Current Psychology (2021) 40:840–852
https://doi.org/10.1007/s12144-018-0011-8

Experience-based knowledge increases confidence in discriminating our memories

Ewelina Cichoń[1] · Łukasz Gawęda[2,3] · Steffen Moritz[3] · Remigiusz Szczepanowski[4]

Published online: 26 September 2018

Abstract

The present study investigated the accuracy of metacognitive judgments in source monitoring with self-report scales engaging either information- or experienced-based knowledge. We expected that the source monitoring abilities may be affected by the origins of meta-knowledge that underlie post-decision wagering (PDW) based on economic categorizations (experience-based scale) and confidence ratings (CR) using a conventional taxonomy of confidence (information-based scale). To examine this hypothesis, healthy participants ($N = 50$) performed an action memory task, in which simple actions were presented in order to be performed or imagined. In the second phase of the task, participants were required to assess source monitoring by distinguishing whether the presented action was performed or imagined. Then, the participants randomly assigned into the PDW or CR group rated their confidence in responses related to source monitoring performance. It was found that source monitoring ability is resistant to manipulation of the type of knowledge used in the scales. However, measures of metacognition indicated that accuracy of the experienced-based judgments of PDW was higher as compared to the CR scale while source monitoring. These findings suggest the origin of knowledge whose justification rests more on empirical observations generates more accurate knowledge than self-evident direct intuition with respect to discriminations of one's own memories.

Keywords Source monitoring · Metacognition · Confidence ratings · Post-decision wagering

Introduction

Correct discriminations between internal and external experience are crucial for adaptive behavior and effective decision-making (Roberts and Blades 2000). All of us may sometimes fail to discriminate the origins of our mental experiences (Mitchell and Johnson 2000). For example, three-year-old children may have difficulties correctly discriminating between fantasy and reality (Taylor and Howell 1973). Researchers refer to as source monitoring the cognitive activity that is engaged in discriminations about information sources in terms of memory, knowledge or beliefs (Johnson et al. 1993). Johnson et al. (1993) distinguished different types of source-monitoring processes based on the various sources the information comes from. For instance, reality-monitoring capacity represents the monitoring process that is related to discriminating the phenomenal qualities of internally generated information and memories of externally derived information (Johnson and Raye 1981). The other class of monitoring processes is considered by Johnson et al. (1993) to be source-monitoring that describes an individual's ability to discriminate between two internal sources of information (e.g. imagined versus perceived memories).

Contemporary experimental research shows that the aforementioned source monitoring processes are fundamental in establishing adequate cognitive functioning in the real world, and their abnormalities more likely affect the quality of an individual's everyday life (Roberts and Blades 2000). For instance, studies on aging have shown that both internal and external source monitoring (Brown et al. 1995; Dulas and Duarte 2014; Mitchell et al. 2006) and action source monitoring become impaired with increasing age. This has been demonstrated in healthy adults who attribute memories and actions to the incorrect source (Cohen and Faulkner 1989). The

✉ Remigiusz Szczepanowski
rszczepanowski@swps.edu.pl

1 Department of Psychology, Faculty of Education, University of Lower Silesia, Wroclaw, Poland

2 II Department of Psychiatry, Medical University of Warsaw, Warsaw, Poland

3 Department of Psychiatry and Psychotherapy, University Medical Center Hamburg-Ependorf, Hamburg, Germany

4 Wroclaw Faculty of Psychology, SWPS University for Social Sciences and Humanities, 30b Ostrowskiego Street, 53-238, Wroclaw, Poland

cognitive conceptualization of people's capacity to discriminate the sources of mental experience also serves as a theoretical background for explaining reality distortions such as hallucinations (Baker and Morrison 1998; Brunelin et al. 2006; Gawęda et al. 2013; Waters et al. 2012; Woodward and Menon 2013) or self-disturbances (Nelson et al. 2012) in psychosis (see meta-analysis: Waters et al. 2012; Woodward and Menon 2013). Nevertheless, as shown before, self-monitoring errors[1] are also common in the general population (Johnson 1997). Regarding potential mechanisms that may negatively affect source monitoring discrimination, it was empirically verified that the more similar the sources of information are, the higher the probability of erroneous discrimination (Johnson 1997). Moreover, when considering internal self-monitoring, internally generated events (e.g. an imagining performing an action) are more likely to be confused with actual events (e.g. action performed in reality) if they are more perceptually vivid (Johnson 1997).

It is important to emphasize that mental experiences from various origins (e.g. perception and imagination) differ in their phenomenal qualities, such as vividness of memories, or spatial and temporal resolutions (Koriat 2006). The extent to which we trust such discriminations depends on subjective assessment of the potential effectiveness of our own cognitive processes (Koriat 2000). This indicates that if one tries to retrieve information from memory, one may also have a feeling that informs us what needs to be done to "guide and affect our behavior" (see Koriat 2000). The subjective assessment of one's own memories engages several cognitive processes with varied hierarchical organization. In fact, most researchers have adopted a conceptual framework of metacognition for elaborating the notion of subjective knowledge and confidence (Nelson et al. 1999). The underlying assumption of such a view is that cognitive processes operate on two or more interrelated levels and there is a dynamic interplay between low-level representations and organizationally higher-level knowledge (Nelson et al. 1999). It has been claimed elsewhere (see: Nelson et al. 1999) that the meta-level is engaged in inspecting and managing object-level operations. It is important to emphasize that inadequate cognitive confidence related to one's own experiences either in clinical or healthy populations may attenuate or even preclude regulative mistrust in faulty decisions and, in fact, may lead to extreme beliefs and distortions in self-monitoring while perceiving reality (Gawęda et al. 2013). Moreover, it turned out that overconfidence in source monitoring errors may prevent alternative explanations and predispose people to keep inadequate knowledge (Moritz and Woodward 2006a, b, c). Thus, if holding a metacognitive view, one can expect that metacognitive judgments can be used to specify the sources of memory efficiently.

Interestingly, there is an important implication of metacognition and self-regulation by Koriat (2006, 2012), who postulates that there are two types of metacognitive judgments that can assess and affect object-level operations: information- and experience-based judgments. In particular, the first type of knowledge represents metacognitive judgments relevant to beliefs and memories about one's own competence and cognitions (Koriat 2006). For example, individuals evaluate performance in tasks on beliefs on the basis of how much expertise they have in some competence domain, saying, "*I have a poor memory*". On the other hand, there are experience-based judgments relying on heuristics that result in a state of intensified subjective feelings (e.g. Koriat 2006, 2012). For instance, one expresses such metacognitive judgments on the contribution of mnemonic cues, such as the fluency with which information is encoded, or its vividness of memories (Koriat 2006, 2012). In the case of information-based judgments, their accuracy depends on the validity of the theories, knowledge and beliefs available in long-term memory, on which they are based (Koriat 2006, 2012). It has been claimed that experience-based judgments depend on the diagnostic value of heuristics and information accessible in short-term memory (Koriat 2006, 2012). This, in turn, raises an important question how different measures of metacognitive judgments can affect internal source-monitoring.

