Intuitive and Deliberative Empathizers and Systemizers

Svedholm-Hakkinen, Annika M.

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RUNNING HEAD: Dual-process theory and E-S theory

Intuitive and deliberative empathizers and systemizers

Annika M. Svedholm-Häkkinen and Marjaana Lindeman,

University of Helsinki

P.O. Box 9

Division of Cognitive Psychology and Neuropsychology

Institute of Behavioural Sciences

00014 University of Helsinki, Finland

Corresponding author: Annika M Svedholm-Häkkinen. E-mail: annika.svedholm@helsinki.fi. Tel:

+358-50 448 4154

Other e-mails: Marjaana Lindeman: marjaana.lindeman@helsinki.fi

Abstract

Objective: Recent findings suggest there may be some overlap between individual differences in orientations for intuitive thinking and empathizing, and between deliberative thinking and systemizing. This overlap is surprising, given that intuitive and deliberative thinking derive from dual-process theories that concern domain-general types of processing, while theoretically, empathizing and systemizing are domain-specific orientations for understanding people and lawful physical phenomena. Method: The present studies (Study 1: N = 2789, Study 2: N = 87; Finnish volunteers ages 15-69, 65 % females) analyzed each of these four constructs using self-report as well as performance measures. Results: Strong correlations were found between systemizing and self-reported need for cognition, and between empathizing and self-reported intuitive thinking. However, neither relationship generalized beyond these specific measures. The relationships of systemizing to cognitive reflection and to actively open-minded thinking, and of empathizing to intuition in explicitly non-social contexts and to heuristic responding, were weaker. Conclusions: The findings indicate that outside social contexts, strong empathizers may be no more intuitive than other people, and that systemizers may not overall think any more deliberatively than others. Based on existing data, deeper parallels between the underlying constructs, and a distinction between "intuitive empathizing" and "deliberative systemizing", are not warranted.

Keywords: dual process theory, intuitive, deliberative, empathizing, systemizing

Intuitive and deliberative empathizers and systemizers

Individual differences in cognition can be characterized along several continua. The present study investigates the relationships between constructs stemming from two orthogonal theoretical perspectives: the empathizing-systemizing theory, and dual-process theories of thinking. The aim is to explore the recent suggestion that the processing styles that can be derived from these theories overlap in important ways.

The empathizing-systemizing (E-S) theory posits that empathizing and systemizing are top-level concepts that can be used to organize broad dimensions of cognition (Baron-Cohen, 2002). Empathizing (a.k.a. "intuitive psychology") refers to social information processing, encompassing both the cognitive empathy ability to infer others' mental states, as well as the affective empathy ability to share others' feelings and to respond accordingly (Baron-Cohen, 2010; Baron-Cohen & Wheelwright, 2004). Systemizing ("intuitive physics"), in turn, includes abilities to understand the causal rules governing lawful, inanimate systems, such as logic, machines, and spatial processing (Baron-Cohen, 2008; Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003). In other words, empathizing and systemizing are domain-specific orientations evolved for understanding psychological and physical phenomena.

Further, E-S theory argues that the drive and ability for empathizing and systemizing vary systematically in the population, and that people's scores on these dimensions account for a tremendous range of individual differences in cognition. These include abilities such as sensitivity to facial expressions, abilities in mathematics and physics, mental rotation, map reading, and mechanics (Baron-Cohen, 2002, 2008), related outcomes such as occupations, hobbies, and relationships (Fields, 2011; Wheelwright et al., 2006), as well as sex differences in all these factors (Baron-Cohen, Knickmeyer, & Belmonte, 2005).

In a different research tradition, the main divide in runs between intuitive (heuristic, Type 1), and deliberative (analytical, reflective, Type 2) thinking processes, that is, along the distinction between gut feelings and reason (Denes-Raj & Epstein, 1994; Evans, 2008). Evans and Stanovich (2013) define intuitive processes as those that run effortlessly and without working memory involvement, while deliberative processes require these resources. Thus, intuitive and deliberative thinking are conceptualized as domain-general means of approaching information in any domain, be it psychological, physical or something else. Individuals shift between intuitive and deliberative processing depending on situational factors, motivation, and available resources, such as time (Evans & Curtis-Holmes, 2005; Hodgkinson, Langan-Fox, & Sadler-Smith, 2008). Individual differences also exist in the type of processing favored by individuals, with others characteristically tending to trust their first impressions, and others more inclined to reason (Epstein, Pacini, Denes-Raj, & Heier, 1996; Frederick, 2005).

Potential Parallels and Overlap

Despite the fact that dual process theories and E-S theory are theoretically orthogonal, several factors suggest that individual differences in the orientations that they describe may overlap. Perhaps most saliently, certain traits are easier than others to imagine co-occurring. First, it is easy to imagine that a person interested in systemizing would also tend to enjoy deliberative thinking, as both have been described as involving abstract, logical thinking, suited for understanding rule-based phenomena (Baron-Cohen, 2010; Billington, Baron-Cohen, & Wheelwright, 2007; Stanovich & West, 2000). Similarly, the notion of a "people person" good at empathizing conjures images of a person who reacts instinctively even to the smallest of cues, rather than someone who spends time engaged in problem solving.

