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Impaired conscious memory in schizotypy

Impaired conscious memory in non-clinical schizotypy

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## Impaired conscious memory in schizotypy

### **Abstract**

*Introduction.* Impaired controlled and preserved/enhanced automatic memory processes have been reported in schizotypy. This memory pattern has been considered as a marker of vulnerability to schizophrenia. Our aim was to further explore this memory pattern in non-clinical schizotypy in order to determine which specific dimensions of schizotypy (i.e., positive, negative or disorganized), and more specifically which components of the dimensions, are most closely related to memory dysfunctions.

*Methods.* Fifty-seven undergraduate students performed a category production task. This was adapted for use with the Process Dissociation Procedure in order to dissociate between automatic and controlled memory processes. The level of schizotypy was assessed using the SPQ.

*Results.* Regression analyses confirmed that controlled memory processes decreased as schizotypy increased. The positive factors (more specifically, the ideas of reference subscale) and disorganized factors (more specifically, the odd or eccentric behavior subscale) were negatively correlated with the controlled memory processes.

*Conclusions.* Our study supports the idea that impaired controlled processes are an early cognitive marker of vulnerability to schizophrenia, and confirm that the disorganized factor contributes the most to vulnerability to memory dysfunction. It also emphasizes the importance of dissociating between each of the features characterizing schizotypy rather than considering it as a whole.

**Keywords:** Implicit memory, explicit memory, schizotypy, cognitive vulnerability marker, schizophrenia.

### **Introduction**

The aim of this study was to explore a cognitive factor of vulnerability to schizophrenia by examining schizotypy in a general population. Schizotypy is defined as a personality trait characterized by at least 3 clinical factors: disorganization (odd or bizarre behavior, incoherent speech), positive (magical thinking, unusual perceptual experiences), and negative (social anhedonia) (Nelson, Seal, Pantelis, & Philips, 2013). Schizotypy has been considered to be a vulnerability factor for schizophrenia (Nelson et al., 2013). According to this view, schizotypy can be considered as the mildest expression of schizophrenia symptoms in a healthy population (Rodríguez Solano & González De Chávez, 2000). Such an approach finds support in the fact that individuals with high schizotypy levels present both a higher risk of developing schizophrenia (e.g., Miller et al., 2002) and symptoms similar to schizophrenia, which can be measured using the Schizotypal Personality Questionnaire (SPQ) (Raine et al., 1994). The similarity between schizotypy and schizophrenia has led some researchers to explore the social and cognitive endophenotype of schizophrenia in schizotypy. Indeed, beside the links between schizotypy and schizophrenia symptoms, similar social (Gooding, Matts, & Rollmann, 2000) and cognitive impairments have been reported, such as executive dysfunction (Vogelmaier, Seidman, Salisbury, & McCarley, 1997) or memory impairment (Bergman et al. 1998). Schizotypy makes it possible to explore social and cognitive dysfunctions without introducing confounding factors such as hospitalization or medication, an important consideration when studying memory-related fields.

Memory has been extensively explored in schizophrenia, and in particular at the level of the distinction between controlled and automatic memory.

## Impaired conscious memory in schizotypy

The distinction between controlled (or explicit) and automatic (or implicit) processes in memory tasks was introduced by Graf and Schacter (1985). According to these authors, the retrieval of encoded information in tasks based on automatic processes does not require the participants' conscious awareness. However, in tasks that involve controlled memory processes, recollection is underpinned by attentional, effortful and conscious processes. In the context of schizophrenia, although some studies found that the involvement of automatic memory processes was either reduced (e.g., Neill & Rossell, 2013) or similar to that of controls (e.g., Besche-Richard & Passerieux, 2003, Experiment 2), a meta-analysis seems to indicate that this involvement may also be enhanced (Pomarol-Clotet, Laws, & McKenna, 2008). Conversely, it has been found that controlled processes are less prominent in individuals with schizophrenia than in controls (e.g., Kern, Hartzell, Izaguirre, & Hamilton, 2010).

The same dissociation has also been explored in schizotypy. Some studies have shown increased or normal levels of implicit memory in non-clinical individuals with high levels of schizotypy (Ferraro & Okerland, 1995; Neill & Rossell, & Kordzadze, 2014; Pedersen & Rist, 2001) coupled with impaired explicit memory (Neill et al., 2014; Song, Kim & Kim, 2011). For instance, Neill et al. (2014) showed that automatic memory processes in high and low schizotypy groups were similar, whereas there was a reduction in the controlled memory processes in the high schizotypy group. According to Burch, Hemley, Corr and Gwyer (2006), higher levels of automatic processes should be observed specifically in participants manifesting a high level of unusual experiences (positive symptoms).

