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**REVIEW**

- 12 Review of source-monitoring processes in obsessive-compulsive disorder  
*Lavallé L, Brunelin J, Bation R, Mondino M*

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## Review of source-monitoring processes in obsessive-compulsive disorder

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### Abstract

Obsessive-compulsive disorder (OCD) is a severe mental illness characterized by persistent, intrusive and distressing obsessions and/or compulsions. Such symptoms have been conceptualized as resulting from a failure in source-monitoring processes, suggesting that patients with OCD fail to distinguish actions they perform from those they just imagine doing. In this study, we aimed to provide an updated and exhaustive review of the literature examining the relationship between source-monitoring and OCD. A systematic search in the literature through January 2019 allowed us to identify 13 relevant publications investigating source-monitoring abilities in patients with OCD or participants with subclinical compulsive symptoms. Most of the retrieved studies did not report any source-monitoring deficits in clinical and subclinical subjects compared with healthy volunteers. However, most of the studies reported that patients with OCD and subclinical subjects displayed reduced confidence in source-monitoring judgments or global cognitive confidence compared to controls. The present review highlighted some methodological and statistical limitations. Consequently, further studies are needed to explore source monitoring with regard to the subcategories of OCD symptoms (*i.e.*, symmetry-ordering, contamination-washing, hoarding, aggressive obsession-checking, sexual-religious thoughts) and to clarify the relationship between source-monitoring subtypes (*i.e.*, reality or internal source-monitoring) and confidence in these populations.

**Key words:** Reality-monitoring; Source-monitoring; Obsessive-compulsive disorder;

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## Subclinical compulsive symptoms

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**Core tip:** Symptoms of obsessive-compulsive disorder (OCD) have been proposed as resulting from a source-monitoring failure, suggesting that patients with OCD fail to distinguish actions they perform from those they just imagine doing. This study provides an updated and exhaustive review of the literature examining the relationship between source-monitoring performances and OCD. Most of the 13 retrieved studies did not report any source-monitoring deficits but reported reduced confidence in source-monitoring judgments in patients with OCD and subclinical subjects compared to controls. Furthermore, this review highlighted some methodological limitations and provided recommendations with respect to future studies focusing on source-monitoring in OCD.

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## INTRODUCTION

Obsessive-compulsive disorder (OCD) is a frequent psychiatric condition that occurs in 2%-3% of the population<sup>[1]</sup>. Symptoms consist of persistent, intrusive and distressing obsessions and/or compulsions, strongly impacting the quality of life of the affected individual<sup>[2]</sup>. Five dimensions of symptoms have been classically defined in patients with OCD: Symmetry-ordering, contamination-washing, hoarding, aggressive obsession-checking, and sexual-religious thoughts<sup>[3-7]</sup>.

The pathophysiological and cognitive mechanisms underlying the symptoms of OCD have not yet been fully elucidated. However, several nonmutually exclusive cognitive models have been proposed to characterize OCD thought processes. For instance, according to the thought-action fusion model<sup>[8]</sup>, excessive importance is given to patients' thoughts by believing that having a thought about an event makes that event more likely to occur. A second model, the meta-memory model<sup>[9]</sup>, proposes that an imbalance between a preserved feeling of remembering (knowing) and an impaired ability to remember physical details (remembering) leads to checking behavior to restore an adequate level of confidence. A third cognitive model proposes that patients with OCD have source-monitoring disabilities<sup>[10]</sup>. Source-monitoring is defined as the ability to discriminate the origin of a remembered piece of information<sup>[11]</sup>. According to this model, patients with OCD would be more likely to confound memories of performed and imagined actions. The resulting uncertainty could therefore contribute to obsessive thoughts that in turn lead to compulsive behaviors to ensure that the intended actions have been carried out.

