Metacognition: Self-Concept, Cognitive Styles And Cognitive Correlates

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This paper reports the outcomes of a large study in which the metacognitive processes which take place during test-taking were assessed. The focus is primarily on confidence judgements that people assign to their answers to cognitive test items. There are pronounced individual differences in these judgments defining a Self-confidence factor, the exact nature of which remains unclear due to a lack of psychological correlates. The main findings presented in this paper show that self-confidence is a stable, broad psychological trait, affected by the dynamics occurring during decision-making in test-taking activities. An extensive battery of different thinking dispositions relating to the way in which people react to, and deal with, uncertainty was employed together with measures of personality and self-concepts. Structural Equation Modelling techniques were employed to provide a broad path model summarising the relationship between these measures and the Self-confidence trait. Self-confidence during test-taking was related only to the Metacognitive Beliefs factor as defined by specific self-concepts. These self-concepts assess competence in the fundamental cognitive abilities used by people in test-taking—memory and reasoning.

Background

Decision-making is one of the most fundamental components of human behaviour. A key aspect of decision-making is the notion of uncertainty (the situation in which certain parameters are unknown) and how to deal with it. One mechanism that helps humans to deal with uncertainty is the ‘meta’ level of human cognition. It enables humans to reflect on past experiences involving uncertainty, and to use this knowledge in future situations. Metacognition is often referred to as being higher than the ‘knowledge’ level of cognition, or “knowing about knowing” (Metcalf & Shimamura, 1994). The latter “knowing” refers to one's understanding of a task, one’s own ability, knowledge, and many other task-related factors, while the former “knowing” represents the assessment of one’s own competency in having this understanding. Most theories distinguish between two major components of metacognition—knowledge about cognition and regulation of cognition (e.g., Nelson & Narens, 1994; Schraw & Dennison, 1994). Knowledge refers to knowledge about ‘self’ and ‘strategies’, about ‘how’, ‘when’ and ‘why’ to use appropriate strategies, and to allocate relevant cognitive resources (ibid). Regulation facilitates the control aspect of learning and it includes a number of processes such as planning, evaluation and monitoring. Monitoring, which is the focus of this paper, is defined as the ability to watch, check and appraise or judge the quality of one’s own cognitive work in the course of doing it (ibid).

The focus of this paper is on the unique immediate confidence judgments which lie at the core of a calibration approach to ‘meta’ knowledge (see Harvey, 1997; Stankov, 1999 for reviews). The calibration paradigm is concerned with explanations of confidence judgments that people assign to events (e.g., answers to questions, decisions, predictions) (ibid). In this paradigm, immediately
after responding to an item in a test, participants are instructed to give a confidence rating (usually expressed in terms of percentages) indicating how confident they are that the chosen answer is correct. These confidence judgments are regarded as an integral part of self-monitoring process of metacognition, as they reflect one’s belief in the accuracy of the decision following a particular cognitive act (ibid).

Numerous studies indicate that confidence judgments have high internal consistency (reliability estimates are typically higher than .90; see Stankov, 1999 for review) and robust test-retest estimates (Jonsson & Allwood, 2003). Importantly, there are systematic individual differences in confidence ratings (see Stankov, 1999 for review). The correlations between accuracy and confidence scores from the same test are significant (average between .40 and .50). Nevertheless, correlations between confidence ratings from a diverse battery of cognitive tests have been consistently high enough to define a strong Self-confidence factor (ibid). The factor reflects the stability of confidence judgments that have been shown to exist across different items, cognitive tests and knowledge domains. Despite an extensive research program, there has been little success in providing a general outline of the possible mechanisms underpinning individual differences in confidence judgments. In general, studies of the nature of this phenomenon have been mainly concerned with their psychological correlates. The results have been somewhat disappointing, as they point to what the construct is not, rather than to what it is.

Self-Confidence and Related Constructs

There are a number of psychological constructs which have been considered in relation to Self-confidence. These constructs include intelligence (e.g., Kleitman & Stankov, 1998; Lichtenstein, & Fischhoff, 1977; Pallier, et al., 2002; Stankov & Crawford, 1997; Stanovich, 1999), cognitive processes involved in test-taking activities (e.g., Allwood & Montgomery, 1987), personality (e.g., Kleitman & Stankov, 2001b; Pallier et al., 2002), and various aspects of self-concept and metacognitive awareness (e.g., Schraw, 1997; Stankov & Crawford, 1997). This line of research resulted in interesting, yet limited findings.