Experimental research attempts to establish assessments of subjective confidence in one's own knowledge by studying self-reports. Self-report procedures such as confidence ratings (CR) and post-decision wagering (PDW) can be considered the most commonly applied measures of metacognition (Dienes and Seth 2010; Sandberg et al. 2010; Persaud et al. 2007; Szczepanowski 2010; Wierzchoń 2013). The CR scale is commonly used with respect to perception tasks in which participants are required to report how certain they are of having perceived an item (Cheesman and Merikle 1984), or about how certain they are of giving a correct response in forced-choice tasks (Sandberg et al. 2010; Szczepanowski et al. 2013). Although CR is considered a very elementary and straightforward measure of meta-knowledge (Sandberg et al. 2010), this scale is sometimes criticized on account of its abstractness (Persaud et al. 2007; Wierzchoń 2013). The PDW scale is an intensely explored method intended to measure metacognitive knowledge, with the amount of wagered money expressed as confidence (Persaud et al. 2007; Szczepanowski 2010; Szczepanowski et al. 2017). This method estimates metacognition by asking participants to place monetary wagers on the accuracy of first-order discriminations (e.g. whether or not a stimulus was presented) or express their confidence in terms of correct or incorrect answers. In particular, PDW represents a variation of metacognition measures that employ wagers (imaginary or real small amounts of money) instead of

[1] Two source-monitoring situations can be identified: (b) *external source monitoring* related to discriminating between (e.g., statements heard on television versus heard from a friend); and (c) discriminating between two internal sources (e.g., imagined versus perceived memories), termed as *self-monitoring* (Johnson et al. 1993).

numerical confidence ratings. In this way, wagering is a sort of a gambling game in which the participant has to bet on the correctness of the yes–no decisions by placing either high or low wagers (Szczepanowski 2010). Correct wagers in such game result in accumulation of earnings from their wagers, while incorrect wagers are being deducted from earnings throughout the whole task. There are several versions of the application of PDW scale. For instance, Persaud and colleagues (Persaud et al. 2007) employed dichotomous scales (high vs. low wager); however, multiple-point scales (such as £1, £2, £5 or £10) may be also used to categorize metacognition (see: Fleming and Dolan 2010; Szczepanowski et al. 2013, 2017). PDW seems to require both adequate metacognitive strategies and heuristics as it increases the chances of making profits and reducing losses (Szczepanowski 2010). Some researchers have also emphasized the fact that this scale is prone to risk aversion (Schurger and Sher 2008), therefore wagering may be biased to some extent: even though participants were certain of their decisions, they tended to bet low (Szczepanowski et al. 2017), particularly when detecting subtle stimuli (Dienes and Seth 2010; Sandberg et al. 2010).

The characteristics of both self-report scales given above have important implications because the use of CR and PDW measures may have a differential impact on assessing source-monitoring processes. In other words, the type of knowledge underlying the metacognitive scale may influence one's own source-monitoring processes. Following the metacognitive considerations by Koriat (2012), it is clear that the CR scale represents an information-based approach that mostly relies on one's own beliefs and knowledge retrieved from long-term memory (Koriat 2012). Unlike information-based judgments, PDW uses typical experienced-based judgments that rely on the contribution of mnemonic cues that are extracted from performance and stored in short-term memory (Koriat 2012). In fact, one can assume that both types of knowledge applied in the scales refer to different origins: rational and empirical (Koriat 2012), respectively. It seems quite clear that CR judgments are self-evident, originate from direct intuition and may represent intuited universal truth (rational knowledge) on one's own knowledge. PDW responses rely on predicted outcomes from a type of gambling game that aims to maximize possible profits and employ specific response strategies, such as loss aversion affecting advantageous wagers (Szczepanowski et al. 2017). This suggests that PDW judgments are more based on empirical knowledge.

Because the origins of knowledge are inconsistent among information- and experience-based judgments, both metacognitive scales may differ in people's subjective assessment of one's own source-monitoring information. Although studies on deficits in source-monitoring and metacognition are well established (e.g., Belli and Loftus 1994), so far, to the best of our knowledge, no empirical study has examined the accuracy of different metacognitive judgments on source-monitoring performance. To investigate empirically the accuracies of both metacognitive judgments in evaluating self-monitoring, we applied PDW and CR scales to an action memory paradigm developed by Moritz et al. (2009) that was used in several studies on clinical population by Gawęda and colleagues (Gawęda et al. 2012, 2013, 2018). In the present study, we administered this paradigm on healthy individuals. Particularly, participants within this paradigm were required to perform or imagine simple physical actions (such as "*Put your hand on your heart*"), and then were asked to distinguish whether the presented action was imagined or performed by them and to rate their confidence in their responses. In the present study, we randomly assigned participants from the population sample according to response mode so that half of the participants used the CR scale, while the other half used the PDW scale. We expected differences in subjective assessments categorized either with information-based or experience-based judgments in attempts to validate their own memories. Following Nelson's view on hierarchical organization of subjective judgments (Nelson et al. 1999) as well as the Koriat's account on the structure of metacognition (Koriat 2012), one can therefore expect that the usage of distinct metacognitive judgments (information-based vs. experience-based judgments) to validate the sources of memory may affect accuracy of metacognitive knowledge. In addition, taking into account a regulatory function of metacognitive knowledge on the low-level information processing (e.g. Nelson et al. 1999), it may be expected that more accurate metacognitive judgments can improve performance in the action memory task. Given these assumptions, our specific hypotheses in the study were the following: (i) the accuracy of meta-knowledge (i.e. levels of confidence, knowledge corruption index (KCI), monitoring resolution (MR) parameter; see the Method section for more details) would be greater for the group using experience-based cues (the PDW scale) than for the group employing information-based judgments (the CR scale); (ii) performance in the action memory task would be better for the use of the PDW scale as compared to the CR scale.

Methods

Participants

Fifty healthy individuals (37 females and 13 males) from the SWPS University of Social Sciences and Humanities in Wroclaw (Poland) with a mean age of 27.84 ($SD = 8.03$) participated in this study after informed consent was obtained. Participants took part in the study in exchange for credit points. All of them had normal or corrected-to-normal vision. Participants who reported a history of psychiatric or neurological disorders were excluded from the study. The study was approved by the local Ethics Committee.

Action Memory Task

We employed an action memory task proposed by Moritz et al. (2009) and adapted to Polish by Gawęda et al. (2012, 2013). Figure 1 presents a diagram of the action memory task procedure used in our study. This research paradigm consisted of two phases. In the learning phase, participants were asked to imagine or perform presented actions in accordance with instructions displayed on a computer screen. An action instruction set presented in green frames had to be performed, whereas action instructions set in red frames had to be imagined, but not performed. Before the experiment, all participants were instructed that they would be required to later recollect the presented actions and distinguish whether the action was imagined or performed by them; before the recognition phase, they were instructed to rate their confidence in their responses.

Before the beginning of the study, all participants took a short practice session that familiarized them with the task requirements. During the practice session, each participant performed two practice trials in order to get familiarized with the action memory task. The first instruction required action to be performed in terms of the memory task, while the second instruction demanded action to be imagined. The type of the practice instruction was administered randomly across participants. The action instructions used in the practice session were not part of the later stages of experiment (i.e. learning and recognition phases). In total, 38 items were used in the learning phase, 19 items requiring the participant to perform actions, and 19 items to imagine. Each instruction on the computer screen was displayed for 10 s. The second phase of this study was held about 24 h (± 1 h) after the learning phase. In this phase, 38 verbal instructions for the learning phase items were presented along with 20 new action instructions not familiar to participants. In the recognition phase, the items were presented in different fonts and placed in different locations on the screen than in the learning phase to preclude physical matching, i.e. prevent similarities between physical features of underlying fonts designed for the test items and previously learned items.

Participants were required to respond whether the corresponding instruction had been presented as a performed, imagined, or new action, and were then asked to rate their confidence on a rating scale. Participants were randomly assigned to groups using either information-based knowledge or experience-based knowledge conditions. The first group expressed their confidence with confidence ratings (CR), and the second group with post-decision wagering (PDW).

