Confusing Action and Imagination

Action Source Monitoring in Individuals With Schizotypal Traits

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Abstract: To explore whether schizotypal traits may undermine source monitoring for actions, 67 undergraduate participants (21 men) completed the Schizotypal Personality Scale and were then given a source-monitoring task in which some specific acts had to be performed, whereas others only had to be imagined. Next, participants had to complete an old-new recognition task and ascribe the source, i.e., whether they had performed or only imagined the items (i.e., source monitoring). Participants also completed a working memory capacity task (i.e., Operation Span task). We found that the higher the Schizotypal Personality Scale scores, the poorer recognition and source attribution scores. Relative to participants with low levels of schizotypal traits (i.e., controls), those with higher levels of schizotypal traits more often falsely claimed to have performed actions when in fact they had only imagined them. Although participants high and low in schizotypical traits did not differ in their working memory capacity, poor working memory capacity was related to source misattribution (i.e., increase false alarms). The present findings indicate that schizotypal traits undermine source monitoring for action in a healthy population.

Key Words: Schizotypal traits, source monitoring, memory, working memory, nonclinical.

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Most people have occasionally experienced difficulties in determining whether they have actually performed an action or only thought about performing that action in the past (Anderson, 1984; Johnson et al., 1993). However, such source monitoring difficulties (i.e., source misattributions) are especially prominent in schizophrenia (e.g.,Brébion et al., 2000). Indeed, a number of recent studies have consistently shown that schizophrenic patients tend to make internal-internal source misattributions (e.g., claiming that you have said something when in fact you only thought about saying it; Nienow and Docherty, 2004) and internal-external source misattributions (e.g., claiming that you did something when in fact someone else did it; Moritz et al., 2003). In an attempt to explain these memory aberrations in schizophrenia, Brébion et al. (2005) found that such source misattributions are related to the presence of positive symptomatology (e.g., hallucinations).

When conceptualizing schizophrenia in terms of a continuum model (Claridge, 1997), it is an interesting question to ask whether source misattributions are also present in participants with high albeit nonclinical levels of schizotypal traits. Remarkably, little is known as to whether these schizotypal traits are related to a heightened susceptibility to source misattribution. Recently, Larøi et al. (2005) found that nonclinical individuals with hallucination proneness (measured by the Launay Slade Hallucination Scale; Launay and Slade, 1981) were more prone to make source misattributions. This is a first indication that these nonclinical schizotypal traits may lead to a perturbation in the control of internally generated cognitive events and thus could inform theories about how people make accurate source monitoring decisions (Johnson et al., 1993). These theories stress that encoding of perceptual features is necessary for correct source attribution at retrieval. The presence of nonclinical schizotypal traits may thus lead to problems in encoding or retrieving distinctive perceptual features of to-be-remembered events, thereby contributing to source misattributions.

A facet of memory that is related to source monitoring is working memory capacity (WMC). As said before, the source-monitoring framework (Johnson et al., 1993) assumes that the encoding of perceptual details is critical for subsequent correct source-monitoring decisions. Watson et al. (2005) but also Peters et al. (2007) reported that WMC is an important antecedent of the encoding of perceptual details. These studies employed the Deese/Roediger-McDermott paradigm (Deese, 1959; Roediger and McDermott, 1995). In this paradigm, participants are asked to remember lists of semantically related words, such as bed, nap, pillow, and snooze, all of which are associated with a theme word, in this particular example the word sleep. This theme word is never presented and serves as a critical lure during recall/recognition. Both Watson et al. (2005) and Peters et al. (2007) found that undergraduates with low WMC were more prone to make source misattributions as measured by an increased tendency

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to recall or recognize nonpresented critical lure words. Because prominent WMC deficits in all modalities have been documented in schizophrenia (see for a recent meta-analysis Lee and Park, 2005) and clinical high-risk populations (i.e., prodromal schizophrenia; Lencz et al., 2006), an interesting question to raise is whether poor WMC is also present in healthy participants with high levels of schizotypal traits and whether this may also be related to source misattributions.