Intelligence/Accuracy. Several studies have shown that although the Confidence factor has a meaningful positive overlap with the factors underlying intelligence, it is separate from these factors (see Stankov, 1999). The relationship between confidence scores remains strong and significant when accuracy is partialled out (e.g., Kleitman & Stankov, 1998; Schraw, et al., 1995) indicating that the factor does extend beyond the ‘knowledge’ level of cognition (i.e., variations in cognitive abilities).

Personality. Self-confidence is sometimes treated as a personality trait, either on its own or as a facet of broader traits. Yet, when an overlap between Self-confidence and personality traits such as those captured by the Big Five model of personality structure is considered, few meaningful associations are evident. As reported by Pallier et al. (2002), previous work in our laboratory has shown that there are statistically significant, although modest associations, between measures of Openness and Proactiveness and measures of Self-confidence (correlations are typically less than .30). Moreover, a closer look at these correlations revealed that they are largely mediated by Openness/Proactiveness-Ability associations (Kleitman & Stankov, 2003).

Self-concept. Stankov and Crawford (1997) argued that different well-established areas of academic Self-concepts might be related to Self-confidence. They utilized scales for the assessment of Mathematics and Verbal facets of academic Self-concept, such as those used in the Self-Description Questionnaire-II (SDQ) (Marsh, 1990). However, the reported findings were similar to those obtained with personality dimensions—only limited support for the hypothesized relationship. Thus, English Self-concept was found to share a low correlation with Confidence
rating measures on a Vocabulary test and Mathematic Self-concept had a low correlation with Confidence ratings based on the Raven’s Progressive Matrices test.

Reflecting on these findings, Stankov (1999) claims that the Self-confidence construct seems to be in a “no man’s land”, the area that lies between intelligence and personality (p. 315). Similarly, Allwood and Granhag (1999) have argued that despite years of research “our understanding of such judgments has only improved to a very limited extent” and that “one way to improve the situation is to more closely attempt to identify the phenomenon under study” (p. 123). Kleitman and Stankov’s (2003) study followed this suggestion by looking at the dynamics involved in decision-making during test-taking, related Self-concepts and their relationship with Self-confidence.

Recent Findings: Kleitman & Stankov’s (2003) Study
Earlier studies provided hints about the processes involved in decision-making during test-taking activities. Evidently, the level of confidence is linked to the degree of uncertainty that one experiences during test-taking: the higher the perceived uncertainty, the lower were confidence ratings (Allwood & Montgomery, 1987). Also, it has been shown that people employ such cognitive processes as inference (reasoning) and answer recollection (memory) as the predominant response selection strategies during test-taking (Allwood & Montgomery, 1987). Notably, employment of these strategies was predictive of the general level of confidence. “Immediate Recognition” of the answer (memory) was associated with the highest confidence judgments. These were followed by the confidence ratings attached to the answers that were inferred (via a ‘reasoning’ response-selection strategy). Kleitman and Stankov (2003) hypothesized that if confidence ratings are reflective of regulative aspects of metacognition, then these dynamics should be related to individual differences in confidence judgments. Thus, it was proposed that in the test-taking situation, people’s perception of their competence in memory and reasoning cognitive abilities is linked to the confidence estimates that people assign to their answers. A self-concept measure, the Memory and Reasoning Competence Inventory (MARCI) was constructed in order to capture these beliefs.

The development of this scale was based on the work of Marsh and his collaborators relating to Self-concept (Marsh, 1986, 1987; Marsh et al., 1992). The inventory incorporated the Internal/External (I/E) Frame of Reference Model (ibid). The I/E model suggests that English and Mathematics Self-concepts are distinct because they are formed in relation to both external and internal comparisons, or frames of reference. According to the external comparisons principle, the development of Self-concept is influenced by the process of social comparison. A person compares his/her ability in maths and reading with the perceived ability of other students in these areas. According to the internal comparisons principle, a person also compares self-perceived ability in maths with his/her self-perceived ability in English. The items that comprise the Memory and Reasoning Competence Inventory (MARCI) reinforced the External (“I can remember more material than the average person”) and Internal (“Compared to my other cognitive abilities [i.e., attention, reasoning], my memory is good”) comparisons.