Subjective Measures of Source Monitoring

Both subjective scales employed in this experiment were randomized across participants, who were asked to rate their

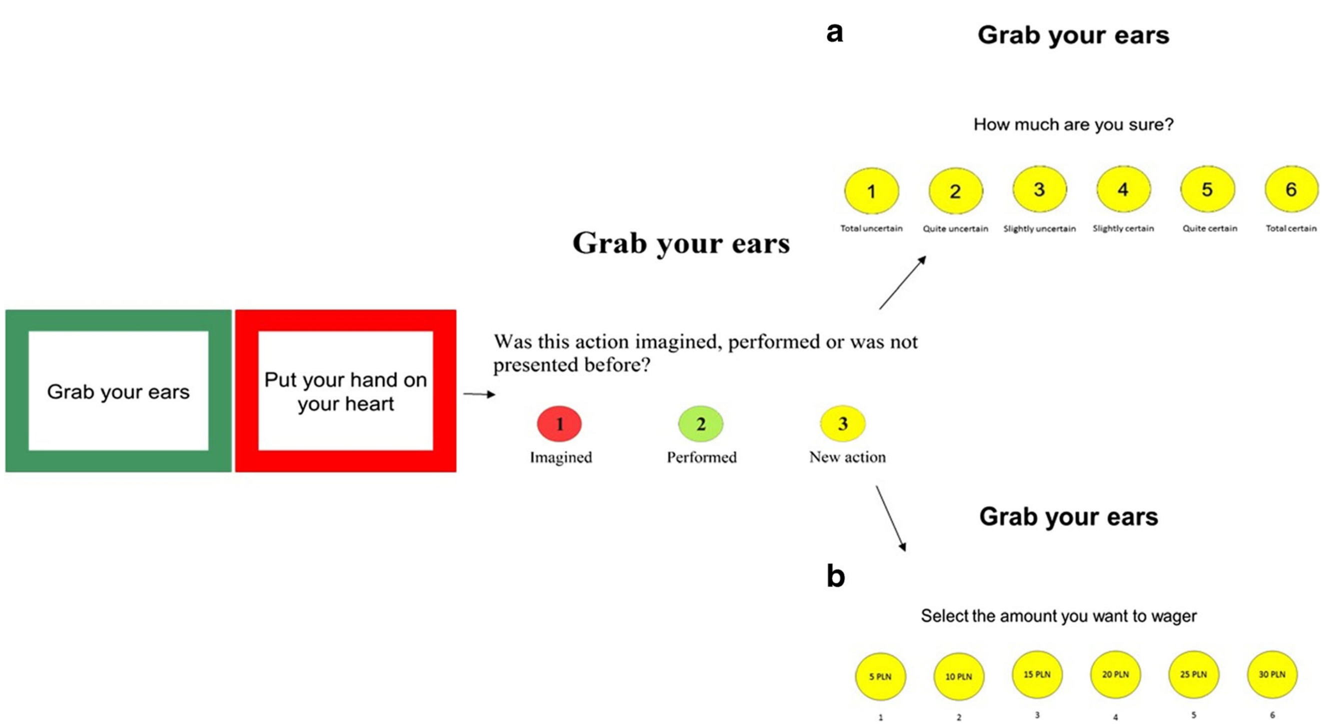

Fig. 1 The procedure of the action memory task with confidence assessment: **a** CR scale; **b** PDW scale. The task consisted of two phases: 1) Learning Phase: participants imagined (19 items) or performed (19 items) presented actions (green frame - performed; red frame - imagined); 2) Recognition Phase: recognition whether instruction had been a performed or imagined action, or was new (20 new action instructions)

certainty in the action memory recognition by choosing numerical keys on the keyboard (from 1 to 6). In the case of the CR scale, the six levels of confidence were expressed in the following manner: 1 – "Totally uncertain", 2 – "Quite uncertain", 3 – "Slightly uncertain", 4 – "Slightly certain", 5 – "Quite certain", 6 – "Totally certain". The Cronbach's alpha coefficient calculated for CR measure reached the value of 0.937. The second PDW scale was adapted in a similar manner as that of Szczepanowski and colleagues (Szczepanowski et al. 2013): participants were asked to express their confidence as imaginary wagers, that is, they did not receive any monetary reward at the end of the task. Wagers of 5, 10, 15, 20, 25 and 30 PLN (1 PLN is around .20 EUR) were used in the present study. The Cronbach's alpha coefficient for the PDW scale was 0.929. Participants were told that they would take part in a gambling game with the imaginary wagered amount gained when they made accurate wagers on correct discriminations. When the wagers were inaccurate, the participants were told that the wagered amount would be lost.

Quantitative Measurements of Meta-Knowledge Accuracy

We inspected the accuracy of information- and experience-based judgments in the action memory task using two measurements that indexed the quality of participants' knowledge. The first measure was the so-called knowledge corruption index (KCI) (Gawęda et al. 2012; Laws and Bhatt 2005; Moritz and Woodward 2006b, c), which takes into account confidence and the extent of source memory errors (Moritz and Woodward 2006b). In particular, by establishing the proportion of high-confident false responses to the number of all high-confident memories (Gawęda et al. 2012; Moritz and Woodward 2006b), the KCI index refers to a proportion of failures in source-monitoring responses that were followed by the highest degree of confidence ("*Totally certain*") to all other responses given with high confidence (Moritz and Woodward 2006b, c). The elevated value of KCI indicates inaccuracy of knowledge suggesting that individuals keep their faulty beliefs (false memories) with strong conviction that their memories are true; whereas the lower KCI value indicates accuracy of knowledge, thus leading people to be convinced that their incorrect memories are false. The second measure of metacognitive accuracy was monitoring resolution (MR), which evaluates the strength of associations between confidence and performance accuracy (Koriat 2006; Koriat and Goldsmith 1996; Koren et al. 2004). The MR parameter refers to the extent to which metacognitive judgments are correlated with performance across items (Koriat 2006; Koriat and Goldsmith 1996; Koren et al. 2004). This parameter is calculated for all responses as the Kruskal-Goodman gamma correlation between confidence levels and the correctness of responses (Koren et al. 2004). Thus, monitoring resolution indicates that the accuracy of knowledge increases when correct responses tend to be assigned with higher confidence and all faulty answers are assigned lower confidence (Koriat and Goldsmith 1996).

Statistical Analysis

First, we assessed effects of metacognitive judgements (information-based vs. experience-based knowledge) on performance in the action memory task. To do so, correct and incorrect responses for old vs. new item recognition and correct and incorrect source-monitoring attributions were calculated. The effects of metacognition were investigated by analyzing group differences with one-way analysis of variance (one-way ANOVA). All responses were submitted to one-way ANOVA, and the impact of the group (the type of knowledge) on old vs. new item recognition and source monitoring attributions was examined. Next, to assess the accuracy of metacognitive judgments made by CR and PDW scales in the context of revealing one's own memories, we calculated the two aforementioned parameters related to accuracy of metaknowledge for old/new and action source-monitoring recognitions using the KCI index (Gawęda et al. 2012; Moritz and Woodward 2006b) and the monitoring resolution parameter (Koren et al. 2004). Then, we used one-way ANOVA to examine how metacognitive knowledge (PDW vs. CR) affected its accuracy by analyzing KCI and MR measures. In the final step, we employed a two-way, mixed-design repeated measures multivariate analysis of variance (MANOVA) to examine effects of metacognition (information-based vs. experienced based knowledge) on confidence in source-monitoring responses: imagined actions as imagined ("imagined-imagined" actions), performed actions as performed ("performed-performed" actions), imagined actions as performed ("imagined-performed" actions) and performed actions as imagined ("performed-imagined" actions). The MANOVA included the between-subjects factor of group (the use of CR vs. PDW) and the within-subjects factor of the "remembered" source of information. The significant interaction effects for the MANOVA were then analyzed with repeated-measures follow-up tests. For all statistical tests, the level of significance was .05.

Results

Demographic Characteristics of the Groups

Demographic characteristics of the groups are presented in Table 1. There were no significant differences between groups regarding the gender factor, $\chi^2(1) = .936$, $p = .333$ and age, $t(48) = 1.39$; $p = .172$ (see Table 1).

Table 1 Demographic characteristics of groups

Source	Response			
	CR (n = 25)	PDW (n = 25)	Statistics	*p* value
Age	29.40 (8.56)	26.28 (7.30)	*t* (48) = 1.39	*p* = 0.172
Gender				
Male	*n* = 8	n = 5	χ2(1) = .936	*p* = 0.333
Female	*n* = 17	*n* = 20		

Mean and standard deviation are given for age and numbers of males/females are given for gender

Analysis of Object-Level Operation for Source Monitoring

The analysis of the data revealed that there was no influence of the type of knowledge used on self-monitoring responses. The results are presented in Table 2. We found no difference between the CR and PDW group in correct recognition of new items, $F < 1$, no effect of the group variable on forgetting performed items and forgetting imagined actions, $F < 1$. No effect of the group was found for correctly performed action recognition, $F < 1$, and correctly imagined actions, $F < 1$. There were no effects of the group for imagined actions misattributed as performed, $F < 1$, or for performed actions recognized as imagined, $F < 1$.

