

ORIGINAL ARTICLE

Hand preference and differences in the ability to solve insight problems, the self-deception, and the extremeness of political attitudes

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Abstract

OBJECTIVE: Inconsistent handers are characterized by higher level of interhemispheric interaction and therefore also by better access to the right hemisphere functioning. We aimed to extend previous research concerning handedness and proposed that inconsistent handedness could be also related to the superior ability to solve insight problems, a lower level of self-deception, and to holding less extreme political attitudes.

DESIGN: 218 people were asked to complete a battery of relevant questionnaires and tasks.

RESULTS: Inconsistent hander solved more insight problems and scored lower on a measure of extremism of political attitudes than consistent handers, but there was no significant difference in the level of self-deception.

CONCLUSION: Results are generally in line with previous findings concerning handedness and further generalize them to topics, where only the role of the right hemisphere or the processes supposed to depend on it have been studied yet.

INTRODUCTION

Right hemisphere and processing of belief-inconsistent information

In order to be able to function optimally in their environment, people have to structure it into meaningful mental representations that enable them to predict causal effects of various events (Heine *et al.* 2006). Studies prove that the knowledge, abstracted from past experiences affects even the perception of simple objects (Bruner & Postman, 1949). Moreover, Lisa Barrett (2017) proposes that the process of perception is mostly driven by simulations - cascades, that begin with an abstract concept and gradually unpack into specific details. Signals captured by sensory organs are

then mostly used just to select the most appropriate simulations.

Such a mode of functioning is generally beneficial because it helps to minimize metabolic costs and to manage uncertainty. However, brain has to reconcile it with sometimes inevitable modification of knowledge in the light of a new evidence. It seems that corresponding processes are lateralized. While the left hemisphere (LH) focuses more on maintenance of stable knowledge and on using it for interpretation of experiences, the right hemisphere (RH) detects anomalies, it is more involved in the subsequent processing of new information and in updating beliefs:

Performance on new tasks generally depends more on the RH, however, with growing amount of expertise the LH is becoming dominant (Goldberg, 2018). Temporary inhibition of the frontotemporal regions of the LH using transcranial direct current stimulation (tDCS) can increase the naturalism of drawings and the proofreading ability in some people (Snyder *et al.* 2003), probably because it enables them better access to the perception of the “real world” instead of its conceptual grasp (Snyder *et al.* 2004). Patients with surgical excisions of the right temporal lobe exhibits worse performance on a hypotheses test because they are less able to give up hypotheses that were explicitly indicated to be incorrect, but those with excisions of the left temporal lobe tend to inappropriately switch hypotheses that were explicitly indicated to be correct (Rausch, 1977). Patients with right parietal lesions, suffering from hemiplegia, tend to create complex rationalizations in order to preserve the pre-damaged belief that they are healthy and they do not seem to look for contradicting evidence, however this behaviour can be temporally reduced by stimulating RH using caloric vestibular test (Ramachandran, 1996). Finally, it has been observed among split-brain patients that their LH is more driven by inferred knowledge and expectations in the object recognition task (Phelps & Gazzaniga, 1992), and it also confabulates in order to explain behaviour, the cause of which has been concealed by experimental manipulation (Gazzaniga, 1989).

Handedness and RH-processes availability

Research also suggests that handedness is an external marker for individual differences in the availability of the RH-processes. Inconsistent handed people are in comparison to consistent handed individuals supposed to have a higher level of interhemispheric interaction (IHI) and therefore also better access to RH-processes. On the neurophysiological level, Luders *et al.* (2010) found negative association between the degree of handedness lateralization and callosal thickness, and according to Propper *et al.* (2012) inconsistent handers are characterized by greater resting RH activity as measured by EEG.

Converging evidence comes from behavioral studies. Several papers, based on these assumptions, examined differences between consistent and inconsistent handed people in the ability to change perspective, consider belief-inconsistent evidence and modify one’s beliefs accordingly. They suggest that inconsistent handed individuals are characterized by greater tendency to update body representation in experiments with rubber hand illusion (Niebauer *et al.* 2002), higher level of flexibility in ambiguous-figure perception (Christman *et al.* 2009), higher probability of updating creationist beliefs about the origin of species, which are prevailing among young children (Niebauer *et al.* 2004), superior ability of counterfactual thinking (Jasper *et al.* 2008), exhibiting more cognitive dissonance (Jasper *et al.* 2009), greater likeli-

hood of attitude-change in experiments with persuasion (Christman *et al.* 2008), and greater tendency to change beliefs after receiving piece of inconsistent information (Jasper *et al.* 2014).

