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Source monitoring for actions in hallucination proneness

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Introduction. In the present study we explored the role of cognitive factors in hallucinatory proneness by utilising an incidental source monitoring task consisting of actions.
Method. A total of 65 normal subjects were administered a source monitoring task and were asked either to: (1) perform the action; (2) watch the experimenter perform the action; (3) imagine him/herself performing the action; (4) imagine the experimenter performing the action; (5) or listen to the experimenter say the action verbally. Following a delay, actions were presented consisting of those already presented in one of the 5 conditions (old), and those never before presented (new). For each action, subjects were required to identify if the action was old or new. If the action was identified as old, subjects were required to identify the source of the word (i.e., one of the 5 conditions). Subjects also completed a questionnaire assessing metacognitive beliefs. Subjects were grouped according to their scores on a revised and elaborated version of the Launay-Slade Hallucinations Scale (LSHS). Those with scores within the top 25% were included in the hallucination-prone group (HP) (n = 16), whereas scores within the lower 25% were included in the nonhallucination-prone group (NHP) (n = 16).
Results. Within the internal conditions, hallucination-prone subjects confused two internal sources (a specific internal-internal source discrimination error). That is, for imagined actions where the subjects performed the action, HP subjects

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erroneously attributed these towards an imagined action performed by the experimenter. Results also revealed that hallucination-proneness was associated with metacognitive beliefs. Finally, there was a significant relation between certain metacognitive beliefs and the internal-internal source discrimination error on the source monitoring task.

Conclusions. Findings from the present study suggest that an important cognitive deficit in the genesis of hallucinations may be a perturbation in the control of internally generated cognitive events.

Recent studies have suggested that an important cognitive process involved in hallucinations may be source monitoring, or the ability to attribute the origin of information (Johnson, Hashtroudi, & Lindsay, 1993). More precisely, Bentall (1990) has proposed a model in which hallucinations are explained by an impairment in a specific aspect of source monitoring, namely the ability to discriminate between real and imagined events (reality monitoring). In particular, a number of studies have repeatedly shown that hallucinations may be a function of an external attributional bias for internal events in schizophrenic patients (Bentall, Baker, & Havers, 1991; Bentall & Slade, 1985; Blakemore, Smith, Steel, Johnstone, & Frith, 2000; Brébion et al., 2000; Johns & McGuire, 1999; Johns et al., 2001; Morrison & Haddock, 1997; Rankin & O'Carroll, 1995) and in nonclinical subjects (hallucination-prone) (Bentall & Slade, 1985; Larøi, Van der Linden, & Marczewski, in press-a; Rankin & O'Carroll, 1995). As the majority of these studies reveal significantly greater reality monitoring errors for self-generated items, source monitoring errors in the context of hallucinations may be viewed as a particular difficulty in the management of internal information or as a perturbation of the control of internally generated material. However, previous studies have not adequately examined this supposition. This is related to the fact that few studies include an examination of the role of multiple internal sources on source monitoring functioning. Indeed, the majority of studies typically include only one internal source. Furthermore, this single source often consists of verbal stimuli (e.g., words) that are produced orally by the subject.

Another possible contributing factor in hallucinations may be metacognitive beliefs, or the beliefs one has concerning own thought processes. Morrison, Haddock, and Tarrier (1995) have argued that metacognitive beliefs that are inconsistent with intrusive thoughts (e.g., ''Not being able to control my thoughts is a sign of weakness'', ''I cannot ignore my worrying thoughts'') lead to their external attribution as hallucinations. Furthermore, it is argued that such a misattribution is maintained because it reduces cognitive dissonance. When the occurrence of intrusive thoughts does not comply with the subject's metacognitive beliefs, an aversive state of arousal results (cognitive dissonance), which the subject tries to escape by externalising the intrusive thoughts (resulting in hallucinatory experiences), thus maintaining consistency in his/her belief system. A number of studies have found evidence for an association between metacognitive beliefs and the presence of hallucinations (Baker & Morrison, 1998; Larøi et al., in press-a; Larøi & Van der Linden, 2004a; Lobban, Haddock, Kinderman, & Wells, 2002; Morrison & Wells, 2003; Morrison, Wells, & Nothard, 2000; Morrison, Wells, & Nothard, 2002). For example, Baker and Morrison (1998) reported that patients with hallucinations scored higher than nonhallucinating subjects on measures of metacognitive beliefs and that this score was associated with a bias towards attributing their own thoughts to the experimenter. Second, in a large group of hallucination-prone subjects, Morrison et al. (2000) replicated the finding of an association between the presence of hallucinations and metacognitive beliefs. In this study, subjects were divided into two groups (those with high and low hallucination proneness) by employing a median split on total scores on an hallucinations scale. The authors found an overall significant difference between subjects with high and low proneness in terms of metacognitive beliefs. Finally, Larøi et al. (in press-a) showed that hallucination-prone subjects scored significantly higher on a scale of metacognitive beliefs compared to nonprone subjects and that errors related to attributing a nonself source to a self-generated event on a verbal reality monitoring task were associated with specific metacognitive beliefs.