Another potential parallel concerns the speed of processing. Intuitive thinking tends to be fast and deliberative thinking slow (Evans & Curtis-Holmes, 2005; Stanovich & Toplak, 2012). Meanwhile, systemizing is negatively, and empathizing positively, related to the jumping-to-conclusions bias in both a healthy (Brosnan, Ashwin, & Gamble, 2013) and a clinical population (Brosnan, Chapman, & Ashwin, 2014). That is, the less people tend to empathize, and the more they tend to systemize, the more time they take to reach decisions.

The findings so far suggest that there is some overlap between the two concept pairs. However, for an overall view of how E-S theory relates to dual-process theories, a total of four relationships should be examined: 1) systemizing–deliberative thinking, 2) systemizing–intuitive thinking, 3) empathizing–intuitive thinking, and 4) empathizing–deliberative thinking. It is unclear whether the evidence presented above speaks to all four relationships, as it relies on inferences based on the incidence of specific heuristics and biases, and only some of it concerns a nonclinical population. Recently, Brosnan, Hollinworth, Antoniadou and Lewton (2014) reported the first study directly exploring all four relationships using self-report measures in the normal population. They found systemizing negatively related to intuitive thinking, and positively to deliberation, while self-reported empathizing was positively related to intuitive thinking, and negatively to deliberative thinking. Thus, they made the compelling case for an overlap. Nevertheless, these findings are preliminary, because of the small sample size (N = 68) used in that study and especially, because intuitive and deliberative thinking were assessed using a narrow set of methods, as discussed below.

Still, the possibility that dual-process and E-S concepts might overlap is exciting and calls for replication. Determining whether the correlations are method specific, or whether they reflect deeper parallels, is critical. Finding that the concepts from the two theoretical

backgrounds, which are defined in such widely different terms, turned out to characterize the same traits, would have wide implications for how we understand the fundamental dimensions of human cognition. In particular, finding that understanding the physical regularities in the environment (systemizing) would tend to involve effortful, deliberative thinking, directly contradicts the very notion of systemizing as a domain-specific capacity for "intuitive physics".

Thus, rather than look for similarities between intuition and empathizing, and between systemizing and deliberative thinking, we find it important to draw attention to both the possible intuitive and deliberative aspects of both empathizing and systemizing. Therefore, the present study extends the analyses to more specific aspects of each of the four concepts.

A Closer Look at Each Concept

First, we examine the relationship between systemizing and deliberative processing. Several assessment methods tap into different aspects of deliberation, and their precise relationship to each other remains unclear (Frederick, 2005; Kokis, Macpherson, Toplak, West, & Stanovich, 2002; Toplak, West, & Stanovich, 2011). Brosnan, Hollinworth, et al. (2014) found that systemizing was strongly related to deliberative processing when it was operationalized as enjoyment and interest in extensive thinking, using the Need for Cognition (NFC) scale (Epstein et al., 1996). However, the relationship was much weaker for the Cognitive Reflection Test (CRT), which assesses the mental restraint that is needed to avoid giving rushed answers to problems (Frederick, 2005).

It can be argued that a comprehensive assessment of individual differences in deliberative thinking also needs to incorporate measures of the willingness for hypothetical thinking. A central aspect of deliberative thinking is decoupling issues from their context and mentally simulating alternatives (Stanovich, 2009). The Actively Open-Minded Thinking (AOT) scale has

been developed to assess this willingness to consider alternative viewpoints and opinions on complex societal issues, such as taxes and legislation. Thus, the AOT may capture deliberative thinking in a different domain than either the NFC or the CRT, and it may function as a test of the generalizability of the positive relationship of deliberation and systemizing.

Second, the relationship between systemizing and intuitive thinking will be analyzed. Several factors suggest that even though systemizing is described as "intuitive physics", its relationship with intuitive thinking is conflicted. One reason concerns Baron-Cohen's (2006) description of systemizing as proceeding serially from a stage of data collection to a stage of law detection, for example from observing an object being manipulated in different ways and producing different outcomes, to understanding the mechanics that govern its function. This description seems incompatible with the idea of intuitive thinking being quick, effortless and parallel. Furthermore, compared to controls, individuals with autism spectrum disorders, who may be conceived of as extreme systemizers (Baron-Cohen, 2002), exhibit fewer heuristics and biases, which are regarded as hallmarks of intuitive thinking (De Martino, Harrison, Knafo, Bird, & Dolan, 2008; McKenzie, Evans, & Handley, 2010; Morsanyi, Handley, & Evans, 2010).

However, the studies so far may have underestimated systemizers' intuitiveness in the normal population. In particular, we argue that self-report measures, such as the Intuition subscale of the Rational-Experiential Inventory (REI; Epstein et al., 1996; Norris & Epstein, 2011), which even Brosnan, Hollinworth, et al. (2014) used, may conflate the domain-general concept of intuition with the more limited construct of social intuition. The following example items from Norris and Epstein (2011) illustrate this conflation: "I trust my initial feelings about people", "For me, descriptions of actual people's experiences are more convincing than discussions about 'facts'." To avoid confounding intuition with social intuition, we developed a

set of new items concerning explicitly non-social contexts, and tested whether a preference for systemizing would be negatively related to intuitiveness even in these. Further, to assess systemizing more broadly, self-reports were accompanied by a set of performance measures.