Based on this evidence, we consider it reasonable to suppose that the ability to detect belief-inconsistent (anomalous) information and accommodate one’s beliefs accordingly is relatively more dependent on the RH and that inconsistent handers are characterized by its superior level because of their better access to the RH processes. However, there are several other constructs apparently associated with this ability, whose relations to the handedness differences remain unexplored. We further focus on three of them, representative of different psychological subfields: The ability to solve insight problems (cognitive psychology), the level of self-deception (personality psychology), and the extremeness of political attitudes (social psychology).

Ability to solve insight problems

Insight problems are generally viewed as a test of creative thinking because unlike analytic problems, they lead problem solvers to inappropriate representation, which needs to be changed in order to obtain the correct operators for searching the problem space (Öllinger & Knoblich, 2009). A study on individual differences by DeYoung *et al.* (2008) is in line with this characterization. It shows that beyond the crystallized and fluid intelligence, a separate ability to break the initial framing of problem situation, operationalized by the task from Bruner & Postman (1949) experiment, is a predictor of success in solving insight problems. Studies by Chi & Snyder (2011, 2012) are further consistent with this findings and also document the importance of the RH – authors found that performance on different insight problems can be enhanced by the stimulation of the frontotemporal regions in the RH and their inhibition in the LH using tDCS, what has been interpreted as a consequence of the decrease in the knowledge driven perception of the task and therefore an opportunity for its more flexible interpretation. However, best to our knowledge, nobody has studied the role of handedness yet.

Self-deception

Ramachandran (1996) suggests that the self-deception, essentially holding false beliefs about oneself, is a natural evolutionary consequence of LH’s tendency to ignore evidence that contradicts expectations in order to maintain the stability of behavior and to simplify decision-making processes. Findings of Peterson *et al.* (2002, 2003) are in agreement with this conception – people characterized by high level of self-deception exhibit worse performance in the task from the Bruner’s and Postman’s (1949) experiment and also a higher tendency to ignore feedback about incorrect decisions made in a gambling-type card playing task. However, best to our

Tab. 1. Insight problems and their solution rates

Insight problem	Solution rate
1.) There is an ancient invention still used in many parts of the world today that allows people to see through walls. What is it? (Glass, window)	67% (3)
2.) Captain Scott was out for a walk, and it started to rain. He did not have an umbrella and he wasn't wearing a hat. His clothes were soaked, yet not a single hair on his head got wet. How could this be? (He is bald)	78% (2)
3.) Mr. Novak was washing windows on a high-rise office building when he slipped and fell off a sixty-foot ladder onto the concrete sidewalk below. Incredibly, he did not injure himself in any way. How is this possible? (He was on one of the lower rungs of the ladder)	47% (4)
4.) A man was reading a book one night. Suddenly, the lights went out. There was no light in the room, but he kept on reading. How is that possible? (He was blind - it was a braille book)	47% (1)
5.) One morning, Elsie's earring fell into her cup of coffee. Even though the cup was full, the ring did not get wet. Why? (The cup had dry instant coffee in it)	42% (0)
6.) Two men played five full games of checkers, and each won an even number of games, with no ties, draws, or forfeits. How is that possible? (They were not playing against each other)	46% (0)
7.) A young boy turned off the lights in his bedroom and managed to get into bed before the room was dark. If the bed is ten feet from the light switch and the light bulb and he used no wires, strings, or other contraptions to turn off the light, how did he do it? (There was outer source of light - it was still daylight, full moon...)	44% (0)
8.) A giant inverted steel pyramid is perfectly balanced on its point. Any movement of the pyramid will cause it to topple over. Underneath the point of the pyramid is a \$100 bill. How could you remove the bill without disturbing the pyramid? (Cut, burn,)	21% (1)

Note. The values in parentheses in the right column indicate the number of participants who had previous experience with the problem. Solution rate is calculated after discarding their answers.

knowledge, nobody has studied the role of handedness nor the RH in a sample of healthy people yet.