At present, studies have only explored relations between hallucinations and reality monitoring functioning with words as stimuli, which greatly limits the possibility of examining several different encoding conditions. In particular, reality monitoring tasks utilising words as stimuli are only able to include one internal source encoding condition. As a consequence of this, studies have not adequately examined the possibility that source monitoring errors observed in the context of hallucinations are the result of a perturbation of the control of internally generated material.

The aims of the present study were twofold. First, relations between source monitoring errors and hallucination-proneness were examined with actions as stimuli. Briefly, the source monitoring task involved encoding actions performed by internal (e.g., the subject performs an action, the subject imagines performing the action, or the subject imagines the experimenter performing the action) or external sources (e.g., the experimenter performs the action). We hypothesised that source monitoring errors in hallucination-prone subjects would essentially involve erroneously attributing self-generated actions to the external source (e.g., actions performed by the subject would be incorrectly attributed as being performed by the experimenter). A second aim was to examine relations between source monitoring errors and metacognitive beliefs. In particular, we hypothesised that external attribution errors would be associated with metacognitive beliefs.

METHOD

Participants

Participants consisted of 76 nonclinical subjects (University students), who were approached for their cooperation, which was voluntary. No incentive was offered for participation. Although subjects were not formally screened for general psychopathology, an exclusion criterion for all subjects was that they had not suffered from a psychiatric condition in the past three years. Eleven subjects were removed due to incorrect filling-out of the questionnaires, or not returning questionnaires. The final experimental group thus consisted of 65 subjects. There were 36 females (55 %) and 29 males (45 %). Subjects were aged between 19 and 39 years with an average age of 24.2 years (*SD* = 3.73). Mean number of years of education after secondary school was 3.45 (*SD* = 1.38).

Materials

Hallucinatory proneness. To assess hallucination-proneness, subjects were asked to complete a French version (Larøi, Marczewski, & Van der Linden, in press-b) of the Launay and Slade Hallucinations Scale (LSHS; Launay & Slade, 1981). The LSHS is a frequently applied questionnaire for measuring hallucinatory experiences in both the clinical and nonclinical population. In the present study, a newly modified and elaborated version of the LSHS was utilised. These modifications are discussed in more detail in Larøi et al. (in press-b). The subjects were explicitly asked not to report experiences when under the influence of alcohol or a narcotic substance. The psychometric properties of the present version of the LSHS have been examined, including its internal validity and reliability (Larøi et al., in press-b). Principal components analysis of the version of the LSHS utilised in the present study revealed four factors, which is similar to previous studies utilising comparable versions of the LSHS (Aleman, Nieuwenstein, Böcker, & de Haan, 2001; Larøi & Van der Linden, 2004b; Levitan, Ward, Catts, & Hemsley, 1996; Morrison et al., 2000), indicating good internal validity. Also, the internal reliability of the present version of the LSHS is adequate, where a moderately high Cronbach alpha coefficient ($\alpha = 0.78$) for all items was reported in Larøi et al. (in press-b).

Metacognitive beliefs. In order to measure metacognitive beliefs, subjects completed the Meta-Cognitions Questionnaire (MCQ; Cartwright-Hatton & Wells, 1997). The MCQ assesses individual differences in positive and negative beliefs about worry and intrusive thoughts, metacognitive monitoring and judgments of cognitive efficiency. The 64 MCQ-items are scored from 1 to 4, whereby 1 = ‘‘do not agree’’, 2 = ‘‘agree slightly’’, 3 = ‘‘agree moderately’’, and 4 = ‘‘agree very much’’. Factor analysis of MCQ items reveals that the MCQ consists of five relatively distinct subscales (Cartwright-Hatton & Wells, 1997). (1) Positive beliefs about worry (PB) consists of items relating to beliefs that worry helps one to solve problems and avoid unpleasant situations. (2) Negative beliefs about the uncontrollability of thoughts and corresponding danger (UD) consists of items relating to beliefs that worry is uncontrollable, than one must control one's worrying, and that worrying is dangerous. (3) Cognitive confidence (CC) includes items relating to concerns about one's cognitive efficiency. (4) Negative beliefs about thoughts in general (in particular relating to superstition, punishment and responsibility; SPR) consists of items relating to fears of outcomes that might result from having certain thoughts, and the acceptance of responsibility for having such thoughts. (5) Cognitive self-consciousness (CSC) includes items related to the tendency to monitor and focus on one's thinking processes. Initial validation studies found that the MCQ has good psychometric properties (Cartwright-Hatton & Wells, 1997). Also, a recent study has shown that the French form utilised in the present study has adequate psychometric properties (Larøi, Van der Linden, & D'Acremont, 2004).