Three types of source-monitoring processes have been described in the literature<sup>[12]</sup>. The first type is reality-monitoring, which characterizes the ability to distinguish whether information was perceived from the environment or imagined (*e.g.*, Did I see my partner turn off the gas or did I only imagine it?). A second type of source monitoring is internal source monitoring, which characterizes the ability to determine whether an internally generated event was expressed in the external space or kept in the internal space (*e.g.*, Did I turn off the gas or did I only think about doing it?). Finally, external source monitoring refers to the discrimination between different externally derived sources (*e.g.*, Did John tell me this information, or did I hear it on the radio?). Deficits in source-monitoring processes have already been associated with some clinical features, such as delusions and hallucinations in schizophrenia. Namely, an incorrect flagging of thoughts as self-generated events may be responsible for altered self-recognition in patients with psychosis. In addition, their propensity to misattribute inner speech to external sources has been associated with the presence of auditory verbal hallucinations<sup>[13,14]</sup>.

Here, we aimed to provide an updated overview of the literature examining the relationship between source-monitoring performances and OCD symptoms. Special attention was given to internal source monitoring since its alteration (*i.e.*, a confusion



between imagined and performed events) seems more related to OCD symptoms than reality-or external source monitoring. Finally, rather than only exploring source monitoring as an OCD trait, this review included both patients with OCD and subjects with subclinical checking rituals (defined as persons with similar checking symptoms as those observed in clinical subjects but with less-disabling consequences<sup>[15]</sup>). This will allow us to explore the relationship between source-monitoring deficits and OCD's related checking symptoms.

To achieve our goal, a systematic review was conducted according to the recommendations from the Cochrane group and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines<sup>[16]</sup>. Details of methods are given in the **Supplementary material 1**<sup>[17,18]</sup>. The primary electronic search in the PubMed, ScienceDirect and psycINFO databases identified 102 articles, and cross-referencing provided 6 additional articles. Removal of duplicate records yielded 100 articles. After reading the titles and abstracts, 24 articles were retained. Eleven records were excluded because they did not use source-monitoring tasks. This process resulted in a total of 13 full-text articles, comprising 10 studies in patients with OCD and 3 studies in a subclinical population of checkers. Main results and methods from the 13 selected studies investigating source-monitoring in patients with OCD and subjects with subclinical checking rituals are given in the **Table 1**<sup>[10,15,19-28]</sup>.

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## INTERNAL SOURCE-MONITORING IN OBSESSIVE-COMPULSIVE DISORDER

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Our systematic review yielded 9 studies that investigated internal source-monitoring abilities. These studies included either patients with OCD or subclinical checking-prone individuals. Among them, 2 studies reported that participants had significantly impaired internal source-monitoring abilities. These 2 studies compared participants with checking symptoms, either clinical (OCD checkers) or subclinical (checking-prone individuals). For instance, Rubenstein *et al*<sup>[15]</sup> compared the internal source-monitoring abilities between checking-prone individuals and healthy controls. They used a word-recognition task requiring participants to either read the second word of a pair of words or to generate the second word from its first letters. Participants were then asked to recognize whether the words were generated in the internal space or the external space (read aloud). The authors reported that checking-prone participants were more likely than healthy controls to misattribute read words as generated. Using a task measuring the participants' ability to remember if they actually performed, imagined themselves performing or imagined someone else performing some actions, Ecker *et al*<sup>[19]</sup> found a significant impairment in OCD checkers compared to low-checking inpatients with other diagnoses. Namely, OCD checkers had poorer free recall of performed actions and made more confusions between performed and imagined actions. Moreover, the authors reported that high-checking inpatients made significantly more misattributions of imagined events as being performed compared to low-checking ones.

In contrast to these studies, 7 other studies did not report any significant impairments regarding internal source-monitoring abilities. Among them, 4 studies included patients specifically suffering from checking symptoms, and 3 studies included patients with general OCD symptomatology. First, McNally *et al*<sup>[20]</sup>, Zermatten *et al*<sup>[21]</sup>, Constans *et al*<sup>[22]</sup>, and Cogle *et al*<sup>[23]</sup> used action recognition tasks requiring participants to discriminate between actual and imagined action performance. They failed to report any significant difference between OCD checkers and noncheckers or healthy controls. Interestingly, Constans *et al*<sup>[22]</sup> and Cogle *et al*<sup>[23]</sup> used anxiety-eliciting actions. Using comparable action recognition tasks, Moritz *et al*<sup>[29]</sup> and Merckelbach *et al*<sup>[25]</sup> did not report any significant difference between patients with general OCD symptoms and healthy controls. They both divided their OCD groups into two subgroups, either high and low checkers<sup>[24]</sup> or checkers and noncheckers<sup>[25]</sup>, but failed to find any significant difference between the subgroups. Finally, by including action items relevant to compulsive OCD behaviors, Hermans *et al*<sup>[24]</sup> also failed to reveal any significant difference between OCD patients and healthy controls.