Extremeness of political beliefs

Several studies document a positive association between consistent handedness and right-wing authoritarianism (Chan, 2018; Christman, 2014; Lyle & Grillo, 2014). According to Lyle & Grillo (2020) this association is mediated by the need for closure – simple and rigid explanations. However, some research also suggests that considering the ability to detect and process expectations-violating information, it is rather the extremeness of one's conviction than its specific (left or right-wing) content, that is important: According to a meta-analysis done by Collins *et al.* (2017) there are no differences between liberals and conservatives in tendencies to ignore contradicting information. Moreover, according to Slegers *et al.* (2015) individuals with both strong liberal and strong conservative attitudes exhibit lower levels of arousal in reaction to unconsciously processed anomalies in the task loosely based on the Bruner's & Postman's (1949) experiment, what has been interpreted as a decreased anomaly detection. Reiss *et al.* (2019) subsequently used the same task and found that the extremeness of attitudes is positively

associated with an attention suppression, measured as higher prestimulus alpha power on EEG. Best to our knowledge, nobody has studied handedness differences in association with the extremeness of attitudes yet.

Aim and hypotheses

We aimed to find out whether findings about handedness differences in the processing of anomalous information can be also generalized to other fields mentioned above. Following hypotheses were formulated: H1: Inconsistent handers have superior ability to solve insight problems than consistent handers. H2: Inconsistent handers are characterized by lower level of self-deception than consistent handers. H3: Inconsistent handers hold less extreme political attitudes than consistent handers.

METHODS

Participants

Participants were recruited via university email services and social networks using snowball sampling technique. The data were collected from 218 subjects (125 women, 93 men) aged between 18 to 72 years ($M = 28.46$, $SD = 10.74$), 64 graduated at most from high school, 63 were

Tab. 2. Descriptive statistics

	M	SD	Md	IQR	Shapiro-Wilk		
					W	df	p
Insight problems solution rate [%]	48.8	26.2	50.0	46.4	0.96	218	< 0.001
Lie score	4.01	2.7	4	4	0.95	218	< 0.001
Extremeness of attitudes	26.4	9.76	25.7	13.3	0.99	218	0.063

currently college students and 91 completed at least an undergraduate degree. All participants signed an informal consent and joined the study voluntarily.

Instruments

Consistency of handedness. A modification of the Edinburgh Handedness Inventory (EHI) (Oldfield, 1971) was used. Participants were asked to indicate their preference of hand use for 10 activities (writing, drawing, throwing, using scissors, toothbrush, knife, holding a spoon, broom, striking a match, opening a box/lid) on a scale consisting of five explicit response options: Always Right (+10), Usually Right (+5), No Preference (0), Usually Left (-5), Always Left (-10). Scores range from -100 (exclusively left-hand use) to 100 (exclusively right-hand use). The scale reached a very good level of reliability ($\alpha = 0.92$, $\omega = 0.93$).

To determine consistency of handedness, we followed the common practice of defining consistent handers as subjects whose scores were equal to or higher than the median value of the sample (i.e., Christman, 2014; Christman *et al.* 2009; Jasper *et al.* 2014). Though this may seem arbitrary, it has been argued that using median value divides sample meaningfully into two natural groups (Christman & Propper, 2010). Just as in majority of studies, the median value of our sample was 80 points. Accordingly, 126 participants were identified as consistent right handers, 7 as consistent left handers and 85 as inconsistent handers. Since there were only 7 left-handed people in our sample, we grouped left and right handers together, and compared only consistent vs. inconsistent handers.

Ability to solve insight problems. We used a scale consisting of 8 commonly used verbal insight problems (see Table 1) of variable difficulty, selected from available studies (DeYoung *et al.* 2008; Laukkonen *et al.* 2021). All problems were presented individually and participants have max 2 minutes to solve them. Performance scores were calculated as a percentage of correct answers on unfamiliar problems. The scale reached a sufficient level of reliability ($\alpha = 0.68$, $\omega = 0.68$).

Self-deception. The Lie scale from standardized slovak version of the *Eysenck Personality Questionnaire Revised -Short Form* (EPQR-S) was used. This scale measures a tendency to exaggerate one's good qualities and play down one's bad qualities (Eysenck & Eysenck,

1993). It contains 12 questions, each answered by YES or NO. Scores were calculated as a simple sum of the answers. The scale reached a good level of reliability ($\alpha = 0.74$, $\omega = 0.74$).