Source monitoring task: Material

A number of criteria were used in the selection of action items in order to render the material as homogenous as possible and to control for the influence of nonpertinent variables that could bias the interpretation of results. To do this, only actions that involved a movement, were as universal and clear as possible, were easy to carry out in the testing situation (sitting down), were gender-neutral, did not necessitate the production of sounds (e.g., clap your hands), and could be carried out quickly and simply by subjects, were included. A total of 120 actions were selected that corresponded to the abovementioned criteria as closely as possible. These were then randomised and 60 actions were chosen as encoding items and the 60 others were chosen as foils. The encoding items and the foils were the same for all subjects. A list of the actions is presented in the Appendix.

Procedure

Study phase. Subjects were tested individually in an isolated room and sat on a chair in front of the experimenter. All subjects were naive to the goal of the experiment. The study was presented to subjects as part of a series of studies concerning motor actions. The procedure consisted of five different conditions. For the motor encoding condition (MOTOR), participants were asked to carry out the action with an imaginary object. For the imagined motor encoding condition (I.MOTOR), subjects imagined themselves executing the action in the room in which the experiment was conducted. In the verbal encoding condition (VERBAL), the action was verbally presented and subjects neither executed nor imagined execute the action. Visual encoding (VISUAL) involved the experimenter carrying out the action in front of subjects. Finally, for the imagined visual encoding condition (I.VISUAL), subjects were asked to imagine the experimenter executing the action in the room in which the experiment was conducted.

The incidental encoding instructions were based on Henkel, Franklin, and Johnson (2000). For the two imagined modalities (I.MOTOR, I.VISUAL), the subject was asked to estimate the degree of ease-difficulty to create the mental image (in terms of clarity and realness). For actions in the two real conditions (MOTOR, VISUAL), the subject was asked to judge the extent to which the action they carried out was representative of a typical action carried out by people in everyday life. For those actions presented verbally (VERBAL), the subject was asked to evaluate the ease of understanding the meaning of the phrase. All evaluations were made with the help of a 5-point visual analogue scale placed in front of subjects during testing.

The encoding list consisted of 60 actions divided up into 15 blocks of 4 actions. A change of encoding condition occurred after each block of four actions. This change was communicated to subjects by the experimenter by indicating the manner in which the action was to be carried out. Each encoding modality was thus applied to 12 items, divided up into three blocks of four actions. The blocks of actions and the different conditions were counterbalanced. Each block of 4 items were found in each of the 15 possible positions in the encoding list. In addition, we controlled the sequential order of the 5 conditions by creating five different presentation sequences. During these sequences, 2 ''real'' conditions (e.g., MOTOR, VISUAL) or 2 ''imaginary'' conditions (e.g., I.MOTOR, I.VISUAL) never directly followed each other in order to avoid any eventual confusion between two conditions of the same encoding type. Each of the five sequences consisted of the 15 orderings of the counterbalanced blocks. The final material consisted of 75 protocols (one per subject), all with different orders (i.e., five sequences of the presentation of the modalities of execution $\times$ 15 sheets representing the position of each block in one of the 15 possible positions). In order to avoid the recapitulation of the last actions in short-term memory, a filler task was completed by subjects between the test and recognition phases, which consisted of carrying out as many arithmetic exercises as possible within a minute.

Recognition phase. A random list of 120 motor actions was presented to each subject, which consisted of the 60 actions of the study phase and 60 foils. For each action, subjects were required to identify if the action was old or new. If the action was identified as new, the subject was asked to estimate the confidence of his/her response on a Likert-type scale from 1 to 5 (1 = I am not at all certain of my response and 5 = I am certain of my response). If the action was identified as old, the subject was asked to report the state of consciousness associated with his/her recognition response using the Remember/Know/Guess procedure (Gardiner, Java, & Richardson-Klavehn, 1996). Furthermore, for items identified as old, subjects were required to identify the source of the action (one of the 5 conditions). Finally, subjects were asked to evaluate their source identification response based on the Remember/Know/Guess procedure (Gardiner et al., 1996).

RESULTS

Memory performance and encoding conditions. In order to examine differences in encoding in the various conditions for the total group, we compared the number of attributional errors based on the type of encoding with the help of a simple-repeated measures ANOVA. As illustrated in Figure 1, certain conditions provoked more attributional errors in subjects than others ($dl = 4$; $F = 26.7$; $p < .01$).

In order to examine if there was a difference between conditions involving a real execution of the action compared to imagined conditions, we regrouped attributional errors from conditions MOTOR and VISUAL into one variable (real execution) and conditions I.MOTOR and I.VISUAL into another (imagined execution). Planned comparisons revealed that subjects committed significantly fewer errors for the conditions implicating a real execution of the action (by the subject or by the experimenter) compared to conditions where subjects were required to imagine the action (where the actor of the action was either the subjects themselves or the experimenter) ($dl = 1$; $F = 27.3$; $p < .01$). In contrast, when subjects were asked to imagine the action, they committed significantly fewer errors compared to when actions were simply verbally presented by the experimenter during encoding (i.e., the VERBAL condition) ($dl = 1$; $F = 21.59$; $p < .01$).