Confidence Ratings for Action Memory Recognition and Action Self-Monitoring

We began our analysis of confidence by comparing the accuracy of the CR and PDW scales for each of the self-monitoring processes. The comparison of the mean ratings is presented in Table 3. We analyzed differences between the groups for true hits, i.e. responses where old items were recognized as old and new items recognized as new. In the case of correct new/old recognition, there were significant differences in the confidence between the groups, F (1, 48) = 5.20, $p = 0.027$, partial $\eta^2 = 0.098$. With regard to incorrect new/old recognition, we also observed group differences, F (1, 48) = 7.38, $p = 0.009$, partial $\eta^2 = 0.133$. It turned out that confidence was higher for the CR scale than the PDW scale both for correct and incorrect new/old recognition.

Furthermore, we examined the group differences in correct and incorrect self-monitoring responses. The ANOVA indicated the differences in confidence responses for incorrect self-monitoring, F (1, 48) = 9.12, $p = 0.004$, partial $\eta^2 = 0.160$. It appeared that for incorrect self-monitoring responses, participants from the CR group evaluated their confidence significantly higher ($M = 4.70$, $SD = 0.85$) than participants using PDW ($M = 3.74$; $SD = 1.36$). No group differences were found with respect to the confidence responses for correct action self-monitoring, F (1, 48) = 0.83, $p = 0.368$, partial $\eta^2 = 0.017$.

Metacognitive Judgments Accuracy

Firstly, we evaluated accuracy of knowledge with KC indices for the old/new recognition and for the discrimination between imagined and performed actions (see Table 4). It turned out that the KCI index for the inability to distinguish imagined from performed actions in the PDW condition was lower ($M = 3.26\%$; SD = 4.26%) than in the CR condition (M = 6.25%; SD = 4.70%), F(1, 46) = 5.27; $p = 0.026$, partial $\eta^2 = 0.103$. However, in the case of false old/new discriminations, no difference between the CR and PDW groups was observed ($M = 10.59\%$; $SD = 7.90\%$; $M = 7.93\%$; $SD = 7.63\%$, respectively), F(1, 48) = 1.47; $p = 0.232$, partial $\eta^2 = 0.030$. This indicated that participants from the CR group were more convinced that incorrect self-monitoring recognition was correct than subjects who used PDW judgments. These findings suggested higher accuracy of the empirically based knowledge that underlies PDW response.

Furthermore, we separately calculated the monitoring resolution values for old/new recognition and self-monitoring (see Table 5). It turned out that MR measures indicated that self-monitoring responses were influenced by the type of

Table 2 Group of the type of scales (PDW vs. CR), differences in recognition of old/new items, and source-monitoring responses

Variables	CR (n = 25) M (SD)	PDW (n = 25) M (SD)	Statistics
Old/new recognition			
Correct responses	41.76 (5.54)	42.36 (6.89)	*F*(1,48) = .115, *p* = 0.736
Performed actions attributed as new (forgetting)	1.76 (1.66)	1.56 (1.58)	*F*(1,48) = .189, *p* = 0.665
Imagined actions attributed as new (forgetting)	4.36 (2.38)	4.32 (3.47)	*F*(1,48) = .002, *p* = 0.962
Source-monitoring responses			
Correct: performed	14.20 (2.56)	14.36 (2.77)	*F*(1,48) = .045, *p* = 0.833
Correct: imagined	12.00 (2.83)	12.48 (4.34)	*F*(1,48) = .215, *p* = 0.645
Imagined actions attributed as performed	2.64 (1.75)	2.08 (2.00)	*F*(1,48) = = 1.109, *p* = 0.297
Performed actions attributed as imagined	2.72 (1.90)	3.00 (2.41)	*F*(1,48) = .207, *p* = 0.651

Table 3 Response confidence (means and standard deviations) for correct and incorrect self-monitoring and old/new recognition

	CR ($n = 25$)		PDW ($n = 25$)				
	Mean	SD	Mean	SD	statistics	p value	partial η^2
New/old Correct	5.26	0.50	4.89	0.65	$F_{(1,48)} = 5.20$	= 0.027	= 0.098
Self-monitoring	5.29	0.53	5.14	0.61	$F_{(1,48)} = 0.83$	= 0.368	= 0.017
New/old Incorrect	4.47	0.76	3.82	0.94	$F_{(1,48)} = 7.38$	= 0.009	= 0.133
Self-monitoring	4.70	0.85	3.74	1.36	$F_{(1,48)} = 9.12$	= 0.004	= 0.160

knowledge, $F(1, 48) = 5.60$; $p = 0.022$, partial $\eta^2 = 0.104$. We found that the MR parameter was higher for the PDW scale ($M = 0.61$; $SD = 0.20$) than the CR scale ($M = 0.44$; $SD = 0.31$). In addition, there were no group differences regarding correct labeling of new/old actions, $F(1, 48) = 0.98$; $p = 0.328$, partial $\eta^2 = 0.020$ ($M_{pdw} = 0.59$; SD = 0.19; $M_{cr} = 0.53$; SD = 0.20). These findings suggested higher accuracy of knowledge engaged in the PDW responses to assess self-monitoring.

Multivariate Analysis of Variance for Confidence Responses in Self-Monitoring

In the final step of our analyses, we tested effects of metacognition (information-based vs. experienced based knowledge) on confidence that was expressed for the self-monitoring responses ("imagined-imagined", "performed-performed", "imagined-performed" vs. "performed-imagined" actions).The MANOVA showed a significant main effect for the group, $F(1, 35) = 7.35$, $p = 0.010$, $\eta_{partial}^2 = .174$. We observed that confidence rated by participants in the CR group was higher (M = 5.10, SD = .15) than for the PDW group (M = 4.48, SD = .17) regardless of the information source. The analysis indicated also the main effect for the remembered actions, Wilks' Lambda = .22, $F(3, 33) = 39.43$, $p < 0.001$, $\eta_{partial}^2 = .782$. The post-hoc analyses with the Bonferroni adjustments ($p < 0.001$, all three tests) indicated the higher confidence for the "performed-performed" actions (M = 5.46, SD = .085) than confidence expressed for other remaining response categories such as "imagined-imagined" actions (M = 4.92, SD = .135), "performed-imagined" actions (M = 4.18, SD = .18), and "imagined-performed" actions (M = 4.60, SD = .18). The post-hoc analysis ($p < 0.001$) indicated also the higher level of confidence for the "imagined-imagined" actions (the correct responses) than the level of the "performed-imagined" actions (the incorrect responses). The MANOVA yielded also a significant interaction effect between meta-knowledge and remembered source of information, Wilks' Lambda = .73, $F(3, 33) = 4.18$, $p = 0.013$, $\eta_{partial}^2 = .275$. To examine this interaction further, we conducted separate analyses of the simple main effects by testing differences in mean confidence across four response categories within the fixed level of the group variable (see Fig. 2). For the CR condition, the follow-up analysis revealed a significant main effect of the remembered source of information, $F(3, 33) = 11.98$, $p < .001$, $\eta_{partial}^2 = .52$. Then, we ran separate post-hoc comparisons with Bonferroni corrections to inspect significant differences in confidence rated for remembered actions with the usage of CR. The post-hoc analyses indicated that the level of confidence in "performed-performed" actions was higher (M = 5.55, SD = .11) than the levels for "imagined-imagined" actions (M = 5.04, SD = .18), and "performed-imagined" actions (M = 4.70, SD = .23); although the level of confidence in "performed-performed" actions was the same as for "imagined-performed" actions (M = 5.10, SD = .23), $p = 0.167$. The post-hoc comparisons showed also no difference between the level of confidence for the "imagined-imagined" responses and the level of confidence