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## OTHER SUBTYPES OF SOURCE MONITORING IN OBSESSIVE-COMPULSIVE DISORDER

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Seven studies investigated other source-monitoring subtypes in patients with OCD or

**Table 1** Details of studies investigating source monitoring in patients with obsessive-compulsive disorder or participants with subclinical compulsive symptoms

Ref.	SM subtype <sup>†</sup>	Samples (n)	SM task: Source encoding conditions	OCD relevant stimuli	Significant between-groups difference in SM performances	Significant between-groups difference in confidence
Hermans <i>et al</i> <sup>[24]</sup> , 2003	Internal	17 OCD; 17 HC	ART: Imagining performing an action a fixed number of times + performing it a various number of times	Relevant compulsive + irrelevant compulsive + neutral actions	No difference between OCD and HC; No difference between high ( <i>n</i> = 9) and low ( <i>n</i> = 8) checkers	OCD < HC for neutral and irrelevant compulsive actions
Merckelbach <i>et al</i> <sup>[25]</sup> , 2000	Internal	19 OCD; 16 HC	ART: Imagining performing <i>vs</i> performing actions	No	No difference between OCD and HC; No difference between OCD checkers ( <i>n</i> = 7) and OCD noncheckers ( <i>n</i> = 12)	OCD < HC. Negative correlation between DES scores and confidence in OCD but not in HC
Cougle <i>et al</i> <sup>[23]</sup> , 2008	Internal	21 OCD checkers; 24 HC	ART: Imagining performing <i>vs</i> performing actions	Bothersome + nonbothersome actions	No difference between OCD checkers and HC in both free recall and recognition tests	OCD checkers < HC
Constans <i>et al</i> <sup>[22]</sup> , 1995	Internal	12 OCD checkers; 7 HC	ART: Imagining performing <i>vs</i> performing actions within action sequences	Anxiety-eliciting + neutral objects	No difference between OCD checkers and HC	No difference
Ecker <i>et al</i> <sup>[19]</sup> , 1995	Internal	24 OCD checkers; 24 HCIP + 48 LCIP	ART: Imagining performing <i>vs</i> performing <i>vs</i> imagining seeing <i>vs</i> subvocal rehearsal	Not specified	OCD < LCIP for free recall of performed actions and made more confusions between performed and imagined perform actions; HCIP: More misattributions of imagined actions as performed than LCIP	OCD checkers < HC, regardless of the instruction modality
McNally <i>et al</i> <sup>[20]</sup> , 1993	Internal	12 OCD checkers; 12 OCD noncheckers; 12 HC	ART: Tracing <i>vs</i> imagining tracing <i>vs</i> seeing drawings or words	No	No difference between checkers and noncheckers	OCD noncheckers < HC for words or drawings they traced. OCD checkers and noncheckers < HC for words they imagined
Moritz <i>et al</i> <sup>[29]</sup> , 2009	Internal	32 OCD; 32 HC	ART: Imagining <i>vs</i> performing actions	No	No difference between OCD and HC	No difference
	External	32 OCD; 32 HC	ART: Verbal <i>vs</i> nonverbal instruction (pictogram)		No difference between OCD and HC	
Rubenstein <i>et al</i> <sup>[15]</sup> , 1993	Exp 1a: Internal + Reality	20 CP; 20 HC	ART: Seeing <i>vs</i> performing <i>vs</i> writing actions	No	CP made more SM confusions than HC	NA
	Exp 3: Internal	20 CP; 20 HC	WRT (word pair completion): Reading a word pair <i>vs</i> generating the second word of a pair	No	CP made more SM confusions than HC	NA

