharp colors and 84.91% for ambiguous ones. The degree of plausibility mean was also higher for sharp colors, 4.675, than for the ambiguous ones, 4.050. In fact, both differences in the percentage of correct answers (Wilcoxon: $z = -3.246, p = 0.001$) and in the degree of plausibility (Wilcoxon: $z = -2.732, p = 0.006$) were significant. The participants performed the task in an individual cubicle and the instructions and trials were given to them via the Presentation 12.1 program in a PC with a CRT screen and refresh rate of 80 Hz. Colors were selected according to the RGB (Red, Green, Blue) System, which allows all colors to be represented by combining the intensities (from 0 to 255 bits) of the three primary colors.

**Table 2.** List of materials used in Experiment 2

<table>
<thead>
<tr>
<th>Sharp colors (RGB)</th>
<th>Percentage of accuracy (%)</th>
<th>Degree of confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow (255, 246, 0)</td>
<td>98</td>
<td>4.09</td>
</tr>
<tr>
<td>Blue (0, 13, 243)</td>
<td>100</td>
<td>4.98</td>
</tr>
<tr>
<td>Orange (255, 150, 0)</td>
<td>100</td>
<td>4.57</td>
</tr>
<tr>
<td>Red (255, 0, 46)</td>
<td>98</td>
<td>4.79</td>
</tr>
<tr>
<td>Green (0, 128, 0)</td>
<td>100</td>
<td>4.89</td>
</tr>
<tr>
<td>Violet (156, 0, 198)</td>
<td>100</td>
<td>4.73</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ambiguous colors (RGB)</th>
<th>Percentage of accuracy (%)</th>
<th>Degree of confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orange (255, 164,21)</td>
<td>67</td>
<td>3.71</td>
</tr>
<tr>
<td>Yellow (255, 203, 17)</td>
<td>95</td>
<td>4.09</td>
</tr>
</tbody>
</table>
Based on the results of the normative study, six sharp and ambiguous colors (yellow, blue, orange, red, green and violet; see Table 2) were selected. The selection criterion for sharp and ambiguous colors was to maximize accuracy while obtaining the biggest difference in plausibility between both sorts of colors, i.e., the aim was to be sure that most participants identified the colors correctly and that they also showed high security in their answer for sharp colors but low security for ambiguous colors. As an example, sharp yellow was a color that people identified as yellow, showing high security in their answer, while ambiguous yellow was a color that although most people identified as yellow, they did not show high security. Pairs of colors (e.g. blue-green) were used and the speed of change from one to another was manipulated. Consequently, four different conditions were created partially combining (a full factorial combination was not needed for the purposes of this study) type of color (sharp or ambiguous) and type of change (gradual or instant): Ambiguous-color gradual-change, Sharp-color gradual-change, Sharp-color instant-change, and No-change.

Each color appeared twice in combination with another one (blue-green, blue-violet, green-yellow, yellow-orange, orange-red and red-violet) in the Ambiguous-color
gradual-change condition. The trials started with ambiguous color and the color gradually changed towards a sharp color. As the animation for each pair of colors started from both poles, a total of 12 items were obtained for this condition. For example, the pair blue-green started with the ambiguous blue (RGB: 0, 117, 138) and finished with the sharp green (0, 128, 0) while the pair green-blue started with the ambiguous green (0, 143,112) and finished with the sharp blue (0, 13, 243). 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.

The key condition was the Ambiguous-color gradual-change condition for two main reasons. Because the participants' initial decision should be perceived as a personal decision when using an ambiguous color, and because the aim was to imitate the ambiguous nature of the stimuli used in the closure task. However, the Sharp-color gradual-change condition was also included to check whether the ambiguity of the initial information used in the closure task was necessary for BADE to show up. In addition, the sharp-color instant-change condition was also included as a control condition to see if the participants were detecting the changes. Each color was paired, in this condition, with another that allowed for the instant change (violet-yellow, red-blue and green-orange). Each pair began once at each pole which gave a total of 6 trials. As all the previous conditions implied a change that could lead to an automation of responses, a No-change condition was created. This No-change condition consisted of 6 trials (violet, yellow, red, blue, green and orange), where the colors remained the same, but with a progressive change in tone.

The task consisted of 36 experimental trials preceded by a practice block. Each trial had two parts. In the first, the participants were shown a colored circle and two color names, one to the right and the other to the left of the circle. The participants were
asked to select the color of the circle by pressing the spatially congruent response key. The reaction time taken to give the first answer (Answer 1) was recorded to control for possible general differences in the motor execution of the two samples, high and low schizotypy (see analysis). After choosing the color (Answer 1), the circle remained up on the screen for up to 10 s and the participant’s task was to press the key only if the color changed during this time. The participants performed the experiment in an individual cubicle and the instructions and trials were shown with the same program and monitor used in the normative study. The 10 s color sequences (going from one of the colors of the pair to the other) were made using the Adobe Flash CS3 program. (See Fig. 2 for discretized examples of the conditions used and <www.reasoning.es/files/greenblue.avi> to see a Sharp-color gradual change item).