However, these studies postulate that memory tasks can assess pure processes (i.e., either automatic or controlled). According to Jacoby, Toth, and Yonelinas (1993), it is intrinsically mistaken to consider that a task depends only on automatic or only on controlled processes. On the contrary, both processes are necessarily involved in all memory tasks and it is possible

## Impaired conscious memory in schizotypy

to assess their respective involvement. Jacoby (1991) proposed a procedure for doing this: the Process Dissociation Procedure (PDP). Basically, this procedure compares participants' memory performances in two conditions that differ only in the instructions given to them. Both conditions contain a learning phase (e.g., items in a word list) and a production phase (e.g., word stem completion) and the measured performance corresponds to the implicit or explicit production of items. In the first condition, called 'inclusion', participants have to complete the stem using either the word presented during the learning phase or the first word that comes to mind. This condition is a facilitation condition since the target can be recalled on the basis of either Controlled (C) or Automatic (A) processes. The inclusion condition is therefore described by the following equation:  $INCLUSION = C + A(1 - C)$ , where C and  $A(1 - C)$  correspond to the probability of recollecting controlled and automatic information, respectively. In the second condition, called 'exclusion', participants are asked to complete the stem but without using (i.e. inhibiting) the words presented during the learning phase. This condition is an interference condition since processes act in opposition. Exclusion performance can thus be described by the formula  $EXCLUSION = A(1 - C)$ . From these two equations, we can derive an estimate the prevalence of controlled processes as  $C = INCLUSION - EXCLUSION$  and of automatic processes as  $A = EXCLUSION / (1 - C)$ .

Besche-Richard, Passerieux, Nicolas, Laurent, and Hardy-Baylé (1999) used the PDP in the context of schizophrenia. They showed that, in comparison with controls, schizophrenia patients presented preserved automatic processes and impaired controlled processes. They proposed two explanations to account for their results: 1) the schizophrenia patients were not able to reach the level of awareness needed for controlled processes to occur and/or 2) they presented difficulties in encoding contextual information and were therefore unable to realize that the items had been presented during the learning phase. Linscott and Knight's (2001) study also showed the impairment of controlled processes in schizophrenia. Beyond impaired

## Impaired conscious memory in schizotypy

controlled processes, Linscott and Knight (2001) showed that automatic processes were mobilized more frequently in schizophrenia participants than in healthy participants. The authors hypothesized that automatic processes are amplified in schizophrenia. These results contrast with those obtained in Besche-Richard et al.'s (1999) study, in which no increase in automatic processes was observed.

The current study has two aims. First, we want to further explore memory process dissociation in schizotypy. Indeed, although the examination of memory process dissociation in schizotypy might be able to provide evidence both about the possibility of it constituting a vulnerability factor for schizophrenia and about why memory dissociations in schizophrenia cannot be explained by other factors, such as medication, only one study has explored this issue: in a study of schizotypy, Linscott and Knight (2004) obtained similar results to those they observed in schizophrenia (i.e., potentiated automatic processes). Second, we want to determine whether specific symptoms are more closely associated with memory dysfunctions.

## **Methods**

### *Participants*

Fifty-seven undergraduate students were recruited at the University of Reims Champagne-Ardenne. All the participants were native French speakers. Given that depression and anxiety influence memory results (e.g., Tarsia et al., 2003), we measured the levels of both of these. To measure depression, we used the Beck Depression Inventory (BDI-13, Beck, 1974). The usual cutoff score for this test was 14 (Vinamaki et al., 2004). To measure anxiety, we used the State-Trait Anxiety Inventory Form Y (STAI-Y, Spielberger, 1983). The usual cutoff for this test is 58 (women) and 55 (men) for the state anxiety and 59 (women) and 57 (men) for the trait anxiety for young adults (Gauthier & Bouchard, 1993). In addition, all the participants completed a self-report questionnaire and reported no current or past history of

## Impaired conscious memory in schizotypy

neurological illness or drug consumption. One of the participants was excluded due to severe depression (BDI = 21).

The participants were volunteers who completed and signed a consent form. The study was designed in accordance with the Declaration of Helsinki.