Zermatten <i>et al.</i> <sup>[21]</sup> , 2006	Internal + Reality	19 CP; 35 nonCP	ART: Imagining performing <i>vs</i> performing <i>vs</i> imagining seeing <i>vs</i> seeing <i>vs</i> verbally repeating	No	CP misattributed more performed actions as seen than nonCP (significant correlation with OCI-R checking); No difference for misattribution of performed actions as imagined perform	No difference
Reese <i>et al.</i> <sup>[26]</sup> , 2011	Reality	20 OCD; 20 HC; 20 BDD	WRT: Imagining seeing <i>vs</i> seeing words	Neutral + negative + BDD-related + OCD-related words	No difference between OCD and HC	No difference
Sher <i>et al.</i> <sup>[10]</sup> , 1983	Reality	26 CP; 28 nonCP	WRT (word pair completion): Imagining the second word of a pair <i>vs</i> seeing it written	No	No difference between CP and nonCP	CP < nonCP
Brown <i>et al.</i> <sup>[27]</sup> , 1994	Reality	28 OCD; 21 HC	WRT: Imagining seeing <i>vs</i> seeing words	No	OCD > HC. Among OCD, checkers ( <i>n</i> = 13) < cleaners ( <i>n</i> = 9)	NA
Kim <i>et al.</i> <sup>[28]</sup> , 2009	External	14 OCD; 14 HC	WRT: Female <i>vs</i> male voices	No	OCD < HC	Cognitive confidence subscores of MCQ were significantly higher in the OCD group than the control group; No correlation between confidence scores and SM

<sup>1</sup>Source-monitoring subtypes investigated in the selected studies were reclassified according to Source-Monitoring Framework as described in Johnson 1993. ART: Action recognition task; BDD: Body dysmorphic disorder; CP: Checking-prone subjects; DES: Dissociative Experience Scale; HC: Healthy controls; HCIP: High-checking inpatients; LCIP: Low-checking inpatients; NA: Not available; NS: Not significant; OCD: Obsessive-compulsive disorder; OCI-R: Obsessive-Compulsive Inventory- Revised; SM: Source monitoring; WRT: Word recognition task.

subclinical participants with checking symptoms.

**Reality-monitoring**

Among them, 4 studies measured reality-monitoring abilities in patients with OCD or subclinical participants with checking symptoms. Zermatten *et al.*<sup>[21]</sup> used an action recognition task including four conditions: A condition in which subjects performed an action, a condition in which they imagined themselves performing the action, a condition in which they saw an action and a condition in which they imagined seeing the action. They found that checking-prone participants misattributed more performed actions as seen than nonchecking prone participants. The number of confusions between performed and seen actions significantly correlated with checking symptoms. Conversely, the 3 other studies did not reveal any significant reality-monitoring deficits. Using a word recognition task with items related or not related to OCD, Reese *et al.*<sup>[26]</sup> did not find any impairments in patients with OCD compared to healthy controls. Surprisingly, Brown *et al.*<sup>[27]</sup> reported that patients with OCD were significantly better than healthy controls in discriminating between words they saw and words they imagined. However, when the group of patients with OCD was split into two subgroups (cleaners and checkers), the authors reported that checkers were significantly impaired in reality monitoring compared to cleaners. Sher *et al.*<sup>[10]</sup> did not observe any significant reality-monitoring impairments in subclinical checkers compared to noncheckers.

In addition, Rubenstein *et al.*<sup>[15]</sup> compared source monitoring between checking-prone participants and healthy controls without distinguishing between internal source- and reality-monitoring abilities. They reported that checking-prone individuals made more confusions between actions they saw, performed or wrote, reflecting a general source-monitoring impairment.

**External source-monitoring**

Finally, 2 other studies compared external source-monitoring abilities between patients with OCD and healthy controls. Kim *et al.*<sup>[28]</sup> found a significant external source-monitoring deficit in patients with OCD. Namely, patients with OCD showed a lower accuracy in recognizing whether words were presented with a male or female



voice compared to healthy controls. In contrast, Moritz *et al*<sup>[29]</sup> did not report any significant external source-monitoring impairment in patients with OCD compared to healthy controls.