As to empathizing and intuitive thinking, much research suggests a positive association. For example, empathizing is related to faster decision-making in social dilemmas (Ramsøy, Skov, Macoveanu, Siebner, & Reinholt Fosgaard, 2014). Thus, it is possible that strong empathizers tend to use intuition in social situations, but at present, it is not known whether they also prefer intuitive thinking in other domains. Conventional self-report measures of intuitiveness likely inflate the relationship with empathizing precisely because they focus on the use of intuition in social situations. If intuitive thinking and empathizing are related more generally, strong empathizers should be expected to also score highly on our new non-social intuition items.

The fourth relationship that deserves attention is between empathizing and deliberative thinking. In the E-S literature, the slow, serial processing style in which one first gathers information and then draws conclusions, is always used to illustrate systemizing, but it is equally compatible with any other domain, including the social domain. In fact, a large literature shows that social information processing involves both intuitive and deliberative processes (Bohl & van den Bos, 2012; Heyes & Frith, 2014; Satpute & Lieberman, 2006). Accordingly, some aspects of empathizing may be enhanced by deliberation. For example, to understand a person with a worldview, experiences or opinions that are widely different from one's own, deliberate reflection is often needed to complement first impressions.

The empathizing construct also comprises several different processes, which may vary in their degree of intuitiveness or deliberativeness. It is possible to distinguish between at least

affective and cognitive components in empathy. Affective empathy has been described as a phylogenetically and ontogenetically early process (Shamay-Tsoory, Aharon-Peretz, & Perry, 2008) that lacks explicit components (Spunt & Lieberman, 2013). Thus, it is possible that it is related to variation in preferences for intuitive thinking, but not deliberative thinking. In contrast, cognitive empathy can be thought of as involving both intuitive and deliberative aspects (Heyes & Frith, 2014; Shamay-Tsoory et al., 2008). To analyze cognitive and affective empathizing in more detail, the present study also included performance measures of both constructs.

Study 1

Method

Participants. The participants were 2789 Finnish volunteers (65% females). Their mean age was 28 years (*SD* = 8.87, range 15–69). Of the participants, 27% were working, 64% were students, and 9% were otherwise occupied. Of the 3086 people who originally took part in the study, 2 were excluded because their comments about the study revealed that they had not completed the questionnaire seriously. In addition, if a participant had 25 % or more missing items on a scale, the sum variable for that scale was not calculated for that participant. Probably because the survey was long (including also scales and tasks not reported here), many participants skipped one or more scales, resulting in a loss of 295 participants.

Procedure. The participants were recruited to the on-line study via several open internet discussion forums, several student mailing lists, and from a participant pool comprising individuals who had expressed an interest to participate in our studies. No exclusion criteria for participation were applied. The participants were told that the study concerned thinking and personality, and confidentiality and voluntary participation were emphasized. In the messages sent out to the internet forums and mailing lists, a hyperlink to the questionnaire was included.

The respondents were given 3 weeks to participate in the study. As compensation, all participants received a thinking style profile based on the AOT.

Measures.

E-S variables. Self-reported empathizing was measured with the short, 15-item version of the Empathy Quotient (EQ) scale (Muncer & Ling, 2006). Reliability (Cronbach's α) for the full EQ score was .81. The emotional reactivity subscale (α = .67) includes 5 questions on how strongly the respondent reacts to social or emotional stimuli (e.g., friend's problems, movies). The cognitive empathy subscale (5 items, α = .79) reflects the respondent's ability to intuitively understand and predict other people's emotions. The social skills subscale (5 items, α = .71) reflects the respondent's ability to function in social situations. As in the original scale, the response format (1 = *Strongly disagree*, 2 = *Slightly disagree*, 3 = *Slightly agree*, 4 = *Strongly agree*) was converted into scores of 0, 0, 1, and 2.

Self-reported systemizing was measured with the short, 18-item (α = .85) version of the Systemizing Quotient (SQ) scale (Ling et al., 2009). An example item is "When I look at a piece of furniture I do not notice details of how it was constructed". Scoring was as for the EQ.

Affective empathic ability was measured by the Pictorial Empathy Test (PET, Lindeman & Koirikivi, 2015). The PET includes 7 photographs that depict men, women, and children feeling sad, fearful, or in pain or variations of these emotions. Each photograph was followed by the question: "How touching do you find the photograph?" (1 = *Not at all*, 5 = *Very much*).

Cognitive empathic ability was measured by thirteen pictures from the revised version of the Adult Reading the Mind in the Eyes Test (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001). The original test includes 36 photographs of the eye-region of the face of actors and actresses, and it assesses how well individuals understand what the person in the picture is

thinking or feeling. The thirteen pictures were evenly selected to represent easy, average and difficult items, based on the normative data provided by Baron-Cohen et al. (2001). For each picture, the participants were asked to choose which one of four listed emotion words best describes what the person in the picture is thinking or feeling. Following the original instructions, the participants were asked to complete the task as quickly as possible.