The socio-demographic and clinical characteristics of the participants are presented in Table 1.

### *Material and Procedure*

*Schizotypal Personality Questionnaire (SPQ, Raine, 1991)*. This questionnaire is a validated self-report scale assessing the global level of schizotypy. This scale contains 74 yes/no items, with one point being awarded for 'yes' answers and 0 points being awarded for 'no' answers. The scale makes it possible to assess the three main dimensions of schizotypy (Reynolds, Raine, Mellinger, Venables, & Mednick, 2000): positive, negative and disorganized. Each of these dimensions encompasses different features. The positive dimension consists of measures of Ideas of Reference (IoR), Odd Beliefs or Magical Thinking (OBMT), Unusual Perceptual Experiences (UPE) and Paranoid Ideation (PI). The measures on the negative dimension include Excessive Social Anxiety (ESA), No Close Friends (NCF) and Constricted Affect (CA), while the measures on the disorganized dimension are Odd or Eccentric Behavior (OEB) and Odd Speech (OS).

*Process Dissociation Procedure (PDP)*. To run the PDP, we used the same material and procedure as Besche et al. (1999). We have first chosen 16 different categories (i.e., four-footed animals, clothes, tools, birds, colors, kitchen utensils, fruits, drinks, vegetables, professions, parts of the human body, flowers, insects, pieces of furniture, trees, fishes). For each of these categories, five words were selected, for a total of 80 different items. In order to avoid the prototype effect, the items did not include any of the ten most frequent category exemplars according to French category tables (Charles & Tardieu, 1977).

## Impaired conscious memory in schizotypy

From the 16 categories, eight were used during the inclusion condition and the other eight were used during the exclusion condition, which means that 40 items were used during the inclusion condition and 40 items were used during the exclusion condition.

During the inclusion condition, the participants had to hear some sentences and they had to detect grammatical errors inserted in each of them. Altogether, there were 25 sentences.

Among these 25 sentences, 20 contained a target word coming from one of 4 categories.

Concerning the 5 last sentences, buffer words were used in the first 2 and the last 3 sentences to avoid primacy and recency effects. The sentences were presented randomly. The test phase consisted of a category-production task: the participants had to produce 6 exemplars from 8 different categories. Four of these categories were the categories used during the learning phase, while the other four were filler categories that were not used during the learning phase. The participants did not hear or see any reference to the learning phase. In order to ensure that the participants understood the instructions, the test phase started with a practice category (i.e., 'family').

In the exclusion condition, the participants had to produce a meaningful sentence including a presented word. Among the 25 presented words, 20 came from four categories that were not used during the inclusion condition. The last five items were buffer words, used similarly to the inclusion phase. The test phase was similar as the test phase during inclusion condition, except that participants were given one more instruction, namely that they had to avoid producing the words that they had used during the sentence production phase.

Given that the learning phase was referred to only during the test phase of the exclusion condition (and thus not in the inclusion condition), the test phase always started with the inclusion condition. Finally, a recognition task involving 32 words (8 from the inclusion condition, 8 from the exclusion condition and 16 new words) was administered. The participants had to say which words had been presented in the study lists.

## Impaired conscious memory in schizotypy

*Binois and Pichot's (1958) Vocabulary test.* This 44-item test assesses the level of vocabulary. Each item scored 1 point if the participant underlined the synonym of a word out of a choice of six items. This test was used in order to ensure that differences in recall could not be attributed to differences in vocabulary knowledge, since the items that we used in the PDP task were not the most prototypical of their categories and might therefore not have been as well known among individuals with poorer vocabulary knowledge.

The tests were administered in the following order: clinical scales, PDP inclusion condition (learning and test phases), vocabulary test, PDP exclusion condition (learning and test phases), and PDP recognition task. The procedure is summarized in Figure 1.

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INSERT FIGURE 1 ABOUT HERE  
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### *Data analysis*

The prevalence of the controlled and automatic processes was calculated on the basis of Jacoby's (1991) equations. We performed hierarchical multiple regression analyses on the SPQ total score. We then performed Bravais-Pearson correlations between the memory processes and SPQ total score and sub-scores. Analyses were performed with R (package QuantPsyc, psych, boot and WRS).

## **Results**

### *Descriptive analysis*

We calculated the level of schizotypy (SPQ total score), depression (BDI-13), state-anxiety (STAI YA), trait-anxiety (STAI YB), and vocabulary (vocabulary test mean). The results of these analyses are summarized in Table 1.