The results demonstrated that the inventory has good psychometric properties (i.e., consistently high reliabilities and replicable factorial structure) and good discriminant and convergent validities (Kleitman & Stankov, 2003). In particular, people’s self-concepts regarding their memory and reasoning were related to actual performance on a variety of tests that relied on these abilities (i.e., fluid intelligence; Gf and crystallized intelligence; Gc). Yet, Self-concepts extended beyond accuracy itself, and loaded on a factor together with the Metacognitive Awareness Inventory of Schraw and Dennison (1994) (in Kleitman & Stankov, 2003). Also, the
correlation between the Reasoning and Memory competency scores was low to moderate, suggesting that people’s perception of competency of these two fundamental cognitive abilities is not general, but ability specific. Importantly, after controlling for accuracy, the Reasoning Competency score of the MARCI was predictive of the Self-confidence trait. In particular, while accuracy explained 14% of the variance in the general level of confidence, the MARCI added a further 11% to this prediction. Together these two variables explained 25% of the variance in the level of confidence (ibid).

It was suggested that the MARCI encapsulates what Schraw and Dennison (1994) referred to as people’s ‘knowledge of them-selves’ and ‘strategies’—the Knowledge About Cognition facet of Metacognition. The reasoning score of this scale seems to reflect a construct that Moshman (1994) views as Conceptual Metareasoning, which involves knowledge about one’s own reasoning, and assessment of its strengths and weaknesses. Thus, important interactions between the Self-confidence trait and MARCI indicate that this trait reflects metacognitive processes.

Kleitman and Stankov (2003) also confirmed that the level of confidence is strongly linked to the degree of uncertainty that one experiences during test-taking: lower confidence ratings were associated with higher perceived uncertainty (see also Allwood & Montgomery, 1987; Kleitman & Stankov, 2001b). However, it remained unclear how people’s perception of their competency in dealing with uncertainty in general relates to Self-confidence. Also, the status of the MARCI in relation to these types of beliefs requires clarification.

In most decision-making situations, an individual faces different degrees of uncertainty. In probabilistic terms, this situation is called ambiguity. The seminal work of Frenkel-Brunswick (1949) introduced the notion of intolerance of ambiguity as an emotional and perceptual personality variable. A review of literature suggests that while some people are capable of handling uncertainty, there are people who find uncertainty difficult to tolerate. This latter group, is said to employ tendencies toward structuring their environment, toward predictability (Budner, 1962; Kruglanski, 1989; Leone, Wallace, & Modglin, 1999; Neuberg, Judice, & West, 1997; Thompson, Naccarato, & Parker, 1989), toward dogmatic and rigid thinking (Budner, 1962; Kruglanski, 1989; Rokeach, 1960; Schultz & Searleman, 2002), and premature closure to handle uncertainty (Kruglanski, 1989; c.f. Neuberg, et al., 1997).

In contrast, there are tendencies towards opened-mindedness, objective and reflective thinking which are said to characterize good decision-makers (Baron, 2000; Stanovich, 1999; Stanovich & West, 1997, 1998). These constructs, commonly labeled as ‘cognitive’ or ‘thinking’ styles (e.g., Sternberg & Grigorenko, 1997), “information-processing habits” (Messick, 1970, p. 190) and “thinking dispositions“ (e.g., Baron, 2000; Sa, et al., 1999; Stanovich & West, 1997). Despite differences in labels and the scope of these approaches, common to most models, this construct is seen to underlie individual differences in information processing and judgment, mechanisms and strategies which direct “broad tendencies of pragmatic and self-regulation” (Stanovich, 1999, p. 158). Throughout this paper this construct will be labeled as ‘thinking dispositions’.

While many different measures reflecting these constructs have been proposed, Leone, et al. (1999) pointed out, one of the problems in this field is the absence of a large-scale study examining the relationship between these measures via factor analytic techniques. Similarly, Sternberg (1997) stressed that this field of research lacks an integrative model which would combine these constructs and study their relationships with each other. Some authors simply use
a composite formed by summing up the scores of measures of cognitive flexibility (e.g., Actively Open-Minded Thinking scale) and subtracting the sum of the scores of inflexible thinking (e.g., Absolutism, Dogmatism) (see Sa, et al., 1999; Stanovich & West, 1997, 1998). Moreover, although many theorists conceptualize thinking dispositions within the realm of personality (see Sternberg & Grigorenko, 1997), there is a lack of studies focusing on thinking dispositions and conceptually related personality or attitudinal measures.