Many source monitoring studies have relied on word list paradigms (e.g., Deese/Roediger-McDermott paradigm; cf. supra). Some have argued that the generalizibility to real-life situations of such paradigms is limited (Henquet et al., 2005; Parks, 1997). Recent studies by, for example, Hornstein and Mulligan (2004) and Larøi et al. (2005) offer more naturalistic source monitoring paradigms. In these studies, simple actions were either performed or imagined, followed by a source-monitoring task.

The aims of the present study were 2-fold. Firstly, we wanted to examine whether source misattributions are related to schizotypal traits in a nonclinical sample. To this end, we employed an action source-monitoring task based on an adapted procedure described by Parks (1997) in which simple actions either had to be performed or imagined. We hypothesized that participants with high levels of schizotypal traits would make more source misattributions compared with those low in schizotypal traits. A second aim was to explore whether poor WMC could account for source misattributions in participants with schizotypal traits.

METHODS

Participants

Sixty-seven undergraduate students (21 men) from Maastricht University and Hogeschool Zuyd volunteered to participate in the study. No incentive was offered for participation. Exclusion criteria were diagnosis of a psychiatric disorder in the past 3 years, history of neurological deficit (e.g., traumatic brain injury), and substance abuse. Two participants were excluded; 1 participant did not complete the schizotypal trait questionnaire, and the other participant did not understand the source-monitoring task. The final sample consisted of 65 participants. Their mean age was 21.01 years ($SD = 2.08$), with no significant differences between male and female participants [$t\ (63) = 1.31$, $p > 0.05$], means being 21.55 ($SD = 2.26$) and 20.81 ($SD = 1.98$), respectively. The study was approved by the standing ethical committee of the Faculty of Psychology of Maastricht University.

Materials and Procedure

Participants were tested individually in a quiet laboratory room. Upon arrival, participants were asked to sign an informed consent form. Instructions, description of action items, and stimulus materials were given on paper (questionnaire and recognition task) or on a computer screen (action source-monitoring task and operation span task).

The study involved 2 sessions, with approximately 24 hours between sessions. All participants were naive as to the purpose of the study. The study was presented as one in a series of studies investigating the relationship between cognitive functions, personality characteristics, and learning of simple motor actions. During the first session, participants completed the Schizotypal Personality Scale (STA) (Claridge and Broks, 1984) and were administered a working memory capacity task (Operation Span task; Engle et al., 1992; Turner and Engle, 1989). Participants were also given the study phase of the action source-monitoring task. Tasks were counterbalanced to exclude order effects. The second session consisted of a surprise recognition task that took place 24 hours after the initial study phase.

Schizotypal Personality Scale

The STA questionnaire (Claridge and Broks, 1984; Cronbach's $\alpha = 0.86$) is designed to measure schizotypal traits in normal (healthy) populations. The STA consists of 37 dichotomous items that are closely related to the DSM-III-R criteria description of schizotypal personality disorder. This scale has been found to load on the "positive" symptoms factor of schizotypy, a factor that primarily consists of unusual perceptual experiences and psychotic-like ideation (Bentall et al., 1989; Rawlings et al., 2001). A sample item is "Are you sure that other people can tell what you think?" Total STA score is obtained by summing up "Yes" answers across all items. High scores indicate higher frequencies of nonclinical schizotypal traits (positive symptomatology).

Operation Span Task (O-Span)

The O-Span task (Engle et al., 1992; Turner and Engle, 1989) is a measure of complex working memory capacity. The present study employed Engle et al. (1992) version. During this task, participants are presented with operation-word pairs (i.e., operation strings). The operation part is a mathematical equation that the participant has to read aloud. The mathematical equation consists of 2 simple operations: a multiplication or division problem and an addition or subtraction problem. An example would be $(8/4) + 5 = 7$. Next, he or she has to verify whether the solution that is offered for the equation is correct or incorrect. Participants are not allowed to use pencil or paper or to make the intermediate calculations aloud. When the participant has given an answer to the equation, he or she has to read aloud the to-be-recalled word that is shown immediately after the equation and to press the space bar as quickly as possible. Following this, another operation string appears. The number of operation strings (set size) within a trial increases from 2 to 5. Every set size is employed thrice. Set size is varied pseudorandomly. Three practice trials are presented, each containing 2 operation strings. The O-Span task consists of 12 trials. At the end of each trial, the participant is presented with 3 question marks centered on the screen. They are then asked to write down in correct order the words that followed the operation strings.