Systemizing skill was assessed by three performance tests: mental rotation, map reading, and mechanics. An overall systemizing skill score was calculated by standardizing the scores on these three tasks and calculating their average. The Mental rotation test included 5 items adapted from the Mental Rotation Test (originally by Vandenberg & Kuse, 1978; stimuli redrawn by Peters et al., 1995). A simplified presentation format was used, whereby each item consisted of two figures, and the task was to judge whether or not the figures depicted the same object. The five item pairs included figures rotated by 40-150 degrees along different axes and in different directions. Map reading ability was assessed using a task inspired by Lobben (2007). The task consisted of four photographs and a map from a real city. The participants' task was to infer where each photograph was taken. The photographs contained landmarks that could be used to infer the location, but no legible street signs. Participants indicated their answer by clicking on the map. A JavaScript function recorded the clicked location. All clicks that fell in the correct area were coded as correct responses. An "I don't know" response option was included, and these responses were coded as incorrect. Sixty-seven participants (2.4 %) indicated that they were familiar with some or all of the places. Familiarity improved the identification of the location of one of the four photos, but since the effect size was negligible, $F(1,3080) = 20.11$, $p < .001$, $\eta_p^2 = .006$, all items were retained in the measure. Mechanical ability was assessed using 9 items from the Physical Prediction Questionnaire (PPQ, Lawson, Baron-Cohen, & Wheelwright, 2004). The

items consist of line drawings of mechanical devices, and the participants' task is to infer how pressing a lever affects the movement of the other parts of the device.

Dual-process variables. Self-reported intuitive thinking was assessed with two scales. First, the 10-item Intuition subscale (α = .79) from the Multifaceted Rational-Experiential Inventory (REIm, Norris & Epstein, 2011) was used. An example item is "I often go by my instincts when deciding on a course of action". Second, to assess reliance on intuition in non-social settings (e.g., logical reasoning, navigation, using technical devices), we developed five new items (α = 77) such as "When I am faced by a technical problem, I try to solve it intuitively rather than by finding out the cause of the problem". All intuition items were rated on a 4-point scale (1 = *Strongly disagree*, 4 = *Strongly agree*).

Self-reported deliberative thinking was assessed with two scales. First, the 12-item Rationality subscale (α = .86, corresponding to the Need for Cognition subscale of earlier REI versions) from the REIm (Norris & Epstein, 2011) was used. An example item is "I enjoy intellectual challenges". The items were rated on a 4-point scale (1 = S*trongly disagree*, 4 = S*trongly agree*). Second, we used the Actively Open-Minded thinking (AOT) scale (Sá, West, & Stanovich, 1999), which measures willingness to perspective switch and decontextualize, and to consider alternative opinions and evidence. The scale (α = .84) includes 41 six-point items (1 = S*trongly disagree*, 6 = S*trongly agree*), such as "Changing your mind is a sign of weakness" (Reflected).

Performance measures of both intuitive and deliberative thinking were provided by the Cognitive Reflection Test (CRT, Frederick, 2005). The test consists of three questions that cue intuitive but incorrect responses that must be resisted in order to calculate the correct answers.

We calculated the number of correct (deliberative) responses, and the number of heuristic (intuitive) responses.

Results and Discussion

For an overview of how the studied constructs relate to each other, we used Confirmatory Factor Analysis. We tested a model with four latent factors representing the four main constructs under study. Each construct was indicated by the measures intended to assess it. Because CFA does not allow the inclusion of variables that are directly linearly dependent, we could only include one of the two CRT variables (the number of correct responses; the number of heuristic responses had to be left outside the CFA). Modification indices suggested adding paths from the Empathizing factor to the REI Intuition scale and to AOT, and allowing the error variances of SQ and NFC to correlate. The final model (Figure 1) showed good fit to the data, CFI = .94, TLI = .92, RMSEA = .055, 90 % confidence interval of RMSEA = [.050, .060]. χ^2 remained significant ($p < .001$), as is usual in large datasets.

The model indicated negative relationships between systemizing and empathizing, between intuitive and deliberative thinking, between systemizing and intuitive thinking, and between empathizing and deliberative thinking. The relationship between systemizing and deliberative thinking was positive and strong, while empathizing and intuitive thinking were nearly independent of each other. In sum, the CFA supported the validity of the constructs, and suggested a few additional links between the studied measures. For more detailed analyses of how the different aspects of each construct relate to each other, we next inspected the correlations between individual measures.

Insert Figure 1 here

Appendix 1 shows the intercorrelations of all the studied variables. All the correlations between measures intended to assess the same construct were positive, while all correlations between intuitive thinking and deliberative thinking were negative. This pattern also indicates that the new non-social intuition scale had adequate criterion validity. Table 1 presents the correlations between intuitive and deliberative thinking, and empathizing and systemizing.