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## CONFIDENCE IN OBSESSIVE-COMPULSIVE DISORDER

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Among the 13 included studies, 11 investigated confidence in source-monitoring judgments in relation to OC symptoms. These studies evaluated either specific confidence in source-monitoring judgments<sup>[10,19-26,29]</sup> or global cognitive confidence using the Meta-Cognition Questionnaire<sup>[24,28]</sup>. A decrease in confidence in source-monitoring judgments was observed in studies including only checkers<sup>[10,19,20,23]</sup> and in those including patients with OCD without discriminating their clinical subtypes<sup>[24,25,28]</sup>.

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## DISCUSSION

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The aim of this review was to summarize the findings from studies investigating source-monitoring abilities in relation to OCD symptoms. The analysis of the literature did not lead to clear conclusions. Indeed, 5 of the 13 studies reviewed highlighted some differences in source-monitoring processes in patients with OCD or subclinical checkers compared to controls. Among them, two found reduced internal source-monitoring abilities in OCD checkers and checking-prone individuals (*i.e.*, confusions between imagined and performed items). One study found reduced reality-monitoring abilities between patients with OCD and healthy controls (*i.e.*, confusions between imagined and seen items). One study found reduced external source-monitoring in patients with OCD compared to healthy controls (*i.e.*, confusions between two external-source items). Finally, one study found that subclinical checkers displayed reduced general source-monitoring abilities than noncheckers. While only a few studies showed differences in source-monitoring performances, most of the studies reported that patients with OCD and checking-prone participants displayed reduced confidence compared to healthy controls.

Several methodological factors could have contributed to these discrepancies between findings. Indeed, we observed high methodological heterogeneity across studies, which limited the ability to make comparisons among studies. First, the current review highlighted disparities between studies regarding the definitions of the explored subtypes of source-monitoring (*i.e.*, reality-, internal source-, or external source-monitoring). To harmonize this, we reclassified the selected studies according to the definitions given by Johnson *et al*<sup>[12]</sup>, where internal source monitoring refers to the distinction between two internal sources of information, reality monitoring refers to the distinction between internal and external sources, and external source monitoring refers to the distinction between two external sources. Thus, according to these definitions, some studies that announced the investigation of reality monitoring were reclassified into studies investigating internal source monitoring. In this way, action recognition tasks involving discrimination between actions that were either performed or imagined by the subject<sup>[19,22-25]</sup> and word recognition tasks involving discrimination between imagined and traced words<sup>[20]</sup> were reclassified as internal source-monitoring tasks (see [Table 1](#))

Second, we observed a large heterogeneity across studies regarding the paradigm used to assess source-monitoring processes. These paradigms included either word, action, drawing voice or object recognition. However, despite this limitation, studies revealing significant differences between OCD-related symptoms and controls used either action or voice recognition tasks. This is in line with studies in patients with schizophrenia that highlighted reality-monitoring impairments using various paradigms, including action, word or speech recognition tasks<sup>[30]</sup>, indicating that the identification of source-monitoring deficits is independent of the experimental paradigm.

Beyond the specificity of the task, the diversity in methods also highlights the importance of ecological validity when assessing source-monitoring performance. Such an approach seems particularly relevant not only in action recognition tasks where patients faced real life settings but also in item choices within tasks<sup>[31]</sup>. For instance, Constans *et al*<sup>[22]</sup>, Cogle *et al*<sup>[23]</sup>, Hermans *et al*<sup>[24]</sup> and Reese *et al*<sup>[26]</sup> investigated source monitoring for anxiety-evoking situations (turning on/turning off the lights). However, these studies did not report any significant impairment in patients, suggesting that this approach may not be useful for investigating source monitoring in patients with OCD. Furthermore, this large heterogeneity could partly

explain the inconsistencies observed between studies. The different categories of stimuli used in each of the retrieved studies (*e.g.*, neutral, OCD-relevant, personally relevant, bothersome, real-life action) limit any comparisons among studies, and therefore, any meta-analysis.