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INSERT TABLE 1 ABOUT HERE

*Memory processes and schizotypy*

In order to determine whether the level of schizotypy had an impact on automatic and controlled memory processes, we performed two-step hierarchical multiple regression analyses on the SPQ total score. In order to ensure that our results were not due to non-controlled variables, we forced the depression level (BDI total score), the anxiety level (both STAY-A and -B) and the vocabulary knowledge in the first step of the analyses. Both controlled and automatic memory processes were then included during the second step. In order to avoid false discovery results, we also performed robust analyses (i.e., adjusted bootstrap percentile on the regression  $bs$ , Wilcox, 2005) and used the Bonferroni correction to determine the significance of the  $p$ -value (which means that we considered a variable as being significant at  $0.05/6 = 0.0083$ ). These analyses revealed that the inclusion of memory processes significantly improved the model,  $F(2, 49) = 4.75, p = .01, \Delta R^2 = 0.09$ . These analyses revealed that controlled processes significantly decreased when schizotypy increased, while automatic processes did not seem to be related to the schizotypy level.

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INSERT TABLE 2 ABOUT HERE

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It could be argued that this dissociation can be attributed to differences in the acquisition of the knowledge. In order to exclude this possibility, we performed correlation analyses between the recognition task and both the SPQ total score and controlled memory processes. Neither of these correlations was significant, suggesting that the decrease in controlled processes is not the consequence of poorer learning abilities.

*Memory processes according to schizotypy profile*

## Impaired conscious memory in schizotypy

In order to determine whether controlled memory processes decrease with the level of schizotypy in general, or whether some more specific aspects of schizotypy are associated with this cognitive specificity, we performed Bravais-Pearson correlations between the controlled memory processes and the SPQ total score and sub-scores. Given that depression was a significant predictor of schizotypy level, we controlled this variable by using partial correlations. We applied Holm's correction in order to control for false discoveries. These analyses confirmed that a high schizotypy level (SPQ total) was associated with a cognitive style based more on automatic than on controlled processes,  $r = -0.43$ ,  $r^2 = .185$ ,  $p < .01$ . As found in previous studies (Burch et al., 2006), the cognitive-perceptual factor was significantly related to the memory processes,  $r = -0.31$ ,  $r^2 = .09$ ,  $p = .02$ . Moreover, the disorganized factor was also related to the decrease in controlled memory processes,  $r = -0.34$ ,  $r^2 = .116$ ,  $p = .01$ . Finally, among the 9 subscales of the SPQ, it appears that two were significantly associated with a decrease in controlled memory processes: namely, the IoR ( $r = -0.43$ ,  $r^2 = .185$ ,  $p < .01$ ) and OEB sub-scores ( $r = -0.37$ ,  $r^2 = .167$ ,  $p = .01$ ).

## Discussion

The results of the current study provide some support to the fact that controlled memory processes are impaired in high level of schizotypy while automatic memory processes does not seem influenced by schizotypy in non-clinical individuals. The aim of the current study was to further explore cognitive vulnerability to schizophrenia in a non-clinical sample according to the level of schizotypy and, more specifically, to determine whether, as in schizophrenia (e.g., Besche et al., 1999), the controlled processes of high schizotypy individuals are less efficient than those of low schizotypy participants, and whether at least the automatic processes are preserved in these high schizotypy individuals.

The same contrast that has been observed in schizophrenia between Linscott and Knight's (2001) study and Besche-Richard et al.'s (1999) study has also been observed in schizotypy

## Impaired conscious memory in schizotypy

between Linscott and Knight's (2004) and our study. Linscott and Knight (2004) showed that automatic memory processes were potentiated in schizotypy, while we showed that controlled memory processes were impaired in schizotypy. These little discrepancies could be due to the task that was used. Although Linscott and Knight (2004) emphasized the crucial difficulty of comparing contradictory results between studies which have used different tasks, we believe that these results are not necessary incompatible. Overall, they suggest that a high level of schizotypy may be associated with reduced controlled memory processes and enhanced automatic memory processes.

If we consider that impaired controlled memory processing is specific to the cognitive profile observed in schizophrenia (Besche-Richard et al., 1999; Linscott, 2001), the current study would show that schizotypy is also associated with a reduction in the efficiency of controlled memory processes, even though these results cannot be attributed to psychotropic treatment.