To rule out the possibility that any relationships between the variables were explained by covariation with sex, we tested all variables for sex differences. In line with previous research (Pacini & Epstein, 1999; Toplak, West, & Stanovich, 2014; Wheelwright et al., 2006), men outscored women on all measures of deliberative thinking and systemizing except AOT, while women showed higher scores than men on all measures of empathizing and intuitive thinking, except for non-social intuition. However, most sex differences were small (η_p^2's $\leq .12$). The only larger sex differences were on SQ (men: $M = 16.87$, $SD = 6.49$, women: $M = 10.65$, $SD = 5.73$, $t(2982) = 26.89$, $p < .001$, $\eta_p^2 = .20$) and on the mechanics test (men: $M = 6.27$, $SD = 2.67$, women: $M = 3.72$, $SD = 2.51$, $t(2790) = 25.06$, $p < .001$, $\eta_p^2 = .18$). We ran additional correlational analyses controlling for sex, but the pattern of results remained nearly unchanged. Thus, only the correlations without controlling for sex are reported. Below, the results are presented for each of the four relationships outlined in the Introduction.

First, the results support the suggestion that the tendency to use deliberative thinking increases along with systemizing. However, large differences were found between the three types of deliberative thinking. While SQ was strongly related to NFC, the relationship of SQ to CRT was only moderate. Even though the correlation of SQ with AOT was also positive, it was very small. For the measures of systemizing skill, the pattern of results was similar as for the self-

assessments. NFC, and particularly CRT, were positively related to performance on all three systemizing tasks, but the correlations of the tasks with AOT were weaker.

Second, for systemizing and intuitive thinking, the previously reported negative relationship was replicated. Moreover, even the non-social intuition items were related to weaker tendency to systemize. All the measures of intuition were also related to poorer performance on the systemizing skill tasks.

Insert Table 1 here

Third, for empathizing and intuitive thinking, the strong correlation previously reported was replicated, but only for the REI Intuition scale. For heuristic responses on the CRT, the relationship was weaker. Moreover, for intuition in non-social contexts, the relationship to EQ was nearly nonexistent. On the performance measures of empathy, the results diverged. The Eyes test was virtually unrelated to all of the variables studied. In contrast, the PET showed a similar pattern of associations as self-reported empathizing did. The more an individual trusted their intuition, the more he or she also felt affected by pictures of people in distress. However, no such relationship existed for the use of intuition in nonsocial situations, and affective empathic reactions to the pictures were only weakly related to heuristic responses on the CRT.

Fourth, empathizing was differently related to the three types of deliberative thinking. While EQ was nearly independent of NFC, and had a small negative relationship to CRT, its relationship to AOT was in the opposite direction. For the PET, these correlations were similar as for the EQ. On the subscales of the EQ, no systematic differences could be discerned in the patterns of correlations with the dual-process variables.

However, the above results on empathizing performance are essentially only informative with respect to emotional empathy, not cognitive empathy. It is unclear what conclusions our measure of cognitive empathy, the short version of the Reading the Mind in the Eyes test, warrants, because the present null correlations with all other variables, in conjunction with other results indicating no consistent relationship of the Eyes test to E-S variables (Morsanyi et al., 2012; Valla et al., 2010), cast doubt on to what extent this test reflects variation in empathizing skills in the normal population. Moreover, as the EQ was not originally designed to differentiate between affective and cognitive empathy, the present results are elusive. Therefore, we conducted Study 2, in which empathy was assessed with an additional measure, the Basic Empathy Scale in Adults (BES-A, Carré, Stefaniak, D'Ambrosio, Bensalah, & Besche-Richard, 2013; see also Jolliffe & Farrington, 2006). BES-A is a valid assessment method of empathic functioning in teenagers and adults. It measures both cognitive empathy, defined as the understanding of another person's mental state, and affective empathy. Unlike other empathy tests, BES-A takes account of the recent view that affective empathy includes both emotional contagion by another person's emotion and a regulatory factor that involves self-protection against extreme emotional impact.

Study 2

Method

Participants and procedure. Eighty-seven Finnish individuals (44.7 % females) participated in the study. Their mean age was 30 years (range 19–65). Of the participants, 21.2 % were working, 47.4 % were students, and 7.9 % were otherwise occupied. A randomly selected sample of 120 participants of Study 1 were invited by e-mail to participate in the follow-up study which consisted of filling in the BES-A via a web-based questionnaire. Of the 120 individuals, 6

did not respond. Of those who responded, 27 were excluded from analyses because of missing values or because it was not possible to match their responses to their previously gathered data.

Measures. The 20 items in the BES-A were rated on a 5-point scale (1 = *Strongly disagree*, 5 = *Strongly agree*). We calculated the subscales of affective empathy (α = .84, 11 items, e.g., "I tend to feel scared when I am with friends who are afraid") and cognitive empathy (α = .86, 9 items, e.g., "I find it hard to know when my friends are frightened").

Results and Discussion

The correlations of the BES-A with the dual-process variables are set out in Table 2. The results indicate that cognitive empathy, as assessed with the BES-A, had no significant relationship with intuitive thinking but a positive relationship with actively open-minded thinking. Meanwhile, affective empathy was moderately related to intuitive thinking, and had no other significant relationships to dual-process variables.