O-Span score was calculated according to the partial-credit unit-weighted procedure as described in Conway et al. (2005). If accuracy for the processing component (mathematical equation) of the task fell below a certain level (i.e., if participant had fewer then 85% of the equation items correct), his or her O-Span data were excluded (Conway et al., 2005).

Action Source-Monitoring Task

The action source-monitoring task was based on a procedure described by Parks (1997) and replicated by Henquet et al. (2005) in schizophrenic patients. In one of Parks' studies, a card depicting questions (e.g., "When were you born?") was shown to participants for a period of 5 seconds, followed by a blank card for 2 seconds. After this card, participants received the instruction "Answer out loud" on it or a card that gave the following phrase in the series. Participants were instructed to read each card in silence and to be prepared to say the answer out loud without actually verbalizing the words unless they were specifically told to do so. After the study phase and a 5-minute filler task, a forced-choice recognition task was presented. This task consisted of the original questions, each being paired with a new question with similar content, for which participant had to make old-new discriminations and source attributions (i.e., imagined or spoken). In the current paradigm, we replaced the question phrases with descriptions of simple actions that either had to be performed or imagined to be performed. The action items described simple nonintrusive acts like for example "break a toothpick into 3 pieces" and "open a newspaper." The items were derived from previous experiments (Goff and Roediger, 1998; Hornstein and Mulligan, 2004; Larøi et al., 2005). Action items were presented on a 15-inch computer screen using PowerPoint (Microsoft Corporation) with font type "Times New Roman," font size 36.

The action source-monitoring task involved 40 trials. On half of them, single actions were presented. On the other half, 2 actions were presented, with 1 action being located at the top half and the other at the bottom of the screen. The order of single and dual presentation modes was quasirandom and 2 counterbalanced versions were used, to which participants were randomly allocated. After each action presentation, participants had to imagine performing the action(s) presented on the screen. Preparation time varied between participants but never took longer than 8 seconds. When the participant indicated that he or she had imagined the action, a blank screen appeared for 3 seconds. Next, an instruction appeared on the screen indicating "Do" for single action presentations and "Do top" or "Do bottom" for dual action presentations. Thus, for dual action trials, participants had to imagine both actions but actually perform only one. This resulted in 40 performed actions and 20 covertly prepared but nonperformed actions.

In case certain objects or materials were needed to perform the actions (e.g., toothpick, paper, etc.), the experimenter provided participants with them after the imagination period. On the dual action trials, materials to carry out both actions were given. On dual action trials, half of the actions that had to be performed were presented at the top, and the other half at the bottom of the screen. Immediately after the action had been completed, all objects were removed from view. Objects were hidden from the participants' view at all times, except when in use. An experimenter was present to monitor whether participants actually performed the actions. All participants were capable of performing the actions. At the end of the study phase, participants were asked to indicate how easy or difficult it was for them overall to create a mental image for the presented actions based on a 5-point scale, (anchors: 1 = very easy to imagine, 5 = very difficult to imagine).

Recognition Session

During the recognition task, the 60 old action items were paired with 60 new action items that were roughly similar in content and form. For example, "break the toothpick in 3 pieces" was paired with "break the toothpick in 2 pieces." For each pair, the participant was asked to make an old-new discrimination (i.e., correct recognition). Furthermore, when participants classified an action item as old, they had to indicate whether they had performed the actions or only thought about performing these actions (i.e. source attribution).