Table 4 Group differences in KC indices (means and standard deviations) for self-monitoring and old/new recognition

	KC index						
	CR ($N = 25$)		PDW ($N = 25$)				
	Mean	SD	Mean	SD	Statistics	p value	partial η^2
Old/new recognition	10.59%	7.90%	7.93%	7.63%	$F(1, 48) = 1.47$	= 0.232	= 0.03
	CR ($n = 25$)		PDW ($n = 23$)				
	Mean	SD	Mean	SD	Statistics	p value	
Self-monitoring	6.25%	4.70%	3.26%	4.26%	$F(1, 46) = 5.27$	= 0.026	= 0.103

Table 5 Group differences in the monitoring resolution parameter (means and standard deviations) for self-monitoring and old/new recognition

	Monitoring resolution						
	CR ($n = 25$)		PDW ($n = 25$)				
	Mean	SD	Mean	SD	Statistics	p value	partial η^2
Old/new recognition	0.53	0.20	0.59	0.19	F (1, 48) = 0.98	= 0.328	= 0.02
Self-monitoring	0.44	0.31	0.61	0.20	F (1, 48) = 5.60	= 0.022	= 0.104

for self-monitoring errors ("performed-imagined", $p = 0.708$ and "imagined-performed" actions, $p = 1.00$); in fact, when participants used the CR scale the levels of confidence in both self-monitoring responses were the same ($p = 0.644$). For the PDW condition, the ANOVA showed also a significant difference among the mean confidence for the remembered actions, F (3, 33) = 29.29, $p < .001$, $\eta_{partial}^2 = .73$. The results of the post-hoc comparisons with Bonferroni adjustments revealed that the level of confidence rated for "performed-performed" actions (M = 5.36, SD = .13) was higher than the levels of confidence for the "imagined-imagined" actions (M = 4.79, SD = .20), $p < 0.002$, "performed-imagined" actions (M = 3.66, SD = .27), $p < .001$ and "imagined-performed" actions (M = 4.10, SD = .27), $p < .001$. The post-hoc analysis ($p < .001$) showed that in case of PDW confidence for "imagined-imagined" responses was higher than for "performed-imagined" actions (self-monitoring error). No difference was observed between confidence for "imagined-imagined" and "imagined-performed" actions, $p = 0.136$ as well as between self-monitoring erroneous responses ("performed-imagined" vs. "imagined-performed" actions), $p = 0.732$.

Then, we ran follow-up analyses of the simple main effects of the scale (PDW vs. CR) within the fixed level of self-monitoring variable (see Fig. 3). We found that there were no significant differences in confidence between the CR and PDW scales for the "performed-performed" actions, F (1, 35) = 1.23, $p = 0.276$ and "imagined-imagined" actions, $F <$ 1. Although, the analyses showed significant differences in the levels of confidence for self-monitoring responses, since there were the main effects of meta-knowledge for the "performed-imagined" actions, F (1, 35) = 8.50, $p = 0.006$, $\eta_{partial}^2 = .20$ and for "imagined-performed" actions, F (1, 35) = 7.93, $p = 0.008$, $\eta_{partial}^2 = .19$) indicating that the levels of confidence in both self-monitoring responses were higher for CR (M = 4.70, SD = .23; M = 5.10, SD = .23) as compared to the PDW condition (M = 3.66, SD = .27; M = 4.10, SD = .27).

Discussion

The present study investigated the accuracy of metacognitive judgments with two self-report scales (post-decision wagering vs. confidence ratings) which utilized experience-based and information-based processes while performing the action memory task. Our study showed that experience-based knowledge involved in the usage of PDW produces more accurate judgments than information-based knowledge generated with the CR when validating self-monitoring. These findings indicate that empirical knowledge serves as more accurate metacognition in validating participant's own memories.

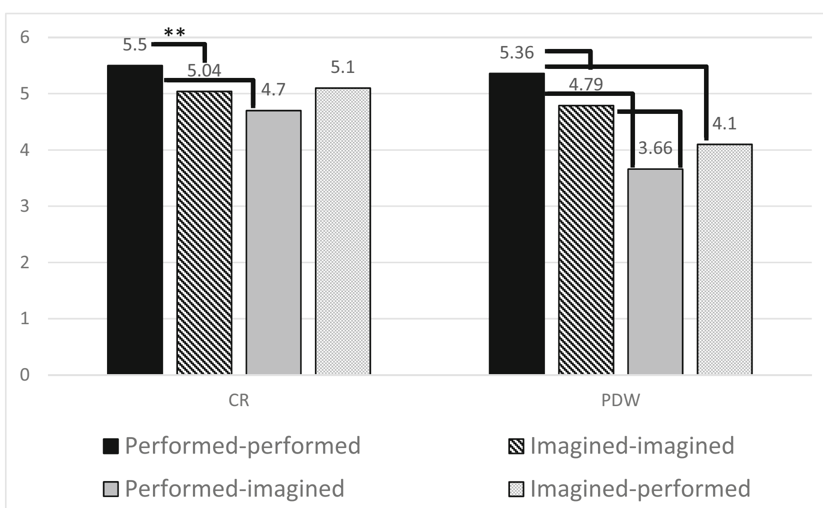

Fig. 2 Differences in levels of confidence in self-monitoring responses with respect to the type of the scale (CR vs. PDW). The mean levels of confidence in responses are presented. Note: ** — $p < 0.01$, *** — $p < 0.001$

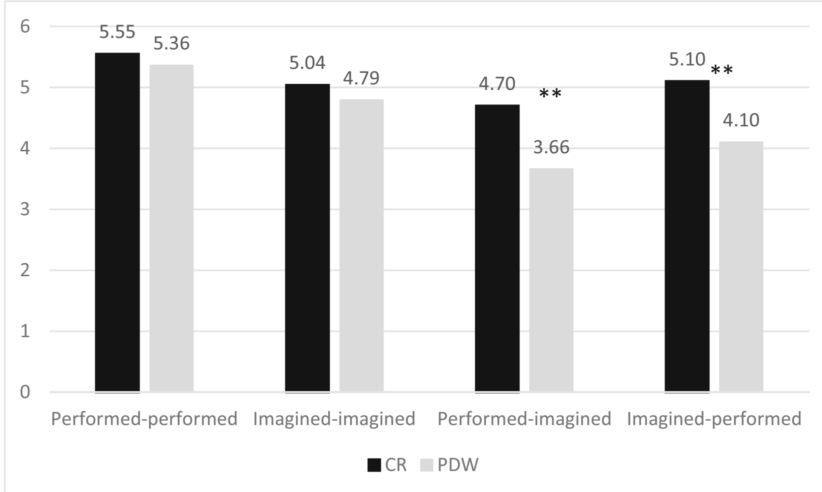

Fig. 3 Comparison for levels of confidence in self-monitoring responses with respect to scale type (CR vs. PDW). The mean levels of confidence in responses are presented. In general, the PDW group used lower confidence than the CR group when misattributed self-information (i.e. assessing performed actions as imagined and imagined actions as performed). Note: * — $P < 0.05$, ** — $P < 0.01$, *** — $P < 0.001$

Our findings were based on values of the knowledge corruption index (KC), which was lower for the PDW scale only in relation to self-monitoring. The KC index indicates that participants more accurately assessed their meta-knowledge using PDW than CR, particularly in respect to self-monitoring discrimination (i.e. imagined vs. performed actions) when compared to old/new recognition. Alternatively, participants using CR indicated diminished knowledge about their response correctness in the self-monitoring task. The higher values of the KC index in the CR group also suggests that participants using information-based reasoning processes are much more convinced that faulty answers for self-monitoring (imagined actions recognized as performed and performed actions recollected as imagined) were correct, relative to subjects using experience-based processes. Thus, disrupted cognitive confidence among participants using CR might have precluded adaptive distrust in incorrect decisions and, consequently, might have led to inadequate knowledge. However, it is worth to mention that although the group differences in accuracy of the metacognitive judgments are significant, the results from the size effect analysis show that these differences are not very large. The type of metacognitive knowledge explains approximately around 10% of variability of the KC and MR values (i.e. partial η^2 yielded the values of 0.103 and 0.104, respectively). Thus, our study suggests that the PDW measure is more accurate than CR, although as this difference may be minor further generalizations should be made with cautions.