Insert Table 2 here

General Discussion

To disentangle the relationships between intuitive and deliberative thinking which stem from dual-process theories, and empathizing and systemizing which stem from E-S theory, the present paper examined each of the four possible relationships between these construct pairs in detail. Looking at the correlations between the latent constructs indicated that overall, empathizing was unrelated to intuitive thinking, whereas systemizing was very strongly related to deliberative thinking. However, more detailed inspection of the correlations between specific measures showed that there were strong correlations between some measures of intuitive thinking and empathizing, and between some measures of systemizing and deliberative thinking, but neither

relationship generalized to all forms of intuitive and deliberative thinking that were assessed in the present study.

To begin with, empathizing was related to certain forms of intuition but not to others. In line with the results of Brosnan, Hollinworth, et al. (2014), both self-reported empathizing and affective empathic reactions were related to intuitive thinking when it was operationalized using the REI Intuition scale. Inspection of latent correlations even indicated that the REI Intuition scale shared variance with empathizing even though the latent construct of intuitive thinking did not. Considering that trusting one's intuition is an appropriate approach in direct interactions with people, and that many of the items on the REI concern such interactions, this correlation is not surprising. However, for heuristic responses on the Cognitive Reflection Test, the relationship to empathizing was weaker than previously reported (Brosnan, Hollinworth, et al., 2014), indicating that high empathizers may not be very prone to favoring heuristics over reason. When considering intuition in explicitly non-social contexts, this relationship was nearly nonexistent, indicating no connection between the strength of people's interest in relating to other people and their tendency to rely on first impressions in contexts such as logical problem solving or navigation.

Further, when empathy was assessed using the Basic Empathy Scale for Adults in Study 2, its relationships to all forms of intuition were weaker than when using the EQ. In fact, only affective empathy was positively related to intuition – for cognitive empathy, the relationships to all forms of intuition were small and nonsignificant. Taken together, these findings suggest that the high correlation between the EQ and the REI Intuition scale that was found in both Study 1 and by Brosnan, Hollinworth, et al. (2014), may be method specific.

The present results also nuance our knowledge about the relationship between empathizing and deliberative thinking. In line with the results of Brosnan, Hollinworth, et al. (2014), self-assessed empathizing was nearly independent of the extensive thinking tendency assessed by NFC, and the negative relationship to cognitive reflection was small. The present results extend these findings by showing that the same was true for affective empathic reactions. However, the form of deliberative processing that is involved in actively striving for open-mindedness (Sá, Kelley, Ho, & Stanovich, 2005) bore a slight positive relation to empathizing, particularly to the domain of social skills. The latent model indicated that when error variance was accounted for, the latent relationship between empathizing and actively open-minded thinking was in fact of moderate magnitude. This relationship illustrates the plausible notion that being warm and socially talented often involves putting effort into understanding other people's point of view, even though it might differ from one's own. Thus, empathizing may be positively related to deliberative thinking in those domains that are of particular interest for empathizers. However, in Study 2, where empathy was assessed using the BES-A scale, this positive association with AOT was not significant.

As some aspects of social information processing are more deliberative than others (Bohl & van den Bos, 2012), the three subdomains of empathizing might have been differently related to dual process variables. However, no systematic differences in the patterns of correlations could be discerned between the subscales. In particular, the idea that cognitive empathy might be more related to deliberative thinking than to intuitive thinking, was not supported. In fact, cognitive empathy was the subscale with the strongest positive correlations to intuitive thinking. However, in Study 2 the results showed the opposite, with no significant relationship found

between cognitive empathy and intuitive thinking. Thus, more research is needed to determine how the dimensions of empathizing relate to intuitive and deliberative processing styles.

Between systemizing and deliberative thinking, there was heavy overlap when considering self-assessed need for cognition. These results indicate that interest in systemizable phenomena increases along with the enjoyment of thinking. However, for other measures of effortful processing, that is, for the CRT and AOT, the relationship to systemizing was moderate or weak. Thus, the overall picture becomes that systemizing is linked to those specific aspects of deliberative thinking that are assessed by NFC, rather than to deliberative thinking overall. This conclusion is supported by the finding of additional shared variance between the SQ and NFC, which was not accounted for by the already strong relationship between the latent constructs of systemizing and deliberative thinking. That is, high systemizers do tend to seek problems on which they can think long and hard, but they are not much more inclined than other people to reflect on their responses when reason and heuristics collide, or to actively use deliberative thinking to understand others' perspectives.

The differences between the NFC and the AOT are striking and may indicate that these two constructs capture deliberative thinking in different domains. This notion is in line with the finding that people's willingness to deliberate on issues with a people-centered focus, as assessed by the AOT, had a positive relationship with empathizing. Thus, rather than revealing any domain-general relationships between E-S constructs and dual-process constructs, the different relationships with empathizing and systemizing that were found for NFC and AOT, may boil down to showing that systemizing is associated with deliberation in systemizable domains, while empathizing is associated with deliberation in empathizable domains.