Statistical Analyses

For all analyses alpha was set at 0.05. Proportion of correct recognition (old-new discrimination) was calculated by dividing the number of correctly identified old items in the recognition test by 60, the total number of old items. Proportion correct source attribution was defined as the number of old items that participants correctly classified as verbalized or covertly prepared divided by 60, the total number of source attributions that had to be made. Moreover, we calculated proportion false alarms (i.e., number of erroneous claims of imagined actions that had been performed divided by 20, which is the total number of imagined actions) and proportion misses (i.e., number of erroneous claims that performed actions had only been imagined divided by 40, which is the total number of performed actions).

To explore the relationships between schizotypal traits, action source monitoring, and WMC, Pearson product-moment correlations (2-tailed) were calculated between STA scores, action source monitoring parameters (i.e., proportion correct recognition, source attribution, false alarms and misses), and O-Span task. Furthermore, following Larøi et al. (2005), participants were grouped according to their STA scores, selecting those participants with the 25% highest (n = 17) and 25% lowest (n = 17) STA scores. Independent samples t-tests were carried out to determine whether these groups differed in action source monitoring parameters and WMC.

RESULTS

Ease of Imagination

Participants rated the imagination difficulty on a 5-point scale. The mean difficulty score was 1.70 (SD = 0.74), which indicates that it was relative easy to imagine the action items. Thus, participants did not have any difficulties in preparing the actions.

STA and O-Span Scores

Mean scores on the STA and O-Span task were 10.11 (SD = 6.09; range = 1–23) and 0.81 (SD = 0.08; range = 0.67–1.00), respectively. These scores are similar to those reported elsewhere (Engle et al., 1992; Muris and Merckel-

TABLE 1. Pearson Product-Moment Correlations Between Schizotypal Personality Scale (STA), Correct Recognition, Correct Source Attribution, False Alarms, and Misses of the Action Source Monitoring Task, and Working Memory Capacity (O-Span Score)

	STA	O-Span[a]
O-Span	−0.09	—
Correct recognition	−0.27*	0.09
Correct source attribution	−0.36†	0.14
False alarms	0.27*	−0.30*
Misses	0.17	−0.01

Only relevant correlations are shown.
*$p < 0.05$.
†$p < 0.01$.
[a]As indexed by partial-credit unit-weighted (PCU) score (Conway et al., 2005).

bach, 2003) for undergraduate students. Distribution of STA and O-Span scores showed no marked deviation from normality (skewness = 0.45 and 0.59, respectively). Men and women did not differ with regard to mean STA and O-Span scores; both *t*'s (63) <1.0, both *p*'s >0.05.

Correct Recognition of Actions

Mean proportion of correct recognition was 0.89 (*SD* = 0.07; range = 0.53–0.98). As Table 1 shows, a significant negative correlation emerged between STA and correct recognition scores ($r = -0.27$, $p < 0.05$), indicating that those with heightened STA scores had poorer memory function. For WMC, correlations with STA and correct recognition remained nonsignificant.

Action Source Monitoring

Overall, participants were quite accurate in their source attributions (*M* = 0.81, *SD* = 0.09; range = 0.45–0.97). Mean proportion false alarms and misses were 0.18 (*SD* = 0.07; range = 0.10–0.40) and 0.09 (*SD* = 0.06; range = 0.00–0.38), respectively. As Table 1 shows, STA scores were negatively related to correct source attribution ($r = -0.36$, $p < 0.01$), indicating that the higher participants scored on STA, the lower their number of correct source monitoring decisions. Conversely, a positive relationship emerged between STA and false alarms ($r = 0.27$, $p < 0.05$). As to the WMC, a significant negative correlation was found between O-span scores and false alarms ($r = -0.30$, $p < 0.05$). All other correlations remained nonsignificant.

Extreme Groups and Source Monitoring

Two extreme subgroups were formed on the basis of their STA scores (Larøi et al., 2005). The subgroup high in schizotypical traits consisted of 17 participants in the top 25th percentile (STA score >16), and the control group (i.e., low in schizotypal traits) consisted of 17 participants who scored in the lower 25th percentile (STA score <5). Participant characteristics for both groups can be found in Table 2. As can be seen, participants in both groups did not differ with regard to age, gender distribution, and O-Span score. Mean score of the group high in schizotypical traits on the STA was 18.53 (*SD* = 2.53), against 3.18 (*SD* = 1.42) for the control group; t (32) = 21.82, $p < 0.001$.