In this context, it is possible to consider that schizotypy is a marker of vulnerability to schizophrenia (Laurent et al. 2001; Linscott & Knight, 2004), and that impaired controlled processes could represent a cognitive factor indicating a risk of developing schizophrenia. In this research, we have emphasized some cognitive features present in the milder forms of the schizophrenia continuum. In order to better understand the relationships between this cognitive specificity and the schizophrenia continuum, future research should compare the extent of the switchover from controlled to automatic processes between non-clinical schizotypy, individuals with schizotypal personality disorder and schizophrenia. In other words, it is necessary to examine whether this relationship is linear or involves an asymptotic switchover.

In terms of processes, our results can be explained as the consequence of either a memory or an inhibition impairment. Indeed, the efficiency of controlled process partially depends on the participant's strategies: An active memory recollection of the encoding context is needed to

## Impaired conscious memory in schizotypy

perform the exclusion task. Given that schizophrenia patients are known to exhibit difficulties in the conscious retrieval of the encoding context (Besche-Richard et al., 1999; Wang et al., 2010), we hypothesize that participants presenting higher levels of schizotypy would exhibit the same difficulties. Although the presentation of semantic categories might have helped the participants to consciously retrieve the target items, this retrieval would not be sufficiently conscious to prevent them from generating target items during the exclusion phase. When recollection is efficient, participants still have to inhibit the production of the corresponding item during the exclusion phase. Consequently, participants with lower inhibition abilities (i.e., high schizotypy participants) would find it more difficult to exclude the answer induced by the automatic processes, thus explaining why they continued to produce the target items. If we consider that our results can be explained in terms of an impaired recollection of the encoding context, we have to discuss the fact that the difference in memory processes along the schizotypy continuum seems to have been more pronounced in the controlled processes in our study (see also Besche-Richard et al., 1999; Song, Kim, & Kim, 2011), whereas it appeared to be more pronounced for the automatic processes in Linscott and Knight's (2004) study. We hypothesize that these discrepancies are related to methodological issues. More specifically, we suggest that differences in semantic saliency could explain these differences. Indeed, Neill and Rossell (2012) reported that the priming effect decreased in schizophrenia when semantic relatedness increased (see also Pomarol-Clotet et al., 2008). Using a trigram stem completion task, Linscott and Knight (2004) ensured that there was only a low level of relatedness between the encoding and the retrieval phases, since their task was more perceptual than semantic. In the current study, the semantic categories experienced during the test phase could be used as semantic cues. Overall, our results, taken together with those of Linscott and Knight (2004), confirm that high semantic relatedness is associated with lower

## Impaired conscious memory in schizotypy

controlled recollection, while low semantic relatedness leads to higher automatic retrieval in high schizotypy participants.

Beyond the fact that high schizotypy participants might rely less on their controlled memory processes and perhaps more on their automatic memory processes, our results showed that this decrease in controlled memory processes is mainly associated with two specific subscales (perceptual-cognitive, disorganization) and, in parallel, with two types of symptoms (Idea of Reference – IoR - and Odd or Eccentric Behavior - OEB). As far as the perceptual-cognitive factor (positive symptoms) is concerned, IoR corresponds to a person's erroneous belief that all events in his/her environment involve him/her. This erroneous interpretation can be considered as a cognitive bias. Indeed, Kazes et al. (1999) reported a negative correlation between the involvement of conscious processes and positive symptoms in schizophrenia. With regard to the relationship between the decrease in controlled memory processes and disorganization, and more specifically OEB (i.e., behaviors such as odd or eccentric ways of dressing), we can hypothesize that, in the case of disorganized schizotypy, this is linked with working memory deficits (Kerns & Becker, 2008). The fact that disorganized schizophrenia is also associated with working memory and impairments to executive functions might provide support for this hypothesis. This view is also corroborated by Cochrane, Petch and Pickering's (2012) study of schizotypy, in which they showed that disorganization is associated with a decrease in negative priming (i.e., decrease in inhibition and reduced involvement of conscious processes). Thus, this association may be explained by the fact that their participants might have experienced difficulties in performing strategic processing (i.e., working memory and strategic encoding) and were thus forced to rely on automatic processes when performing memory tasks.