Why No Signs of Systemizers' Intuition?

Finally, as the E-S literature describes systemizing as stemming from intuitive physics (Baron-Cohen, Wheelwright, Spong, Scahill, & Lawson, 2001), systemizing could be expected to increase with a preference for using intuition. Nevertheless, on both self-reports and performance measures of systemizing, the present results confirmed that the more people preferred to think intuitively, be it in social settings, non-social settings, or on reasoning tests, the worse their systemizing was. One way to incorporate these theoretical views and contradictory findings is by considering the nature of the measures that were used to assess systemizing. Mental rotation, mechanical reasoning and map reading, which have been suggested to reflect systemizing (Baron-Cohen, 2002), may inadvertently be biased towards assessing deliberative forms of systemizing, and too difficult to solve using intuitive physics alone. For example, on the mechanics task, one has to consider the impact of pressing the lever on each consecutive part of the device, thus necessitating a serial, deliberative type of thinking. Even though these tasks likely engage core systemizing capacities, they may not have allowed participants to respond based on their first impressions. Thus, they may overlook the intuitive roots of systemizing.

An important question is why research has tended to focus on systemizing tasks whose difficulty level exceeds that of empathizing tasks. One possibility is that the literature has conflated systemizing as an interest domain and as a process. The description of systemizing as data collection and law detection (Baron-Cohen, 2008) may have put too much focus on serial processing, and made it easy to ignore that each of these subprocesses may function intuitively – detecting laws may not have to be explicit. The argument that assessments have focused too much on deliberative forms of systemizing applies above all to the performance measures, but perhaps also to self-assessments. It can be argued that several SQ items focus on explicit understanding of systems, for example: “If I were buying a computer, I would want to know

exact details about its hard disc drive capacity and processor speed", "I find it difficult to understand information the bank sends me on different investment and saving systems". Thus, the SQ may fail to touch on those contexts in which systemizing can be intuitive.

Nevertheless, we argue that such a thing as the systemizers' intuition is likely to exist. Consider tasks such as assembling a piece of furniture. For some, they are easy, whereas for others, they require time and effort and often trial and error before they are successfully finished. We argue that the reason these tasks is easy for some is that these individuals are able to rely on their strong intuitive physics skills. To assess the elusive concept of intuitive systemizing, a more likely avenue is in tasks and items that concern the kind of basic intuitive physical capacities that are involved in, for example, the online prediction of objects' movement (McCloskey, Caramazza, & Green, 1980). Thus, a challenge for future studies is to find systemizing tasks that can be solved quickly, based on first impressions. Here, the reasoning field offers experimental paradigms such as limited response times and working memory load, which have been found successful in hindering deliberative processing and bringing out intuitive processing.

Limitations

The present conclusions are limited by a few circumstances. As the data was collected online, it was not possible to control the setting in which participants completed the questionnaire. Studies indicate that Internet questionnaires do tend to be generally credible and their results consistent with results from studies using traditional methods (Gosling, Vazire, Srivastava, & John, 2004). Nevertheless, some participants may, for example, have asked other persons for help on the performance measures. Future studies may minimize this possibility by using tasks with limited response times or by recording how long participants take to respond to individual tasks.

Moreover, self-selection tends to be amplified in online studies (Nichols & Edlund, 2015). Thus, it is possible that the sample was biased towards, for example, particularly active internet users or people with a particularly positive attitude towards academic research. Future studies should strive to recruit samples that are more representative of the population at large.

Conclusion

The present data established that individual differences in the orientations for empathizing and systemizing reliably covary with individual differences in favoring some aspects of intuitive and deliberative thinking. However, these findings do not warrant generalizations of the type that "empathizing is intuitive" and "systemizing is deliberative". Rather, the correlations seem to be limited to narrow applications of the two processing styles. That is, people who are strongly oriented towards empathizing may end up reporting a strong reliance on intuition because in social interactions, relying on intuition tends to be a reasonable strategy. Conversely, those with a systemizing orientation may report high engagement in deliberative thinking because their self-selected technical occupations and pastimes build on intuitive physics but often go beyond it and therefore invite extensive thinking. The correlations that were found, strong as they are, do not diminish the importance of distinguishing between domain-specific modes of processing and domain-general processing of mental and physical information. In short, covariation of individual differences does not translate into deeper similarity of processes.