As can also be seen in Table 2, control participants outperformed those high in schizotypal traits on correct recognition and correct source attribution; both *t*'s (32) >2.60, both *p*'s ≤0.01. Thus, participants scoring high on STA were poorer in remembering which actions they had seen 24 hours earlier and they were also impaired in ascribing the correct source for these actions, compared with participants with low STA scores. The effect sizes for these differences (in terms of Cohen's *d*) were in the large to very-large effect size range (both *d*'s >0.90). In addition, participants high in schizotypical traits made more misses and false alarms; both *t*'s (32) >2.00, both *p*'s <0.05. Again, effect sizes were in the large-effect range (both *d*'s >0.78).

DISCUSSION

The main results of the present study can be summarized as follows. Firstly, significant negative correlations were found between STA scores, correct recognition, and source attribution scores, indicating poorer memory functioning and more source misattributions (i.e., false alarms) with increasing levels of schizotypal traits in healthy undergraduates. Secondly, this conclusion is further substantiated by extreme group analyses based on STA scores. These analyses showed that participants high in schizotypical traits performed poorly in correctly recognizing previously presented

TABLE 2. Demographic, STA, and Memory Data of Participants High in Schizotypal Traits and Control Participants

	High Schizotypal Trait Participants (n = 17)	Control Participants (n = 17)	Statistics
Age	21.41 (1.58)	21.12 (2.23)	t (32) = 0.44; NS
Gender (men/women)	5/12	6/11	χ^2 (1) = 0.13; NS
Average STA score	18.53 (2.53)	3.18 (1.42)	t (32) = 21.82; $p < 0.001$
Average O-span score	0.80 (0.09)	0.81 (0.05)	t (32) = 0.20; NS
Correct recognition	0.87 (0.06)	0.92 (0.05)	t (32) = 2.60; $p = 0.01$
Correct source attribution	0.77 (0.09)	0.86 (0.06)	t (32) = 3.46; $p < 0.01$
False alarms	0.21 (0.07)	0.16 (0.06)	t (32) = 2.08; $p < 0.05$
Misses	0.10 (0.06)	0.06 (0.04)	t (32) = 2.20; $p < 0.05$

Standard deviations are given in parentheses.

actions (Laws and Bhatt, 2005). Furthermore, in line with prior research (Larøi et al., 2005), compared with controls, high STA participants made more erroneous claims of imagined actions as performed and vice versa. This shows that high levels of schizotypal traits are not only associated with poor recognition memory, but also with a profound tendency to make source misattributions. On the other hand, participants with high and low levels of schizotypal traits did not differ in their scores on the working memory indices. Meanwhile, working memory was negatively related to source misattributions, in that low WMC was accompanied by an increase in false alarms (i.e., claiming that one performed an action when, in fact, it was only imagined).

We found that participants high in schizotypal traits exhibited a deficiency in internal source attribution (e.g., "did I do this or did I only imagine this?"), which is in line with the results of Larøi et al. (2005), who found that hallucination-prone (i.e., nonclinical positive symptomatology) participants made significantly more internal source misattributions. Moreover, we also showed that high schizotypal and control participants did not differ in their working memory performance. In line with these findings, Lenzenweger and Gold (2000) also failed to find specific working memory disruptions in schizotypal trait individuals. How can these results best be explained? One important prerequisite for efficient source monitoring is the encoding and/or retrieval of a sufficient amount of perceptual detail and contextual information (Johnson et al., 1993). It is plausible to assume that carrying out an action offers more perceptual, sensory, and spatiotemporal information than just imagining actions. Thus, in the former case, the production of a distinct memory trace is more probable. Perhaps, then, specific cognitive and/or personality factors (but not working memory) contribute to difficulties in encoding and retrieving such action information in participants with high levels of schizotypal traits, thereby making the memory traces of these actions less distinctive, which, in turn, could lead to source misattributions.