Group comparisons on the memory task. Two groups were established according to their scores on the LSHS. The group of hallucination-prone

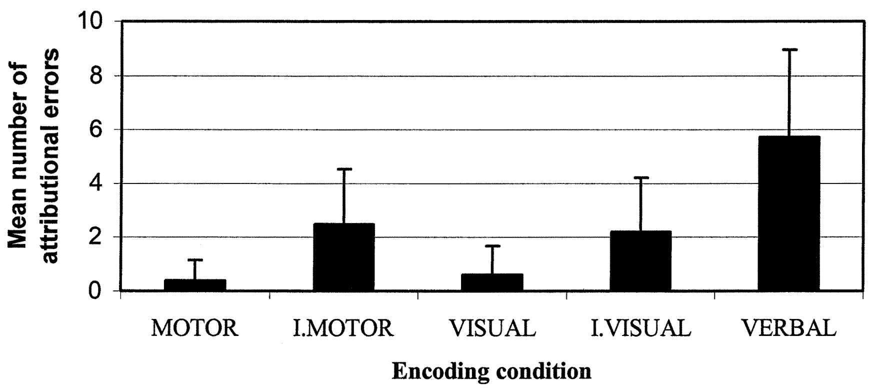

Figure 1. Average attributional errors according to the encoding condition.

subjects (HP) consisted of subjects in the top 25th percentile (score > 25) (n = 16) and the group of nonhallucination-prone subjects (NHP) consisted of subjects in the lower 25th percentile (score < 11) (n = 16). Subject characteristics for both groups and for the total sample are presented in Table 1.

We examined possible differences between groups in terms of subjective evaluations for the incidental instructions (Student t-test for independent samples; dl = 30). There were no significant differences between HP and NHP subjects in terms of the representativeness of actions executed for the MOTOR conditions ($t = -0.75$; $p = .46$) or VISUAL ($t = 0.21$; $p = .82$). Neither were there significant differences between the two groups in terms of the difficulty of imagining the actions for the I.MOTOR condition ($t = -1.57$; $p = .13$) or I.VISUAL ($t = -0.26$; $p = .8$). In addition, the two groups did not differ significantly in terms of their evaluation of understanding the actions in the same manner for the VERBAL condition ($t = -0.5$; $p = .62$).

Old-new recognition. Scores were analysed in terms of the proportion of correct recognitions (Hits; proportion of actions correctly recognised as old), false recognitions (FA; proportion of items falsely identified as old), Pr-scores (Hits-FA) as the discrimination index, and Br-scores [FA/1-(Hits-FA)] as a measure of response bias (Snodgrass & Corvin, 1988). A 2 (group) × 5 (encoding conditions) ANOVA for Hits revealed an encoding condition effect (dl = 4; F = 14.4; $p < .01$). Post-hoc comparisons (Newman-Keuls) revealed fewer Hits from the VERBAL encoding condition compared to Hits from the other encoding conditions ($p < .01$). However, the ANOVA did not reveal a group effect (dl = 1; F = 0.1; $p = .76$), nor was there found an interaction effect between group and encoding condition (dl = 4; F = 0.22; $p = .92$). Also, Student t-tests for independent samples revealed no differences between groups in terms of FA (dl = 30; $t = -1.55$; $p = .14$), the Pr-score (dl = 30; t = 1.01; $p = .32$), and the response bias score (Br) (dl = 30; $t = -1.55$; p = .13). In sum, the two groups did not differ significantly in terms of old-new recognition.

TABLE 1
Subject characteristics for the total sample and for both groups

	Total sample	*NHP*	*HP*	*t*	*p*
Average age	22.6 (3.6)	23 (4.3)	22.8 (4.9)	0.12	.91
Average LSHS score	18.6 (10.2)	6.5 (3.0)	32.8 (5.1)	−17.7	< .01
Educational level[a]	3.5	3.6	3.2	0.79	.44
Sex ratio (M/F)	29/36	8/8	9/7		

[a] Number of years in higher education/University.

Source monitoring. During the source monitoring phase, the items that belonged to one of the five encoding conditions had to be attributed to its source by the subject. This gives rise to a combination of 25 (5×5) possible source attributions. A student *t*-test for independent samples revealed that HP subjects committed a significantly greater number of global source monitoring errors ($dl = 30$; $t = -2.93$; $p < .01$) compared to NHP subjects (means: NHP = 4.88; HP = 9.81).