Interestingly, Perfect (2004) showed that information-based judgments, such as presumptions about abilities, are commonly accurate in relation to general knowledge, but not in situations in which an individual has no knowledge about the accuracy of a performance and how confident he/she should be. Indeed, our results suggest that information-based judgments (CR) were not as accurate as experience-based judgments (PDW) when capturing meta-knowledge for self-monitoring. At the same time, both PDW and CR conditions did not differ with regard to metacognitive accuracy for recognition of new vs. old actions. Moreover, it turned out that the average confidence for old/new correct and incorrect recognition was higher when participants used the CR scale than the PDW scale. This suggests that impairments of meta-knowledge in self-monitoring with respect to the CR scale cannot be attributed to overall poorer meta-memory of the items, as indicated by old/new recognition. Yet, previous studies in a clinical sample (Gawęda et al. 2012, 2013) showed that old/new recognition is relatively less demanding than self-monitoring decisions. Hence, participants in decision-making for old/new actions may be more knowledgeable about the correctness of their decisions than when self-monitoring. For that reason, we suggest that improvements in metamemory accuracy influenced by experience-based processes may be specific for the more demanding cognitive activity associated with heuristics and specific response strategies. Our study also showed differences in monitoring resolution for usage of the PDW and CR scales. It was found that monitoring resolution varies depending upon the scale employed and higher values of monitoring resolution for PDW.

Again, these results suggest that the ability to discriminate between correct and incorrect answers is better when engaging experience-based knowledge (PDW judgments). The group who used experience-based judgments more frequently made correct decisions with higher confidence and expressed lower confidence for incorrect judgments. In fact, these findings are in line with the assumption that judgment based on heuristics such as vividness of memory is mostly accurate for discriminating true and incorrect memories (Moritz and Woodward 2006c). Thus, PDW scale-based processes that are more heuristic (e.g. vividness of memories) may facilitate more accurate metacognitive judgments. Thus, basing metacognitive judgments on heuristics, such as vividness of memories, may generate confidence that is more precise. Indeed, the monitoring resolution parameter as the measure of associations' strength between confidence and performance accuracy indicated that experienced-based knowledge generates more accurate judgments (MR = 0.61 for self-monitoring assessed by PDW; see Table 5) than information-based knowledge (MR = 0.44 for self-monitoring assessed by CR; see Table 5). Therefore, in the situations of more exacting tasks, the CR scale may activate fewer cognitive resources which would be necessary to assess the accuracy of knowledge compared to the PDW scale. This may cause that the assessment based on CR may be less accurate than appraisals done with PDW. It is worth noting that monetary incentives and economic decisions associated with PDW induce risk aversion, and one may expect a tendency to be more careful in judgments when wagering confidence of one's own performance. Specifically, participants more frequently made lower wagers on correct discriminations in visual perceptual tasks (Szczepanowski et al. 2017; Wierzchoń et al. 2012). On the other hand, Koriat (2006) emphasizes that people generally accurately evaluate their knowledge by demonstrating a positive correlation between performance and metacognitive judgments (Koriat 2006). Evidence of accuracy in subjective assessment of their knowledge is provided by studies on judgment of learning (JOL) (Dunlosky and Nelson 1992; Nelson and Dunlosky 1991). With respect to this concept, participants' ability to judge their own learning allows them to decide whether items being studied have been acquired sufficiently well (Nelson and Dunlosky 1991). Metacognition accuracy is assessed by comparing magnitudes of JOLs for the learned items with future recall. If participants' subjective evaluation is more accurate, then items receiving high JOLs are more likely to be recalled than items receiving lower JOLs. In fact, positive correlations between subjective and objective indexes of knowing are observed in empirical studies investigating confidence judgments in assessing the correctness of perceptual decisions (Szczepanowski et al. 2013). Our study extends previous findings by showing that the accuracy of meta-cognitive knowledge is a combination of task difficulty and the type of processes that are engaged in making a meta-cognitive decision. For less demanding tasks (new vs. old items recognition), theory-based and experience-based judgments lead to similar accuracy. However, meta-cognitive knowledge on more cognitively demanding self-monitoring decisions was significantly more accurate for the PDW condition.

In fact, the subsequent MANOVAs in our study have revealed interesting patterns of metacognition in the general population in terms of self-monitoring activity. The results clearly showed that the highest confidence was given to correct answers ("performed- performed" actions) when using the information-based knowledge. In particular, participants from the CR group expressed higher confidence for this response category than confidence for other type of correct answers ("imagined-imagined" actions) as well as self-monitoring erroneous responses (misattributed performed actions as imagined) as opposed to confidence expressed for incorrect answers ("imagined-performed" actions) that was on the same level. Moreover, we observed that confidence ratings for this type of error ("imagined-performed" actions) were at the same level when participants correctly recognized their imagined actions. Indeed, this striking pattern of metacognitive responses suggests that information-based judgments may activate in people who recognize their own real experiences from the past strong beliefs, accompanied by a high sense of truth, that any performed actions they experienced was real indeed. In fact, similar findings were observed in the study on self-monitoring in clinical population demonstrating that false beliefs related to some extent to real experienced activity were persistent and reluctant to change (Gawęda et al. 2012, 2013; Moritz et al. 2011). Interestingly, our study also shows that experienced-based knowledge may represent a more accurate form of meta-cognition. Clearly, the PDW group showed lower confidence for self-monitoring errors (i.e., misattributed imagined actions as performed) than confidence in correct answers related to performed actions remembered as performed. Our results also show that experienced-based knowledge results in diminished confidence in case of both types of misattribution errors (i.e. misattributed imagined actions as performed and misattributed performed actions as imagined). These findings may suggest that increased accessibility of experience-based processes may reduce overconfidence in faulty decisions and beliefs.

In fact, lower confidence for self-monitoring errors in the PDW group seems to be important for therapeutic reasons in terms of using such scale, for example, for metacognitive training for psychiatric disorders treatments. In the context of psychosis, it is clear that disturbances in the meta-level (confidence) may falsely appraise the object-level (basic perception processes, etc.), resulting in consequence in wrong beliefs held with strong conviction (e.g. delusional thinking). In fact, it was shown that therapeutic interventions based on metacognitive training aimed at weaken trust in delusional thoughts are efficient in reducing such clinical symptoms (Aghotor et al. 2010; Eichner and Berna 2016; Moritz et al. 2011; for review: see: Moritz et al. 2014). Thus, although our study was designed to investigate basic mechanisms linked with meta-cognitive judgments and self-monitoring, our findings may be applicable to the psychopathologies of metacognition, particularly in psychiatric disorders. Recent studies on psychiatric population that used similar action monitoring tasks (Gawęda et al. 2012, 2013; Moritz et al. 2009) or other types of source-monitoring paradigms have consistently shown that patients with schizophrenia tend to misperceive imagined actions as being performed (Franck et al. 2000; Mammarella et al. 2010; Gawęda et al. 2012). This specific self-monitoring bias was frequently observed in individuals with schizophrenia who experienced hallucinations (Gawęda et al. 2013). Moreover, patients with schizophrenia tend to be overconfident in their false decisions in a wide range of cognitive tasks, including a self-monitoring task (Moritz et al. 2005; Gawęda et al. 2012, 2013). A recent study has also suggested that above mentioned deficits are observed in the populations at clinical risk for psychosis and early psychosis (Gawęda et al. 2018). Confusing inner and outer sources of information (Morrison et al. 2007; Varese and Bentall 2011; Morrison et al. 1995; Morrison 2001; Garety et al. 2001), as well as confusing imagery with reality (Gawęda et al. 2013) are hypothesized to underlie psychotic symptoms. However, previous studies on cognitive confidence and self-monitoring utilized mostly CR taxonomies, investigate in this fashion the influence of theory-based decision processes on metacognition. Our findings suggest that it is likely that metacognitive judgments based on experience-based processes in psychiatric population may have impact on making more accurate decisions in self-monitoring. In fact, these outcomes are important for development and maintenance of psychosis because it is commonly observed that abnormal metacognition prevents reduction of psychotic symptoms, and often makes such symptoms more burdensome.