During encoding, perceptual and contextual features of an experience (e.g., performing a specific action) need to be bound together efficiently. WMC is a necessary function for holding these memory representations online, updating, assigning memory for temporal order, manipulating information, and selective attending to-be-stored information during encoding. In the present study, we found a significant negative association between working memory and false alarms. These findings underscore previous findings of Watson et al. (2005) and Peters et al (2007) showing a robust relationship between (poor) working memory capacity and (poor) source monitoring performance. One explanation for the intimate link between working memory and source monitoring is that poor working memory restricts the encoding of distinctive information. This, in turn, may interfere with source monitoring during retrieval.

During retrieval, the encoded memory representations need to be retrieved and source monitoring decisions must be made to discriminate between previously executed actions and imagined actions. Therefore, inhibition of irrelevant information (e.g., fantasizing about imagined actions) is needed. Interestingly, previous studies have found that participants with high levels of schizotypal traits show difficulties in actively inhibiting irrelevant information (e.g., Moritz and Mass, 1997). Thus, participants high in schizotypical traits may be inundated with an increased array of percepts or "loose" associative (i.e., fantasizing) links. Failing inhibition then leads to increased reliance on these general similarities or fantasies, which may provide optimal conditions for source misattributions to arise. More specifically, a source misattribution and, in particular, a tendency to treat imagined events as having a real/performed origin (i.e., false alarm) may convey a sense of realness to unusual sensations, paranoid ideation, and idiosyncratic beliefs and perceptions. In this way, source misattributions arise between internal experiences that are tagged with "nonself" characteristics. This line of reasoning may also apply to explaining paranormal experiences which are often reported in relation to schizotypal traits (e.g., Goulding, 2004; Lange and Houran, 1998).

Another related possibility is that, compared with others, individuals with high levels of schizotypal traits deeply encode the characteristics of imagined actions, which could also lead to source misattributions. One argument in favor of this possibility is that schizotypy and fantasy proneness overlap substantially (e.g., $r = 0.60$; Merckelbach et al., 2000). Fantasy prone individuals tend to have very intense and detailed imaginations, and this can contribute to source misattributions.

Our findings may have relevance to schizophrenia spectrum disorders. However, caution must be exercised when linking the present results to, for example, people with schizotypal personality disorder, prodromal individuals, or schizophrenic patients. That is, relations between schizotypal traits, schizotypal personality disorder, prodrome, and schizophrenia are complex and findings are mixed in the literature. Thus, cognitive impairments in people with nonclinical schizotypal traits are very different from those in schizophrenic patients with distinct aetiologies and prodrome states, as was the case for working memory capacity difficulties in our study (e.g., Lee and Park, 2005; Lencz et al., 2006; Lenzenweger and Gold, 2000). Furthermore, the participants in our study were not prodromal individuals, nor did they show clinical symptomatology. As it stands, the connection between schizotypal traits and schizophrenia spectrum states is not fully understood. Future research could shed light on this relationship, thereby including larger and more diverse samples for a direct comparison between the groups in question.

In sum, then, our data as well as those of others (e.g., Larøi et al., 2005) clearly imply that people high in schizotypal traits have profound source monitoring difficulties, but why this is the case remains unclear. Future studies should focus on whether encoding deficiencies, inhibition difficulties, or intense imagination related to fantasy proneness underlies this phenomenon. One limitation of the current study is that it relied on a homogeneous sample of undergraduates. Another limitation is that it did not include further personality measures or cognitive indicators such as fantasy proneness, thought action fusion, inhibition, etc. Follow-up studies relying on larger heterogeneous samples and fantasy proneness and inhibition measures would be able to disentangle the antecedents of source misattributions in participants with high levels of schizotypal traits.

In conclusion, the present study found evidence of poor correct recognition and source monitoring in individuals high in schizotypal traits. Our results are, however, silent about the causal status of source monitoring, which can best be established in future longitudinal studies.

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