Bidirectional frequency of confusion between instruction modalities. Calculations of the bidirectional frequency of confusion between instruction modalities were based on Ecker and Engelkamp (1995). The dependent variable consisted of the absolute frequency of confusion between two instruction modalities divided by the frequency of actually recognised items (Hits). For example, a subject with 12 actually recognised MOTOR encoding items (i.e., correctly classified as old) and 2 MOTOR encoding items falsely identified as I.MOTOR encoding items, plus eight actually recognised I.MOTOR encoding items (i.e., correctly classified as old) and one I.MOTOR encoding item falsely identified as a MOTOR encoding item, scored 3 (2+1) of 20 (12+8) possible confusions and received, therefore, a bidirectional I.MOTOR-MOTOR confusion score 3/20 = 0.15.

Table 2 shows the means per group and modality pair. The only significant differences (based on Student *t*-tests for independent samples) consisted of HP subjects confusing I.MOTOR and I.VISUAL more frequently ($dl = 30$; $t = -2.47$; $p = .02$) and confusing VERBAL and I.VISUAL more frequently ($dl = 30$; $t = -2.05$; $p = .05$), compared to NHP subjects.

TABLE 2
Mean relative (bidirectional) confusion frequencies per modality pair for NHP and HP groups

Modality pair	*NHP* (*SD*)	*HP* (*SD*)
MOTOR-I.MOTOR	0.011 (0.019)	0.024 (0.045)
MOTOR-VISUAL	0.005 (0.022)	0.016 (0.031)
MOTOR-I.VISUAL	0	0
MOTOR-VERBAL	0	0.008 (0.023)
I.MOTOR-VISUAL	0	0.005 (0.022)
I.MOTOR-I.VISUAL	0.021 (0.038)	0.076 (0.080)
I.MOTOR-VERBAL	0.098 (0.115)	0.145 (0.144)
VISUAL-I. VISUAL	0.011 (0.020)	0.019 (0.028)
VISUAL-VERBAL	0.003 (0.011)	0.006 (0.016)
VERBAL-I.VISUAL	0.073 (0.064)	0.140 (0.144)

Unidirectional frequency of confusion between I.MOTOR, I.VISUAL, and VERBAL encoding. Student *t*-tests were then carried out, which compared each of the pairs of encoding modalities that were shown to be significant based on the bidirectional calculations presented above. The means per group and modality pair are presented in Table 3. The only significant group difference was for the I.MOTOR-I.VISUAL pair modality. That is, HP subjects revealed significantly more wrongly attributed actions where subjects were required to imagine themselves perform the action (I.MOTOR) as coming from visual imagined encoding (I.VISUAL) ($dl = 30$; $t = -3.47$; $p < .01$).

R/K/G responses and old-new recognition. Due to technical reasons we were unable to analyse R/K/G responses for recognition Hits for each encoding condition separately. However, we were able to carry out analyses for R/K/G as total scores over all encoding conditions. Also, we could perform R/K/G analyses for each recognition error independently. Student *t*-tests for independent samples were performed on subjects' certainty ratings and R/K/G responses given during the recognition phase. For Hits for old items, there were no significant groups differences between HP and NHP for R ($dl = 30$; $t = 1.06$; $p = .3$), K ($dl = 30$; $t = 0.07$; $p = .94$), and G ($dl = 30$; $t = -1.85$; $p = .07$) responses. Concerning FA, there were no significant differences between groups for R ($dl = 30$; $t = -0.13$; $p = .89$), K ($dl = 30$; $t = 1.56$; $p = .13$), and G ($dl = 30$; $t = 0.2$; $p = .84$) responses. Regarding confidence ratings for New responses, Student *t*-tests for independent samples did not reveal any significant differences between HP and NHP groups in terms of Hits ($dl = 30$; $t = 1.044$; $p = .31$) nor in terms of FA ($dl = 30$; $t = -0.917$; $p = .37$).

R/K/G responses and source monitoring. Due to the same technical reasons, we were unable to analyse R/K/G responses for correct source attributions from each encoding condition separately. However, we were able to carry out analyses for R/K/G responses as total scores over all encoding conditions. Also, we could perform R/K/G analyses for each source monitoring error independently. Student *t*-tests for independent samples revealed no significant group

TABLE 3
Mean unidirectional confusion frequencies for NHP and HP groups

Modality pair	*NHP* (*SD*)	*HP* (*SD*)
I.MOTOR-I.VISUAL	0.010 (0.028)	0.075 (0.069)
I.VISUAL-I.MOTOR	0.032 (0.060)	0.076 (0.131)
I.VISUAL-VERBAL	0.035 (0.074)	0.068 (0.088)
VERBAL-I.VISUAL	0.127 (0.120)	0.230 (0.244)

differences for R ($dl = 30$; $t = 1.39$; $p = .18$), K ($dl = 30$; $t = -0.54$; $p = .59$), and G ($dl = 30$; $t = -1.76$; $p = .09$) responses that were associated with a correct source judgement (Hits). Student *t*-tests for independent samples were carried out, which compared the two groups in terms of R, K, and G responses associated with a source monitoring error (i.e., when an action is not correctly attributed to its source). These analyses were first done separately for discrimination errors committed from each of the five encoding conditions (without taking into account which source it was erroneously attributed to). No significant group differences were found (*p*s ranged from .09 to .88). The same analyses were performed for attributional bias errors committed to each of the five attributional conditions (regardless of the original encoding modality). These analyses did not reveal any significant group differences (*p*s ranged from .08 to .92).