To summarize, our results show that various taxonomic characteristics of scales can engage various processes that underpin accuracy and inaccuracy of metacognitive judgments during self-monitoring. Particularly, the experience-based judgments associated with PDW can lead to more valid meta-knowledge in the context of monitoring processes. Thus, although the rational and empirical components of our knowledge are inseparable (Koriat 2012), our study suggests that people's epistemology, which often rests more on the 'external' world is more effective than self-evident direct intuition when assessing individual memories.

Funding This research has been supported by the National Science Center (Poland), and funded under the award number 2014/15/B/HS6/03834 to R.S. ŁG was supported by Ministry of Higher Education and Science of the Republic of Poland (0295/E-393/STY/10/2015, 1258/MOB/IV/2015/0). We thank Xiangen Hu for valuable comments that considerably improved the manuscript.

Compliance with Ethical Standards

Conflict of Interest Ewelina Cichoń declares that he has no conflict of interest. Łukasz Gawęda declares that he has no conflict of interest. Steffen Moritz declares that he has no conflict of interest. Remigiusz Szczepanowski declares that he has no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

Aghotor, J., Pfueller, U., Moritz, S., Weisbrod, M., & Roesch-Ely, D. (2010). Metacognitive training for patients with schizophrenia (MCT): Feasibility and preliminary evidence for its efficacy. *Journal of Behavior Therapy and Experimental Psychiatry, 41*(3), 207–211. https://doi.org/10.1016/j.jbtep.2010.01.004.

Baker, C. A., & Morrison, A. P. (1998). Cognitive processes in auditory hallucinations: Attributional biases and metacognition. *Psychological Medicine, 28*(05), 1199–1208.

Belli, R. F., & Loftus, E. F. (1994). Recovered memories of childhood abuse: A source monitoring perspective. In S. J. Lynn & J. W. Rhue (Eds.), *Dissociation: Clinical and theoretical perspectives* (pp. 415–433). New York: Guilford Press.

Brown, A. S., Jones, E. M., & Davis, T. L. (1995). Age differences in conversational source monitoring. *Psychology and Aging, 10*(1), 111–122. https://doi.org/10.1037/0882-7974.10.1.111.

Brunelin, J., Combris, M., Poulet, E., Kallel, L., D'Amato, T., Dalery, J., & Saoud, M. (2006). Source monitoring deficits in hallucinating compared to non-hallucinating patients with schizophrenia. *European Psychiatry, 21*(4), 259–261. https://doi.org/10.1016/j.eurpsy.2006.01.015.

Cheesman, J., & Merikle, P. M. (1984). Priming with and without awareness. *Perception & Psychophysics, 36*(4), 387–395. https://doi.org/10.3758/BF03202793.

Cohen, G., & Faulkner, D. (1989). Age differences in source forgetting: Effects on reality monitoring and on eyewitness testimony. *Psychology and Aging, 4*(1), 10–17. https://doi.org/10.1037/0882-7974.4.1.10.

Dienes, Z., & Seth, A. (2010). Gambling on the unconscious: A comparison of wagering and confidence ratings as measures of awareness in an artificial grammar task. *Consciousness and Cognition, 19*(2), 674–681. https://doi.org/10.1016/j.concog.2009.09.009.

Dulas, M. R., & Duarte, A. (2014). Aging affects the interaction between attentional control and source memory: An fmri study. *Journal of Cognitive Neuroscience, 26*(12), 2653–2669. https://doi.org/10.1162/jocn_a_00663.

Dunlosky, J., & Nelson, T. O. (1992). Importance of the kind of cue for judgments of learning (JOL) and the delayed-JOL effect. *Memory & Cognition, 20*(4), 374–380. https://doi.org/10.3758/BF03210921.

Eichner, C., & Berna, F. (2016). Acceptance and efficacy of metacognitive training (MCT) on positive symptoms and delusions in patients with schizophrenia: A meta-analysis taking into account important moderators. *Schizophrenia Bulletin, 42*(4), 952–962. https://doi.org/10.1093/schbul/sbv225.

Fleming, S. M., & Dolan, R. J. (2010). Effects of loss aversion on post-decision wagering: Implications for measures of awareness. *Consciousness and Cognition, 19*(1), 352–363. https://doi.org/10.1016/j.concog.2009.11.002.

Franck, N., Rouby, P., Daprati, E., Daléry, J., Marie-Cardine, M., & Georgieff, N. (2000). Confusion between silent and overt reading in schizophrenia. *Schizophrenia Research, 41*(2), 357–364. https://doi.org/10.1016/S0920-9964(99)00067-5.

Garety, P. A., Kuipers, E., Fowler, D., Freeman, D., & Bebbington, P. E. (2001). A cognitive model of the positive symptoms of psychosis.

Psychological Medicine, 31(02), 189–195. https://doi.org/10.1017/S0033291701003312.

Gawęda, Ł., Moritz, S., & Kokoszka, A. (2012). Impaired discrimination between imagined and performed actions in schizophrenia. *Psychiatry Research, 195*(1), 1–8. https://doi.org/10.1016/j.psychres.2011.07.035.

Gawęda, Ł., Woodward, T. S., Moritz, S., & Kokoszka, A. (2013). Impaired action self-monitoring in schizophrenia patients with auditory hallucinations. *Schizophrenia Research, 144*(1), 72–79. https://doi.org/10.1016/j.schres.2012.12.003.

Gawęda, Ł., Li, E., Lavoie, S., Whitford, T. J., Moritz, S., & Nelson, B. (2018). Impaired action self-monitoring and cognitive confidence among ultra-high risk for psychosis and first-episode psychosis patients. *European Psychiatry, 47*, 67–75. https://doi.org/10.1016/j.eurpsy.2017.09.003.

Johnson, M. K. (1997). Source monitoring and memory distortion. *Philosophical Transactions of the Royal Society of London B: Biological Sciences, 352*(1362), 1733–1745.

Johnson, M. K., & Raye, C. L. (1981). Reality monitoring. *Psychological Review, 88*(1), 67–85. https://doi.org/10.1037/0033-295X.88.1.67.

Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin, 114*(1), 3–28. https://doi.org/10.1037/0033-2909.114.1.3.

Koren, D., Seidman, L. J., Poyurovsky, M., Goldsmith, M., Viksman, P., Zichel, S., & Klein, E. (2004). The neuropsychological basis of insight in first-episode schizophrenia: A pilot metacognitive study. *Schizophrenia Research, 70*(2), 195–202. https://doi.org/10.1016/j.schres.2004.02.004.

Koriat, A. (2000). The feeling of knowing: Some metatheoretical implications for consciousness and control. *Consciousness and Cognition, 9*(2), 149–171. https://doi.org/10.1006/ccog.2000.0433.

Koriat, A. (2006). *Metacognition and consciousness*. University of Haifa: Institute of Information Processing and Decision Making.

Koriat, A. (2012). The subjective confidence in one's knowledge and judgements: Some metatheoretical considerations. In M. J. Beran, J. L. Brandl, J. Perner, & J. Proust (Eds.), *Foundations of metacognition* (pp. 213–233). Oxford: Oxford University Press.

Koriat, A., & Goldsmith, M. (1996). Monitoring and control processes in the strategic regulation of memory accuracy. *Psychological Review, 103*(3), 490–517. https://doi.org/10.1037/0033-295X.103.3.490.

Laws, K. R., & Bhatt, R. (2005). False memories and delusional ideation in normal healthy subjects. *Personality and Individual Differences, 39*(4), 775–781. https://doi.org/10.1016/j.paid.2005.03.005.