Extremeness of political attitudes. We used The 12 Item Social and Economic Conservatism Scale (SECS), which was designed as a valid tool for research in political psychology (Everett, 2013). The whole scale can be broken down into two subscales: 7-items scale that measures level of social conservatism and 5-items scale that measures level of economic conservatism. In both cases, participants express their opinions on relevant topics, presented in a single-word form (e.g., „Abortion“), on a scale ranging from 0 (negative) to 100 (positive). Following Slegers *et al.* (2015) and Reiss *et al.* (2019), the extremeness of attitudes was defined as the deviation from the neutral point (50), which was calculated for each item and averaged into a single score. Social conservatism scale reached a good level of reliability ($\alpha = 0.83$, $\omega = 0.84$). The reliability of economic conservatism scale was insufficient ($\alpha = 0.26$, $\omega = 0.33$), therefore we excluded it from further analysis (see the discussion).

RESULTS

All data were analyzed in Jamovi 1.6.23. Descriptive statistics are provided in Tab. 2. Normally distributed variables were assessed using the Independent Samples t Test. For non-normally distributed variables the Mann-Whitney U test was used.

Inconsistent handers solved more insight problems (Md = 62.5%, IQR = 37.5%) than consistent handers (Md = 37.5%, IQR = 37.5%), $U = 3398$, $p < 0.001$, $r = 0.40$. Inconsistent handers were also characterized by less extreme political attitudes ($M = 23.8$, $SD = 9.13$) than consistent handers ($M = 28$, $SD = 9.82$), $t(216) = 3.2$, $p < 0.001$, $d = 0.44$. But there was no significant difference between consistent (Md = 4, IQR = 3) and inconsistent handers (Md = 4, IQR = 4) in the level of self-deception, $U = 5622$, $p = 0.47$, $r = 0.01$.

Subsequently, we also conducted an analysis with consistency of handedness treated as a continuous variable, examining relationships between measures using spearman's correlational coefficient. Similar results to the categorical ones were observed: A moderate

negative relationship between consistency of handedness and the percentage of solved insight problems ($r = -0.37, p < 0.001$); a small positive relationship between consistency of handedness and the extremeness of political attitudes ($r = 0.27, p < 0.001$); no statistically significant relationship between consistency of handedness and the level of self-deception ($r = 0.11, p = 0.12$).

DISCUSSION

Ability to solve insight problems

The findings regarding the ability to solve insight problems are consistent with the studies documenting the importance of RH processes for these kinds of thinking (Chi & Snyder, 2012, 2011), as well as with research showing that the inconsistent handedness is associated with higher level of IHI and therefore also with an increased availability of these processes (Christman et al. 2008; Luders et al. 2010; Niebauer et al. 2002; Propper et al. 2012). Based on that, we think that most probably it is the greater independence of the RH of the top-down information processing (Snyder et al. 2004) that mediates this relationship via an advantage in breaking frame (DeYoung et al. 2008) or in making the decision to leave the initial problem space (Öllinger et al. 2014).

However, there is a plausible alternative and perhaps complementary interpretation: Another good predictor of the ability to solve insight problems is divergent thinking (DeYoung et al. 2008; Gilhooly & Murphy, 2005). Shobe et al. (2009) found that inconsistent handedness is associated with better performance in tests of divergent thinking and according to the authors it is rather due to the mere state of greater connectivity of the hemispheres, not the better availability of RH processes induced by it.

Further research is needed to clarify these issues: We suggest that the use of more complex insight problems might be promising, because different stages of their solution process can be manipulated by experimental conditions (Jones, 2003; Öllinger et al. 2014). If they could be attributed precisely to the predictors of the ability to solve insight problems (e.g., those identified by DeYoung et al. (2008)), the role of not only handedness could be further examined in a much more detail.

Self-deception

In the case of self-deception, our predictions were not supported. Potential explanation lies in the greater than expected complexity of the relationship between self-deception and RH processes. Our hypothesis assumed that the lower availability of RH processes, presumably associated with the consistent handedness, should be causing a higher tendency to ignore anomalous information, and therefore also increased level of the self-deception. However, it is also possible that high levels of self-deception are associated with an increased

tendency to ignore anomalous information because of motivated tendency to do so, independently of the availability of right hemisphere processes. This proposition would not imply that the self-deception cannot be affected by the impaired ability to process anomalies, but rather that this should be the case only if it reaches extreme proportions - e.g., due to the RH damage (Ramachandran, 1996).

Alternatively, it is conceivable that the level of self-deception is affected also by subtler differences relating to the ability of processing anomalous information, but handedness is too indirect measure of them to find an association with self-deception. This interpretation would be in line with the above-mentioned possibility that it is (also) divergent thinking that mediates handedness-related differences in the ability to solve insight problems. The use of more direct evaluation of RH processes availability, such as resting RH activity (Propper et al. 2012) could be therefore an interesting subject of further research concerning this topic.