![Figure 2a: Example of Sharp-color instant-change](image)

![Figure 2b: Example of Sharp-color gradual-change](image)
3.2. Results and discussion

Certain studies have reported that schizophrenic and high schizotypal participants are slow in some chronometric tasks (Lipp, et al., 1994). This is why the reaction time for the first response was analyzed, in which the participants had to choose the name of the initial color as quickly as possible. Only correct answers (according to the previous normative study) were recorded and three participants were eliminated because they erred in more than one third of the items (two from the low and one from the high schizotypy group). The results did not differ significantly between the groups for any condition ($F$s<1), which indicates that participants with high schizotypy are not slower in this task than those in the low schizotypy group. This measure has been used for an additional purpose: as it was a measure of the decision speed, it was taken as a covariate for the second response where the participants had to change their initial decision. The objective was to have a pure measure of the time the initial decision was maintained without the interference of the decision speed. Indeed, this covariate reduced the unexplained variance in the model (for the three DV´s analyzed).
As regards the second response, the length of time the participants maintained their first hypothesis for each color was examined (see Fig. 2). The mean for the low schizotypy group was 5291(743) ms and for high schizotypy 5470(460) ms in the *sharp-color instant-change* condition with no significant differences between the groups, $F(1, 53) = 1.230, p=0.273$. The mean for the low schizotypy group was 5958(704) ms and for the high schizotypy 6281(804) ms in the *sharp-color gradual-change* condition without significant differences observed, $F(1, 53) = 1.946, p=0.169$. Finally, in the *ambiguous-color gradual-change* condition, the mean for the low schizotypy group was 4045(829) ms and for the high schizotypy 4626(733) ms As predicted, the high schizotypy group took significantly longer to change their hypothesis than the low-schizotypal participants, $F(1, 53) = 8.816, p=0.005$. In general, these results suggest that high schizotypal participants tend to stick to the previous hypothesis longer in all the conditions, although the effect is significant only for the *ambiguous-color gradual-change* condition. As suggested in the expected outcomes, this difference between a sharp and ambiguous presented color may be due to the fact that the latter is experienced as more controversial, thereby implying a personal decision and, therefore, less willingness to change it.
Outwardly, the closure task (Experiment 1) and the chronometric task (Experiment 2) yield quite different measures. The former is based on plausibility judgments while the latter on the time taken to change an initial selection. However, the hypothesis here was that both measures are essentially affected by a common phenomenon: the tendency to maintain initial hypotheses against evidence. As the participants were the same in Experiments 1 and 2, a correlation between the meaningful measures can be computed. The initial-decision time was used again as a covariate to reduce the unexplained variance and have a pure measure of decision maintenance. In this case, a linear regression with the initial time (Answer 1) as IV and change-time as DV was used for this purpose and the correlation with the unstandardized residuals of that regression was performed. The correlation between the BADE index and the residuals of RTs for the Gradual-change conditions in Experiment
2 was moderate but reliable \((p<0.05\) one-tailed) for the Ambiguous-Gradual condition: \(r= -0.236\), and for the Sharp-Gradual condition: \(r= -0.242\). The negative correlation indicates a longer time to change in the RT measures for a lesser change in BADE index, so both measures (BADE index and RT in gradual conditions) might be related to the maintenance of the initial hypothesis (see Table 3). No correlation was obtained for the Sharp-Instant condition \((r= 0.005\). The moderate correlation found between the indices of the Experiment 1 and 2 could be due to the scores obtained in Experiment 1, which might not reflect BADE itself because the closure task may not be able to detect reliable differences between high and low schizotypy groups.

**Table 3.** Summary of the main results

<table>
<thead>
<tr>
<th></th>
<th>Low schizophrenia</th>
<th>High schizophrenia</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>BADE</td>
<td>-.817</td>
<td>-.669</td>
<td>(p =0.378)</td>
</tr>
<tr>
<td>Response 1 for</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambiguous-Gradual</td>
<td>1487(395)</td>
<td>1582(561)</td>
<td>(F(1,53)=0.528;)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(p=0.471;)</td>
</tr>
<tr>
<td>Response 1 for</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sharp-Gradual</td>
<td>1238(357)</td>
<td>1193(310)</td>
<td>(F(1,53)=0.254;)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(p=0.617)</td>
</tr>
<tr>
<td>Response 1 for</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sharp-Instant</td>
<td>1244(554)</td>
<td>1147(233)</td>
<td>(F(1,53)=0.750;)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(p=0.390;)</td>
</tr>
<tr>
<td>Ambiguous-Gradual</td>
<td>4045(829)</td>
<td>4626(733)</td>
<td>(p=0.005)</td>
</tr>
<tr>
<td>Sharp-Gradual</td>
<td>5958(704)</td>
<td>6281(804)</td>
<td>(p=0.169)</td>
</tr>
<tr>
<td>Sharp-Instant</td>
<td>5291(743)</td>
<td>5470(460)</td>
<td>(p=0.273)</td>
</tr>
</tbody>
</table>