In order to ensure that group differences were due to a response bias in subjects and not to uncertainty when responding, we performed a 2 (group) × 3 (R/K/G response) ANOVA for attributional errors. The ANOVA did not reveal an effect of group ($dl = 1$; $F = 0.009$; $p = .93$), R/K/G response effect ($dl = 2$; $F = 1.92$; $p = .16$), nor was there found an interaction ($dl = 2$; $F = 1.6$; $p = .21$). Therefore, since the two groups did not differ in terms of Guess responses for attributional errors, this suggests that group differences were not due to uncertain responses.

Metacognitive beliefs. Table 4 compares mean scores on the MCQ in HP and NHP groups. HP subjects obtained significantly higher scores on all five of the MCQ subfactors, compared with NHP subjects. Scores on the LSHS and the

TABLE 4
Mean scores on the Meta-Cognitions Questionnaire (MCQ) and differences between NHP and HP groups (Student *t*-tests)

MCQ	*NHP (SD)*	*HP (SD)*	*t*	*p*
PB	29.06 (6.58)	39.38 (9.5)	−3.6	< .01
UD	26.69 (8.13)	40.44 (9.48)	−4.4	< .01
CC	14.63 (2.8)	22.56 (6.61)	−4.4	< .01
SPR	19.06 (4.1)	24.75 (4.48)	−3.7	< .01
CSC	15.69 (2.68)	18.31 (2.91)	−2.7	.01
Total score	105.13 (17.59)	145.44 (23.68)	−5.5	< .01

PB = Positive beliefs about worry; UD = Negative beliefs about the uncontrollability of thoughts and corresponding danger; CC = Cognitive confidence; SPR = Negative beliefs about thoughts in general (in particular relating to superstition, punishment, and responsibility); CSC = Cognitive self-consciousness.

MCQ were also correlated, which revealed significant correlations for all MCQ subfactors ($p < .01$) except for the CSC subfactor ($p = .078$).

Furthermore, there was a significant positive correlation between I.MOTOR-I.VISUAL unidirectional errors and subfactors CC ($r_s = .26$, $p = .04$) and PB ($r_s = .24$, $p = .05$) of the MCQ, and a nonsignificant trend with the subfactor CSC ($r_s = .24$, $p = .06$). There were no significant correlations between I.MOTOR-I.VISUAL unidirectional errors and the subfactors UD ($r_s = .16$, $p = .20$) and SPR ($r_s = .18$, $p = .14$) of the MCQ.

DISCUSSION

The main results of the present study can be summarised as the following. In line with previous studies (cf. Anderson, 1984; Engelkamp, 1998), for the whole population (i.e., hallucination and nonhallucination-prone subjects), subjects committed significantly fewer source judgement errors following a ''real'' encoding compared with an ''imaginary'' encoding of actions. In contrast, memory performance in conditions requiring an ''imaginary'' encoding was significantly better than for actions that were simply verbally encoded. Also, confirming other studies utilising verbal source monitoring tasks (cf. Larøi et al., in press-a), we did not observe any significant differences between hallucination-prone and nonhallucination prone subjects in terms of target information recognition. Furthermore, there were no significant differences between the two groups in terms of the subjective states associated with the retrieval of the different actions and the source.

Nevertheless, hallucination-prone subjects showed a significantly greater number of source monitoring errors. More specifically, within the internal conditions, hallucination-prone subjects confused two internal conditions. That is, for the imagined condition where the subjects performed the action, hallucination-prone subjects erroneously attributed these towards an imagined action performed by the experimenter. This type of error can be termed an internal-internal source discrimination error (i.e., errors in discriminating between two internal sources of information).

It remains to be explained why hallucination-prone subjects confused two internal conditions and why these subjects did not reveal a bias in attributing an internal source to a real external source (i.e., attributing a nonself source to a self-generated event) as has been typically found in previous studies. This may be related to the difference between source monitoring tasks involving actions compared to other material, such as words. One could argue that there is a greater distinction between performing an action and imagining performing an action, compared to the distinction between saying a word and imagining having heard the word. In other words, it appears to be easier to confuse *imagine having heard the word table* with *having heard the word table*, than to confuse *imagine yourself opening a window* with *open a window*. Since the execution of an action implicates perceptual, sensory, and spatiotemporal information, the production of an extremely distinct memory trace is more probable. One can therefore suggest that in a task involving actions, there is a much greater scission between internal and external information. It should also be noted that Hashtroudi, Johnson, and Chrosniak (1989) suggest that an internal-internal discrimination (i.e., the discrimination between two internal sources of information) is more difficult than an external-internal discrimination (i.e., reality monitoring, or the discrimination between an external and internal source of information).