## Impaired conscious memory in schizotypy

In conclusion, by exploring a non-clinical sample of participants along the schizotypy continuum, the current study supports the idea that impaired controlled processes are an early cognitive marker of vulnerability to schizophrenia. Our results indicate that increased schizotypy is associated with a decrease in controlled processes in memory tasks, and that this finding is particularly true for the IoR and OEB subscales of the SPQ. We emphasize the importance for future research into schizotypy as a vulnerability factor for schizophrenia of dissociating carefully between each of the features characterizing schizotypy rather than considering it as a whole.

Impaired conscious memory in schizotypy

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## Impaired conscious memory in schizotypy

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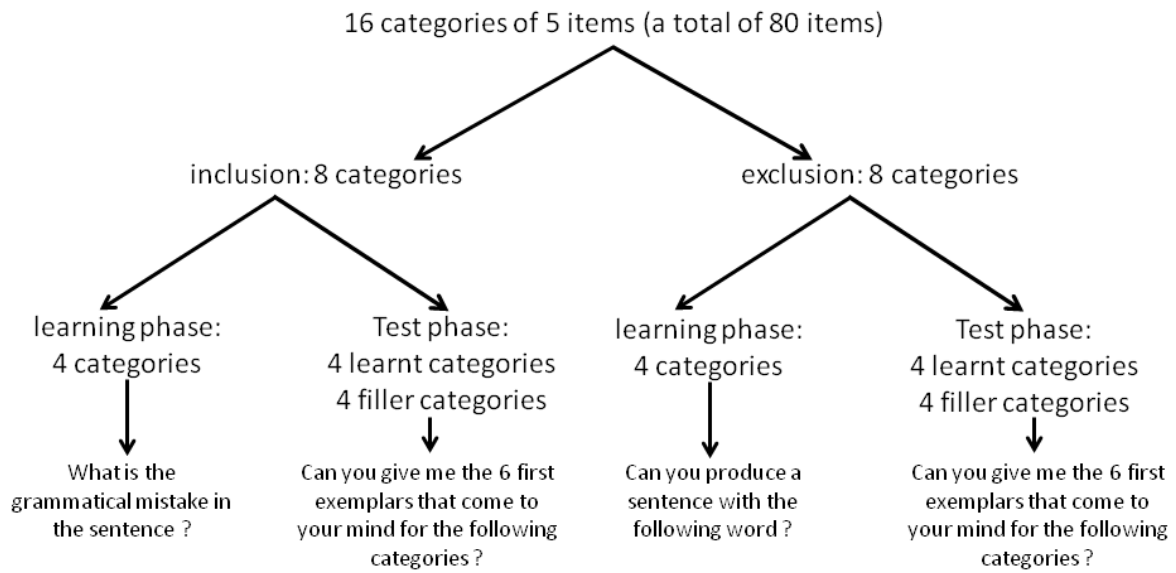
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**Figure 1.** Summary of the procedure.

**Table 1**

Socio-demographic and clinical characteristics for the whole sample.

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	Mean $\pm$ S.D. (n = 56)
Age	22.04 $\pm$ 2.78
Education (number of years)	14.2 $\pm$ 1.5
Total SPQ score	21.64 $\pm$ 10.17
Total BDI-13	4.59 $\pm$ 4.16
Total STAI-A	32.18 $\pm$ 10.26
Total STAI-B	42.95 $\pm$ 10.19
Vocabulary level	25.86 $\pm$ 4.87

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Note. *p*-values correspond to Student's *t* test probability.

**Table 2**

Hierarchical linear multiple regression of memory processes on the Schizotypal Personality Questionnaire. In this table, b represents the parameter, BCa represents the 95% adjusted bootstrap confidence interval,  $\beta$  represents the standard parameter,  $\Delta R^2$  represents the difference in  $R^2$ , t represents the t-test value, and p the probability of the t-test.

	b	BCa	$\beta$	$\Delta R^2$	t	P
First step						
BDI total score	1.32	0.68 to 1.97	.54	.40	3.57	<.001
STAI Y-A total score	-0.07	-0.34 to 0.20	-.07	<.01	0.58	.56
STAI Y-B total score	0.08	-0.20 to 0.34	.08	.02	0.55	.58
Binois and Pichot's	0.07	-0.38 to 0.50	.04	.01	0.31	.75
Vocabulary test						
Second step						
Controlled memory processes	-0.42	-0.64 to -0.20	-.34	.09	3.07	.003
Automatic memory processes	-0.15	-0.67 to 0.35	-.06	<.01	0.57	.57