Mammarella, N., Altamura, M., Padalino, F. A., Petito, A., Fairfield, B., & Bellomo, A. (2010). False memories in schizophrenia? An imagination inflation study. *Psychiatry Research, 179*(3), 267–273. https://doi.org/10.1016/j.psychres.2009.05.005.

Mitchell, K. J., & Johnson, M. K. (2000). Source monitoring: Attributing mental experiences. *The Oxford Handbook of Memory*, 179–195.

Mitchell, K. J., Raye, C. L., Johnson, M. K., & Greene, E. J. (2006). An fMRI investigation of short-term source memory in young and older adults. *Neuroimage, 30*(2), 627–633. https://doi.org/10.1016/j.neuroimage.2005.09.039.

Moritz, S., & Woodward, T. S. (2006a). A generalized bias against disconfirmatory evidence in schizophrenia. *Psychiatry Research, 142*(2), 157–165. https://doi.org/10.1016/j.psychres.2005.08.016.

Moritz, S., & Woodward, T. S. (2006b). Metacognitive control over false memories: A key determinant of delusional thinking. *Current Psychiatry Reports, 8*(3), 184–190. https://doi.org/10.1007/s11920-006-0022-2.

Moritz, S., & Woodward, T. S. (2006c). The contribution of metamemory deficits to schizophrenia. *Journal of Abnormal Psychology, 115*(1), 15–25. https://doi.org/10.1037/0021-843X.15.1.15.

Moritz, S., Woodward, T. S., Whitman, J. C., & Cuttler, C. (2005). Confidence in errors as a possible basis for delusions in schizophrenia. *The Journal of Nervous and Mental Disease, 193*(1), 9–16. https://doi.org/10.1097/01.nmd.0000149213.10692.00.

Moritz, S., Ruhe, C., Jelinek, L., & Naber, D. (2009). No deficits in nonverbal memory, metamemory and internal as well as external source memory in obsessive-compulsive disorder (OCD). *Behaviour Research and Therapy, 47*(4), 308–315. https://doi.org/10.1016/j.brat.2009.01.004.

Moritz, S., Kerstan, A., Veckenstedt, R., Randjbar, S., Vitzthum, F., Schmidt, C., Heise, M., & Woodward, T. S. (2011). Further evidence for the efficacy of a metacognitive group training in schizophrenia. *Behaviour Research and Therapy, 49*(3), 151–157. https://doi.org/10.1016/j.brat.2010.11.010.

Moritz, S., Andreou, C., Schneider, B. C., Wittekind, C. E., Menon, M., Balzan, R. P., & Woodward, T. S. (2014). Sowing the seeds of doubt: A narrative review on metacognitive training in schizophrenia. *Clinical Psychology Review, 34*(4), 358–366. https://doi.org/10.1016/j.cpr.2014.04.004.

Morrison, A. P. (2001). The interpretation of intrusions in psychosis: An integrative cognitive approach to hallucinations and delusions. *Behavioural and Cognitive Psychotherapy, 29*(03), 257–276. https://doi.org/10.1017/S1352465801003010.

Morrison, A. P., Haddock, G., & Tarrier, N. (1995). Intrusive thoughts and auditory hallucinations: A cognitive approach. *Behavioural and Cognitive Psychotherapy, 23*, 265–280. https://doi.org/10.1017/S1352465800015873.

Morrison, A. P., French, P., & Wells, A. (2007). Metacognitive beliefs across the continuum of psychosis: Comparisons between patients with psychotic disorders, patients at ultra-high risk and non-patients. *Behaviour Research and Therapy, 45*(9), 2241–2246. https://doi.org/10.1016/j.brat.2007.01.002.

Nelson, T. O., & Dunlosky, J. (1991). When people's judgments of learning (JOLs) are extremely accurate at predicting subsequent recall: The "delayed-JOL effect". *Psychological Science, 2*(4), 267–271. https://doi.org/10.1111/j.1467-9280.1991.tb00147.x.

Nelson, T. O., Stuart, R. B., Howard, C., & Crowley, M. (1999). Metacognition and clinical psychology: A preliminary framework for research and practice. *Clinical Psychology & Psychotherapy, 6*(2), 73–79. https://doi.org/10.1002/(SICI)1099-0879(199905)6:2<73::AID-CPP187>3.0.CO;2-7.

Nelson, B., Thompson, A., & Yung, A. R. (2012). Basic self-disturbance predicts psychosis onset in the ultra high risk for psychosis "prodromal" population. *Schizophrenia Bulletin, 38*(6), 1277–1287. https://doi.org/10.1093/schbul/sbs007.

Perfect, T. J. (2004). The role of self-rated ability in the accuracy of confidence judgements in eyewitness memory and general knowledge. *Applied Cognitive Psychology, 18*(2), 157–168. https://doi.org/10.1002/acp.952.

Persaud, N., McLeod, P., & Cowey, A. (2007). Post-decision wagering objectively measures awareness. *Nature Neuroscience, 10*(2), 257–261. https://doi.org/10.1038/nn1840.

Roberts, K. P., & Blades, M. (Eds.). (2000). *Children's source monitoring*. Mahwah: Lawrence Erlbaum Associates.

Sandberg, K., Timmermans, B., Overgaard, M., & Cleeremans, A. (2010). Measuring consciousness: Is one measure better than the other? *Consciousness and Cognition, 19*(4), 1069–1078. https://doi.org/10.1016/j.concog.2009.12.013.

Schurger, A., & Sher, S. (2008). Awareness, loss aversion, and post-decision wagering. *Trends in Cognitive Sciences, 12*(6), 209–210. https://doi.org/10.1016/j.tics.2008.02.012.

Szczepanowski, R. (2010). Absence of advantageous wagering does not mean that awareness is fully abolished. *Consciousness and Cognition, 19*(1), 426–431. https://doi.org/10.1016/j.concog.2009.12.011.

Szczepanowski, R., Traczyk, J., Wierzchoń, M., & Cleeremans, A. (2013). The perception of visual emotion: Comparing different measures of awareness. *Consciousness and Cognition, 22*(1), 212–220. https://doi.org/10.1016/j.concog.2012.12.003.

Szczepanowski, R., Wierzchoń, M., & Szulżycki, M. (2017). Neuronal network and awareness measures of post-decision wagering behavior in detecting masked emotional faces. *Cognitive Computation, 9*, 1–11. https://doi.org/10.1007/s12559-017-9456-6.

Taylor, B. J., & Howell, R. J. (1973). The ability of three-, four-, and five-year-old children to distinguish fantasy from reality. *The Journal of Genetic Psychology, 121*(2), 315–318. https://doi.org/10.1080/00221325.1972.10533157.

Varese, F., & Bentall, R. P. (2011). The metacognitive beliefs account of hallucinatory experiences: A literature review and meta-analysis. *Clinical Psychology Review, 31*(5), 850–864. https://doi.org/10.1016/j.cpr.2010.12.001.

Waters, F., Woodward, T., Allen, P., Aleman, A., & Sommer, I. (2012). Self-recognition deficits in schizophrenia patients with auditory hallucinations: A meta-analysis of the literature. *Schizophrenia Bulletin, 38*(4), 741–750. https://doi.org/10.1093/schbul/sbq144.

Wierzchoń, M. (2013). *Granice świadomości*. Kraków: WUJ.

Wierzchoń, M., Asanowicz, D., Paulewicz, B., & Cleeremans, A. (2012). Subjective measures of consciousness in artificial grammar learning task. *Consciousness and Cognition, 21*(3), 1141–1153. https://doi.org/10.1016/j.concog.2012.05.012.

Woodward, T. S., & Menon, M. (2013). Misattribution models (ii): Source monitoring in hallucinating schizophrenia subjects. In R. Jardri, A. Cachia, P. Thomas, & D. Pins (Eds.), *The Neuroscience of Hallucinations* (pp. 169–184). New York: Springer.