Extremeness of political attitudes

Findings regarding the extremeness of political attitudes are consistent with the research in which a tendency to avoid monitoring and processing of anomalies in people with both extreme conservative and extreme liberal attitudes was found (Reiss et al. 2019; Slegers et al. 2015). But they further connect them to the findings that consistent handedness is associated with right-wing authoritarianism, which is similarly characterized by a reduced level of cognitive flexibility and by resistance to change - supposedly because of low RH processes availability (Chan, 2018; Christman, 2014; Lyle & Grillo, 2014, 2020), therefore the results provide an extended framework for their interpretation in the context of possible neural correlates.

An interesting follow-up area of research would be the difference between consistent and inconsistent handers in the reaffirmation behavior - Slegers et al. (2015) further found that individuals that hold stronger beliefs have a stronger need to reaffirm their other beliefs if they are violated. Therefore, the hypothesis that a better access to the RH processes should reduce also this tendency seems plausible to us.

However, these results are limited by the unacceptable reliability of the economic conservatism scale. This could be due to an inappropriate adaptation of some of the terms into slovak language and cultural environment - at the end of the questionnaire several participants reported that they did not understand the term "Obmedzená vláda" (translated from: "Limited government") or "Fiškálna zodpovednosť" ("Fiscal responsibility"). Therefore, the results are limited to the already explored area of holding extreme attitudes about social issues: Slegers et al. (2015) used the scale of social conservatism (e.g., measuring attitudes toward rights of gay people) and Reiss et al. (2019) used the scale

of ethnocentrism. Further research should therefore address generalizability to other areas of political life.

General limitations and further directions

In addition to the topic-specific limitations listed above, we are aware of the more general ones, present in our study. Firstly, our survey was administered online using snowball technique, therefore further research on a randomly selected sample in precisely controlled conditions is needed to confirm the validity of our results.

Another limitation related to the sample concerns the number of consistent left-handers. Since only a small number of them participated in our study, we grouped them together with consistent right-handers, based on the presupposition that it is not the direction, but the degree of handedness which is associated with differences in cognitive (and emotional) processes (Christman & Propper, 2010; Prichard et al. 2013). However, it is possible that both the direction and the degree of handedness are important factors. Given that consistent left-handers are only about 1-3% of the population, studies comparing consistent right vs. left handers are rare (Prichard et al. 2013). Although Lyle et al. (2012) demonstrated on a large sample, that only the degree of the handedness is associated with differences in episodic memory, it is not clear to what extent these findings can be generalized to other domains, such as belief-updating. To account for possible contamination of the results, we also conducted an analysis of the data after the exclusion of the consistent left-handers, but it resulted only in the negligible increase of the effect sizes. Nonetheless, further research devoted specifically to the differences between consistent left and right handers in the ability to update beliefs is needed.

Apart from the research sample, the interpretation of our findings is limited by the fact that we did not incorporate any specific measure of the ability to notice belief-inconsistent (anomalous) information and update one's beliefs accordingly. As we noted in the introduction, some studies devoted to insight problems, self-deception, and political attitudes (DeYoung et al. 2008; Peterson et al. 2002; Slegers et al. 2015), used a task from or based on the Bruner's and Postman's (1949) experiment to operationalize this ability. However, although we consider studies on differences between consistent and inconsistent handed individuals in the processing of belief-inconsistent information to be conceptually related to it (e.g., Christman et al. 2008; Jasper et al. 2014), they typically used more complex tasks, so performance on them probably depends on a broader set of different cognitive processes. Therefore, it would be appropriate for further research to also examine handedness-related differences in this ability measured directly by Bruner's and Postman's (1949) task, and subsequently conduct more complex analysis in relation to the more complex phenomena.

Finally, considering the IHI itself, it should be noted that handedness is only its indirect indicator. Therefore, we believe that it would be interesting and of potential value to examine whether converging evidence could be also obtained using the method of dichotic stimulation or technique of visual fields, which may provide more precise measurement of the level of IHI (Špažděl, 2016, 2020). All results are also only of a correlative nature and causal inferences cannot be made from them. Therefore, it would be useful to also conduct experiments with bilateral eye movements, which are supposed to increase the level of IHI (Shobe et al. 2009).

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