The present review also highlighted a large heterogeneity among studies regarding the included population. Indeed, the various studies investigated source monitoring in patients with general OCD symptomatology<sup>[24-29]</sup>, in patients with OCD specifically displaying checking symptoms<sup>[19,20,22,23]</sup> and in subclinical checking-prone individuals<sup>[10,15,21]</sup>. Most studies failed to reveal any significant source-monitoring deficits. However, it should be noted that among 5 important studies<sup>[15,19,21,27,28]</sup>, 4 revealed internal source-, reality-, or external source-monitoring deficits in checkers (clinical or subclinical) compared to noncheckers<sup>[15,19,21,27]</sup>. This suggests that a possible general deficit in discriminating the source of information may specifically affect subjects with checking compulsive behaviors. Current observations emphasize that research on source-monitoring deficits in OCD should consider the type of OCD as an essential variable (*i.e.*, checking, symmetry-ordering, contamination-washing, hoarding). Nevertheless, several studies we reviewed here show a great heterogeneity or even a lack of measurement of OCD symptoms, preventing us from distinguishing source-monitoring abilities across subgroups of patients<sup>[24-26,28,29,31]</sup>. Consequently, future research would benefit from considering the multidimensional property of OCD and incorporating a more comprehensive measure of OCD symptoms by a systematic use of standardized classifications such as the Yale-Brown Obsessive-Compulsive Scale<sup>[32,33]</sup>.

Finally, several confounding factors were not controlled: the duration of the disease, age of onset were not reported, pharmacological treatments were either heterogeneous or not reported, and patients with comorbidities were excluded, included or not controlled. Moreover, although consistent differences between gender and ethnicity have been reported regarding OCD phenomenology<sup>[34,35]</sup>, most of the studies retained in the current review did not provide results or did not assess their influence on source monitoring performances. Furthermore, the number of subjects included in the studies (from 12 to 48, mean across studies < 25) was too small to achieve sufficiently statistical power to conclude that there was no source-monitoring deficit associated with OCD's related symptoms, gender or ethnicity. Additionally, from a methodological point of view, some authors first investigated source monitoring in patients with OCD without a priori differentiating clinical subtypes but undertook an a posteriori comparison between checkers and noncheckers<sup>[24,25,27]</sup>. This approach did not allow an adequate a priori estimation of the sample size required to conclude with sufficiently statistical power. Another methodological limitation was the interpretation of negative findings based on p values using a frequentist approach. Further studies with Bayesian statistics could help us to determine whether to reject the null hypothesis.

A confidence impairment in general memory has been associated with OCD severity<sup>[36]</sup>. Here, the numerous studies reviewed reported a lack of confidence in source-monitoring functioning or a lack of global cognitive confidence. Interestingly, this lack of confidence has been found in both checkers<sup>[10,19,20,23]</sup> and noncheckers<sup>[20,24,25]</sup>, suggesting that it is a cognitive marker for general OC symptoms. These findings raise the question of whether the participant's lack of confidence participates in his or her potential source-monitoring deficit. However, only three studies that revealed a significant source-monitoring deficit also investigated confidence, leading to heterogeneous results. Namely, a single study from Ecker *et al*<sup>[19]</sup> revealed positive results, whereas Zermatten *et al*<sup>[21]</sup> found no difference in confidence between groups, and Kim *et al*<sup>[28]</sup> found no correlation between source-monitoring results and confidence. This observation should be carefully considered since Kim *et al*<sup>[28]</sup> evaluated the participants' global cognitive confidence, whereas the other two studies specifically measured confidence in source-monitoring judgments. Future studies should systematically investigate the relationship between source-monitoring scores and source-monitoring confidence.

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## CONCLUSION

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With most of studies concluding with negative results, the present review suggests a lack of global source-monitoring or specific internal source-monitoring deficits in patients with OCD. However, this review highlighted several methodological limitations regarding the tasks used and the statistical power of the included studies. A crucial factor to explain this is the age of the studies, which were published between 1983 and 2011. Future studies with sufficiently powered samples of patients

with OCD should consider the multidimensional property of OCD (*i.e.*, symmetry-ordering, contamination-washing, hoarding, aggressive obsession-checking, sexual-religious thinking), explore the subtypes of source-monitoring abilities (reality-, internal source-, external source-monitoring), and systematically investigate source-monitoring scores in relation with an evaluation of confidence in judgments.

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