Also, lack of an externalising effect coupled with the fact that the source monitoring errors that significantly differentiated the two groups remained confined within the two internal encoding conditions, may be related to phenomenological characteristics of hallucinations. Studies have shown that subjects may perceive their hallucinations as occurring within the subject or outside the subject, or both (Copolov, Trauer, & Mackinnon, in press), and some find it difficult to make this distinction when reporting hallucinations (Nayani & David, 1996). In other words, hallucinations do not necessarily have to be attributed to an external object for them to be a hallucination. Indeed, they may remain an internal/perceptual experience that subjects simply characterise as having an ''alien'' or ''nonself'' quality to them (i.e., not experienced as belonging to them) but without them actually being externalised. In this context, the ''imagine-myself actions'' can be viewed as relatively more personal and less alien compared to the ''imagine-experimenter actions''. If a feeling of ''alienship'' or ''nonself'' of internally generated stimuli occurs in hallucination-prone subjects, then this may explain why the ''imagine-myself actions'' were attributed to the imagine-experimenter modality, and not the opposite.

Another reason why we did not find a typical externalising bias as reported in the literature may be related to the fact that the task we utilised was not sensitive to internal-external source monitoring biases. Indeed, a cognitive task more sensitive to detecting an internal-external cognitive bias may show such an externalsing bias. Another explanation as to why an externalising bias was not observed in the present study may be related to the phenomenological heterogeneity of hallucinations. In particular, it may be suggested that various types of attributional errors are associated with (different types of) hallucinations. Indeed, a recent phenomenological study has reported that even a subset of hallucinations (i.e., auditory-verbal hallucinations) involve a number of dimensions, such as location in inner/outer space, linguistic complexity, and self/other attribution (Stephane, Thuras, Nasrallah, & Georgiopoules, 2003). That is, certain hallucinations may implicate the attributional bias observed in the present study (i.e., a nonself attribution in inner space), whilst others may be associated with the ''classical'' externalising bias reported in the literature (i.e., a nonself attribution in outer space). Given such a multidimensional phenomenology, it is likely that even other (unexplored) attributional biases may be implicated in hallucinations. It should be noted that studies suggest that the abovementioned phenomenological dimensions may have different neuro-physiological underpinnings. For example, Hunter et al. (2003) reported differences in neural substrates for auditory stimuli perceived outside the head, relative to those perceived inside the head. In addition, a number of studies indicate that the concept of self is underlined by specific neural substrates, in particular, in frontal areas (for a review see Kircher & David, 2003).

These findings should also be discussed in relation to methodological limits of previous studies. As mentioned in the Introduction, the majority of studies have only examined relations between hallucinations and reality monitoring functioning where there are only two sources (one external and one internal source). The subject is therefore confronted with a limited choice between an external and an internal source. If we take into account the fact that hallucinators experience stimuli as being alien to them, then the obvious choice between the two would be to attribute internally generated stimuli to the other source, namely, the external source. It is therefore not surprising that previous studies have revealed an externalising bias in hallucinators.

Associations between metacognitive beliefs and hallucination-proneness were also examined. The results revealed that hallucination-prone subjects obtained significantly higher scores on a measure of metacognitive beliefs, compared to nonprone subjects. Furthermore, there was found a significant positive correlation between scores on the metacognitive beliefs measure and the degree of hallucination-proneness. These findings confirm previous studies with schizophrenic patients (Baker & Morrison, 1998; Lobban et al., 2002; Morrison & Wells, 2003) and hallucination-prone subjects (Larøi et al., in press-a; Larøi & Van der Linden, 2004a; Morrison et al., 2000, 2002). Furthermore, the findings are in agreement with theoretical interpretations arguing for the determining role of metacognitive beliefs in the onset and maintenance of hallucinations (Morrison et al., 1995).

Finally, relations between metacognitive beliefs and source monitoring errors were studied. There was a significant association between specific metacognitive beliefs (cognitive consciousness and positive worry beliefs) and the internal-internal discrimination error observed in hallucination-prone subjects (i.e., for imagined actions where the subjects performed the action, hallucination-prone subjects erroneously attributed these towards an imagined action performed by the experimenter). These findings correspond with previous studies with schizophrenic patients with hallucinations (Baker & Morrison, 1998) and with hallucination-prone subjects (Larøi et al., in press-a).