However, such personality dimensions as Extraversion, Openness to Experience, Proactiveness and Conscientiousness may have important links with the constructs of thinking dispositions outlined above. People who score highly on the Openness to Experience scale (also sometimes referred to as “Intellect”, see Ashton, Lee & Vernon, 2000) are said to be analytic, knowledgeable and broad-minded (Costa & McCrae, 1992). This personality dimension might be inversely related to thinking dispositions which reflect rigidity of thinking (e.g., Closed-mindedness, Dogmatism, Absolutism). Also, the Conscientiousness factor assesses responsibility, organization and scrupulousness. These aspects may have important links with Need for Order feature of the Need for Closure construct. In addition, individuals who score highly on the Extraversion scale are said to be prone to risk-taking, to be assertive and optimistic (e.g., Costa & McCrae, 1992). These aspects of Extraversion may have important links with decisiveness feature of the Need for Closure construct. Similarly, Irvine's (1999) Proactiveness scale assesses personality traits of determination and decisiveness. This suggestion is consistent with recent findings (Neuberg et. al., 1997), showing that Decisiveness may not fit with the intolerance of ambiguity and the need for closure constructs. Hence, it is important to study thinking dispositions together with related personality dimensions.

Moreover, to aid in improved understanding of the nature of metacognitive beliefs in relation to perceived competency of one’s fundamental cognitive abilities, it is important to study the relationship between Memory and Reasoning self-concepts (reflected by MARCI) and the abovementioned thinking dispositions constructs. Similarly, the relationship between thinking dispositions and more general metacognitive awareness (reflected by Metacognitive Awareness Inventory or MAI; Schraw & Dennison, 1994) needs to be studied.

To investigate the factorial structure of thinking disposition and related measures two studies—one exploratory and one confirmatory—were performed. The results of Study 2 were essentially the same as those revealed in Study 1. Thus, this paper only reports the results of the second, confirmatory study. The aims of this study are: 1) to examine the factorial structure of thinking dispositions and personality variables employed together with metacognitive constructs (reflected by MAI and MARCI scales) with confirmatory techniques; and 2) to present a broader path-analytic model that explores and summarizes relationships between the resulting constructs and Self-confidence and ability factors.

**Method**

**Participants**
This study employed 296 1st Year Psychology students (85 males). Mean age was 18.99 (SD=3.15). Participants were tested in groups of twenty.

**Questionnaires**
(1) Dogmatism scale, Comprised of 14 items from Adorno et al., 1950, Trolldahl & Powell, 1965, Paulhus & Reid, 1991 and Rokeach, 1956 scales (in Robinson, Shaver, & Wrightsman, 1991) scales. It assesses inflexibility and rigidity of thinking using items such as “No one can talk me out of something I know is right”.
(2) **Absolutism scale.** The scale corresponds to 9 "Dualism" items of the Erwin’s Scale of Intellectual Development (1981, 1983). With items such as “Right and wrong never change” it reflects an individual’s tendency to see the world in absolute terms, as being unidimensional rather than multidimensional.

(3) **Actively Open-Minded Thinking (AOMT)** (Stanovich & West, 1998). This 10-items scale assesses a tendency to unbiased information-processing (e.g., “A person should always consider new possibilities”).

(4) **Intolerance To Ambiguity Scale (ITAS)** (Budner, 1962). This 9-items scale assesses the tendency to be uncomfortable with uncertainty and towards rigidity (e.g., “The sooner we all acquire similar values and ideas the better” and “I don’t like things to be uncertain and unpredictable”). To improve the poor reliability estimate of the scale revealed in Study 1 (i.e., .57) 7 additional items were included from Webster, Stanford & Freeman’s (1955) Intolerance of Ambiguity facet of A New F (Authoritarianism) scale (in, Robinson et al. 1991).

(5) **Proactiveness.** This questionnaire consists of 15 Proactiveness items from the True Self-Report Inventory (Irvine, 1999). It required self-report responses to statements such as “I am self-confident, assured”.

(6) **Openness (O).** The scale contained 12 items from the Openness sub-scale of the OCEANIC scale (Roberts, 2001). Example: I have thought about the origins of the universe.