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Figure Captions

Figure 1

Confirmatory Factor Analysis of variables in Study 1

Table 1

Correlations

	Intuitive thinking			Deliberative thinking		
	Intuition	Non-social intuition	CRT heuristic	NFC	CRT correct	AOT
Systemizing						
SQ	-.259	-.141	-.214	.504	.233	.081
Systemizing skill	-.267	-.186	-.431	.392	.488	.148
Mental rotation	-.163	-.141	-.319	.247	.355	.086
Map reading	-.142	-.109	-.263	.241	.303	.119
Mechanics	-.285	-.165	-.373	.385	.421	.124
Empathizing						
EQ	.425	.047	.153	-.045	-.164	.160
Emotional reactivity	.336	.011	.149	-.190	-.155	.104

(Table 1 continued)

(Table 1 continues)

Cognitive empathy	.416	.115	.153	.001	-.156	.069
Social skills	.211	-.020	.046	.084	-.062	.190
EYES	.060	-.020	.032	-.031	-.023	.065
PET	.259	-.032	.122	-.075	-.120	.116

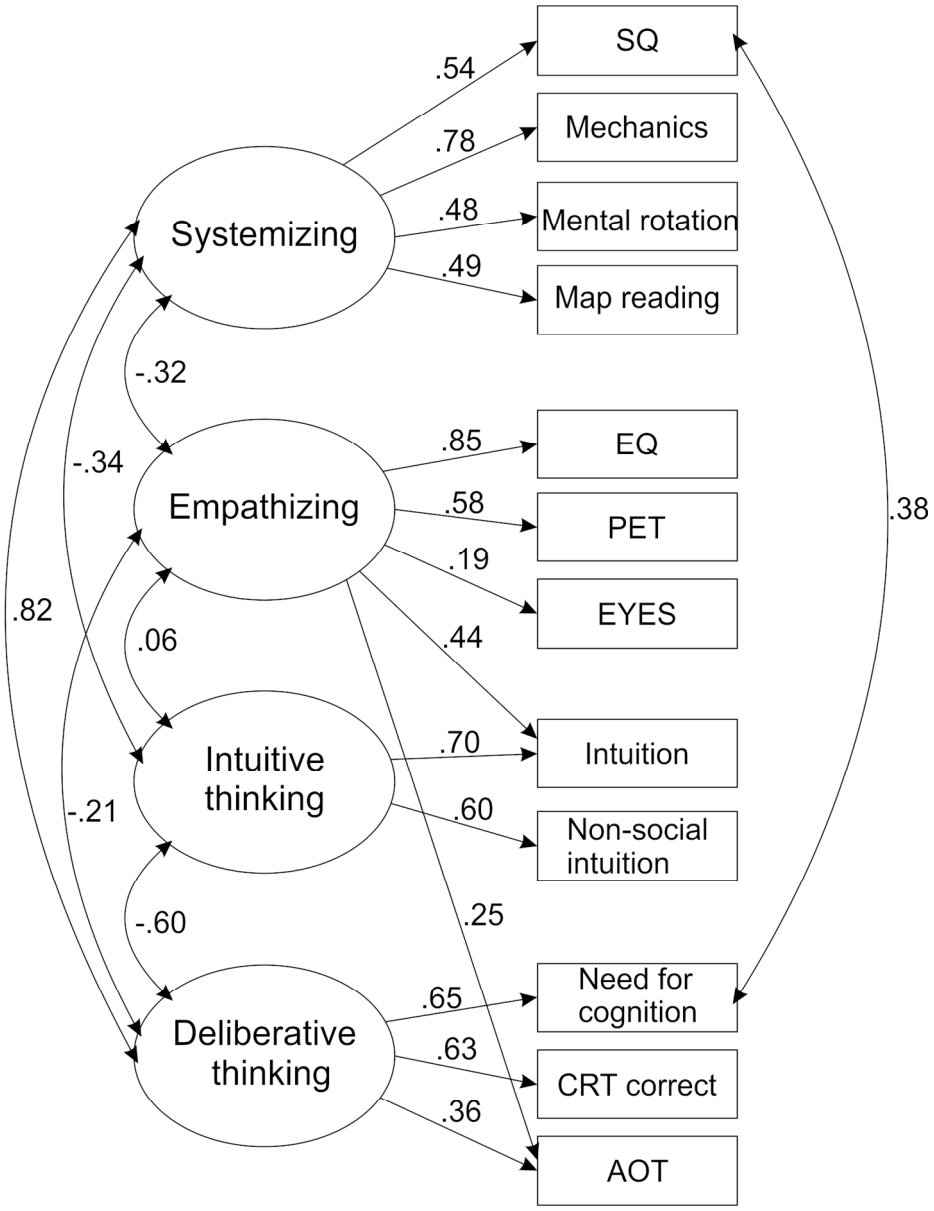
Note. All *r*'s > .06 are significant at $p < .001$; $r = .05$, $p < .01$; $r = .03–.04$, $p < .05$. SQ = Systemizing Quotient, EQ = Empathizing Quotient, EYES = Reading the Mind in the Eyes Test, PET = Pictorial Empathy Test, NFC = Need for Cognition, CRT = Cognitive Reflection Test, AOT = Actively Open-Minded Thinking.

Table 2

Correlations between intuitive and deliberative thinking and cognitive and affective empathy assessed using the Basic Empathy Scale in Adults

	Intuition	Nonsocial intuition	CRT heuristic	NFC	CRT correct	AOT
Cognitive empathy	.126	-.046	.129	.070	-.081	.200
Affective empathy	.296	.066	.117	-.215	-.124	.154

Note. Correlations $r > .22$ significant at $p < .05$. NFC = Need for Cognition, CRT = Cognitive Reflection Test, AOT = Actively Open-Minded Thinking.



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