**4. General discussion**

The bias against disconfirmatory evidence (BADE) is thought to be associated with schizophrenic delusions and hypothesized as a possible vulnerability factor for
schizophrenia (Freeman et al., 2002; Garety et al., 1991; Garety and Freeman, 1999; Garety et al., 2001). The present study investigated, in two experiments, whether this bias extends to non-clinical populations with high schizotypal traits, as well as whether it can be measured using both a typical plausibility-judgment task and a new chronometric paradigm. In Experiment 1, BADE was examined using the picture-based version of the closure task, a plausibility-judgment task previously found to successfully detect BADE in schizophrenic patients (Moritz and Woodward, 2006; Woodward et al., 2006a; Woodward et al., 2006b). But the results failed to detect a significant difference in BADE between participants with high and low scores in the Schizotypal Personality Questionnaire (SPQ). The new chronometric task was presented to the same sample in Experiment 2. The time taken to change a salient hypothesis that is increasingly proved to be false is the critical value for considering the existence of BADE. The results showed a significant difference between the groups for this value: as expected, participants with high scores in SPQ took longer to change a hypothesis formulated on an ambiguous color than those with low scores.

The lack of effect found in Experiment 1 is consistent with two alternative general explanations: firstly, it could be that BADE is only present in clinical schizophrenia and cannot be found in schizotypy; secondly, a BADE is present in schizotypy in a moderate degree so that the usual tasks for schizophrenia cannot detect it easily. The results of the second experiment support this second view by showing a clear effect of belief maintenance and by correlating positively with the traditional BADE. Furthermore, it is equally consistent with a previous identification of BADE in high schizotypy using a written-version of the closure task (Buchy et al, 2007). Hence, this study is an addition to the stream of research that understands schizophrenia and
schizotypy as different points in the same dimension (Chapman et al., 1995; Claridge 1985, 1997; Claridge et al., 1996; Siever and Davis, 2004).

One relevant question for future research is how this tendency is related to other cognitive variables that show up as being dysfunctional in schizophrenic patients. Based on the absence of psychometric relationships in high schizotypy between BADE as measured with the written version of the closure task and other cognitive domains (memory, etc.), Woodward et al. (2007) have argued that BADE possibly constitutes a specific and independent cognitive mechanism able to account for the formation and maintenance of delusions. It may also be linked to a general deficit in inhibitory memory processes.

In fact, our results can be related to the general deficit in inhibitory processes of memory found in the schizophrenic spectrum. Indeed, belief change entails inhibition of an initial belief. A considerable amount of research has demonstrated cognitive-inhibition impediments in delusional patients (Cohen and Servan-Schreiber, 1992; Cohen et al., 1996; Perlstein et al., 2001). In particular, it seems patients have difficulties inhibiting the active information which interferes with the processing of the new incoming information. As dopamine is related to the inhibition and maintenance of information in working memory, this deficiency has been associated to a dopaminergic-hyperactivity (Cohen and Servan-Schreiber, 1992; Cohen et al., 1996; Perlstein et al., 2001; see also Rolls et al., 2008 for a description of computational models in schizophrenia describing how dopamine could help to explain schizophrenia symptoms).

Other findings on the cognitive functions in the schizophrenia spectrum might be related to this inhibitory retardation. For example, a similar mechanism has been suggested for the lack of differences between related and unrelated stimuli in a priming
task observed in both schizotypal (Kiang and Kutas, 2005) and schizophrenic participants (Kiang et al., 2008; Kuperberg et al., 1998; Kuperberg et al., 2006). It also found a reduction of the N400 ERP-component evoked by items-discrepancy in delusional patients (Debruille et al., 2007) and schizotypal personality (Prévost et al., 2010). This kind of mechanism has also been proposed as being responsible for the alteration of theory of mind in schizotypy (Langdon and Cotheart, 1999) and schizophrenia (Brune, 2005; Frith, 1994). In sum, a hindrance in processing the latter of two consecutive items has been attributed to a difficulty in the maintenance and inhibition of information in working memory in many fields of cognitive research.

Retardation of inhibition of first hypothesis could explain the differences found in the chronometric paradigm. If people with high schizotypy have a delay in inhibition, the processing of the second color might be hindered. As a consequence they would need more time to change their initial hypothesis. This process can explain the fact that the BACE (Bias Against Confirmatory Evidence) index is not affected in patients or participants with high scores in schizotypy: a lack of inhibition of the first hypothesis would support the correct conclusion for the BACE index because the participants’ answer is the same, they don’t need to change their hypothesis; but this would lead to BADE (where the initial hypothesis becomes incorrect). In conclusion, BADE should be related to a general cognitive mechanism present in a non-clinical population too.

In summary, our results can be easily affixed to previous knowledge to support the idea of some continuity between personality traits and mental illness. The introduction of a sensitive chronometric task to test belief change and maintenance in the schizophrenia spectrum could be a useful tool for further research.
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Appendix 1a: Example of materials in Experiment 1 with clues (fixed trials)
Appendix 1b: Example of materials in Experiment 1 with open question (self-generated trials)