In conclusion, based on the findings from the present study and previous research, it is possible to propose certain suppositions regarding the onset of hallucinations. The inability to adequately attribute the detailed origin of an internal cognitive event may be seen as an important cognitive deficit in the genesis of hallucinations. Although it is not entirely clear what this cognitive deficit may consist of, it may be related to impaired encoding of information permitting to make memory traces more distinctive, in particular, memory traces concerning internal cognitive events. In addition to this, motivational factors may also play a part (e.g., escape from a negative affective state). When the occurrence of an intrusive thought does not comply with the subject's meta-cognitive beliefs (especially negative beliefs concerning intrusive thoughts), an aversive state of arousal follows (cognitive dissonance). The subject tries to escape this aversive state by not accepting the intrusive thought as his/her own (resulting in a hallucinatory experience) in order to maintain consistency in his/her belief system. To do this, the subject attributes a sense of alienship to the intrusive thought, proclaiming that this internal cognitive event is not his/her own. Such an interpretation is in accordance with the view that hallucinations are private events (intrusive thoughts) that are misattributed to a source that is alien to the self. It is important to mention that other mechanisms for self/other confusions in hallucinations may also be involved. In particular, the absence of corollary discharge has been suggested as playing an important role (Feinberg, 1978; Frith, 1987). Basically, corollary discharge is a mechanism that enables one to distinguish between our own actions and those that are not our own. When this central monitoring system is defective or absent, events we perform may be experienced as being performed by something or someone else (giving it an alien character) and consequently are interpreted as being a hallucinatory experience.

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APPENDIX

Test materiel and foils used in the task.

Test material

1. play the piano
2. raise your glass to say ‘‘cheers’’
3. whisk some eggs
4. unscrew the cap of a bottle
5. change channels with a remote control
6. saw a plank
7. perform a military salute
8. iron a shirt
9. wipe out a blackboard with a rag
10. pour a cup of coffee
11. fold out the blade of a Swiss Army knife
12. throw a dart
13. crack a nut with a nutcracker
14. take a photo
15. put on the brakes of a bike
16. open a drawer
17. open a window
18. peel a potato
19. staple two sheets of paper together
20. play the violin
21. make a ball of paper
22. put air into a bike-tube with a bicycle pump
23. light a match
24. put butter on a slice of bread
25. uncork a wine bottle
26. eat soup with a spoon
27. put on the handbrake of a car
28. put a jacket on a coat-rack
29. tie your shoes
30. erase a sentence written with a pencil
31. brush your hair with a hairbrush
32. open a tin with a tin-opener
33. write an address on an envelope
34. cradle a baby in your arms
35. caress a cat
36. toss a salad
37. type on a computer keyboard
38. drink a glass of water
39. knock on a door
40. draw some curtains back
41. milk a cow
42. dry your hair with a towel
43. close a jacket with a zipper
44. open an umbrella
45. break a chocolate bar into two
46. make the gesture ‘‘come here’’
47. knock in a nail with a hammer
48. turn the pages of a book
49. pick up the telephone
50. paint with a roller
51. squeeze a lemon
52. look at the time on a wristwatch
53. squeeze a wet rag
54. bite into an apple
55. put the cap back onto a pen
56. pick up a needle
57. blow your nose with a tissue
58. screw in a light-bulb
59. rip up a sheet of paper
60. open a newspaper

Foils

1. pull the trigger of a rifle	21. paddle a kayak	41. turn on the faucet
2. play the guitar	22. make a ‘‘goodbye’’ gesture	42. hitch-hike
3. kill a mosquito with a fly-swatter	23. attach your watch on your wrist	43. throw some dice
4. put gloves on	24. toss a pancake from a fryingpan into the air	44. use a yo-yo
5. cut paper with a pair of scissors	25. scratch your head	45. sharpen a pencil
6. wash your hands	26. mail a letter	46. put a coin into a moneybox
7. light a lighter	27. put on the hood of your coat	47. use a rolling pin
8. remove a clothes peg from a clothes line	28. scratch a freckle with your nail	48. peal a banana
9. open a car window manually	29. paste a stamp on an envelope	49. make a volleyball pass
10. wipe your mouth with a serviette	30. draw a line on a blackboard	50. sew on a button
11. play marbles	31. open a packet of crisps	51. put a plug in a socket
12. pick an apple from an apple tree	32. put soap on your face	52. put on a ring
13. brush your teeth	33. clean your ears with a Cue Tip	53. use a Hoover
14. cut a cake	34. throw a stone	54. open a pencil case using the zipper
15. put on a safety belt	35. put on a cap	55. clean your glasses
16. lock a door with a key	36. put on a necklace	56. crack an egg on the side of a bowl
17. pull back a bow	37. spin a lasso over your head	57. wind some thread around a spool
18. dry a plate	38. turn the valve of a radiator	58. switch on the lights
19. make a threatening gesture with your forefinger	39. thread the eye of a needle	59. open a tin
20. attach a shirt-button	40. put on perfume from a vaporiser	60. throw a bowling ball