(7) **Conscientiousness (C).** This scale contained 12 items from the Conscientiousness sub-scale of the OCEANIC scale (Roberts, 2001). Example: I would describe myself as efficient.

(8) **Extraversion (E).** This scale contained 12 items from the Extraversion sub-scale of the OCEANIC scale (Roberts, 2001). Example: I like to be where there is lots of action.

(9) **Optimism Bias (OB).** This 10-items scale measures optimistic (5 items) and pessimistic (5 items) attitudes about future events in one’s life. Respondents are asked to estimate (on a scale from 0 to 100) how probable it is that a particular event will happen to them. The respondents had to judge their chances to “succeed in your studies” (optimism) and to “develop a drug problem” (pessimism). The scale was employed as a measure of both attitudes towards one’s future and unrealistic optimism (see Chang, & Farrehi, 2001 for review).

(10) **Need For Closure Scale (NFCS)** (Kruglanski, et. al., 1993). This 42-items scale has 5 sub-scales: (1) Preference for Order (e.g., “I find that a well ordered life with regular hours suits me”), (2) Preference for Predictability (e.g., “I don't like to go into a situation without knowing what I can expect from it”), (3) Decisiveness (e.g., “When faced with a problem I usually see the one best solution very quickly”), (4) Discomfort with Ambiguity (e.g., “I don’t like situations that are uncertain”) and (5) Close-Mindedness (e.g., “I do not usually consult many different opinions before forming my own view”).

(11) **Metacognitive Awareness Inventory (MAI)** (Schraw & Dennison, 1994). This is a 52-item questionnaire specifically designed to assess awareness of metacognitive processes (e.g., “I understand my intellectual strengths and weaknesses”; “I have a specific purpose for each strategy I use”).

(12) **Memory & Reasoning Competence Inventory (MARCI)** (Kleitman & Stankov, 2001b, 2003). The inventory consisted of 16 items, 8 items for memory and reasoning facets respectively (see above).

All questionnaires, except for the Optimism Bias (OB) scale, required self-report responses on a six-alternative Likert scale. For questionnaires 1-5 responses alternatives consisted of the following: “disagree strongly”, “disagree moderately”, “disagree slightly”, “agree slightly”, “agree moderately” and “agree strongly”. For the questionnaires 6-11 responses were: "never", "rarely", "sometimes", "often", "usually", and "always". For the MARCI, item response categories were the same as the ones in the Self Descriptive Questionnaire II (Marsh, 1990),
ranging from False to True. For the OB measure, respondents had to rate (on a scale from 0 to 100) how probable they consider a number of events to happen. All measures were given in a pencil-and-paper format.

Tests
(1) Quantitative Switching task (QST) (attention switching measure, 60-number strings). For odd items participants have to search the string and report the largest even digit. For even items they have to report the smallest odd digit. The test had a 2-minute time limit. Examples: 1) 3 5 6 4 5 2 3 7 Ans..(6); 2) 8 7 9 6 5 8 2 2 Ans.(5).
(2) Verbal Reasoning Test (VRT) (Kleitman & Stankov, 2001b, 2003). The 30 items employed in this test were designed specifically to elicit memory recollection and reasoning response selection strategies, as described above (see Kleitman & Stankov, 2001b, 2003 for details). The test has been shown to be a factorially complex measure as it loads on both the Gf and Gc factors (Kleitman & Stankov, 2003).
(3) Nonsense Syllogisms Test (NST) (French, Ekstrom, & Price, 1963). This test of deductive reasoning consists of 16 two-choice items, asking the participant to evaluate the quality of reasoning using items with a nonsense content (i.e., All trees are fish. All fish are horses. Hence, all trees are horses [Ans. Valid reasoning]).
(4) Esoteric Analogies Test (EAT) (Stankov, 1997). Participants have to choose one word out of four provided to complete verbal analogies. This test of inductive reasoning contains 20 items: Example: CHICK is to HEN as CALF is to: BULL, COW, COAT, ELEPHANT (Ans. COW).
(5) General Knowledge Test (GKT) (14 items) is a part of the Gf/Gc ‘Quickie battery’ (Stankov, 1997). Example: Leucocytes are: 1) Small bones in our hands; 2) Small blood cells; 3) Small hair cells in our ears; 4) A form of bacteria; 5) Male hormones. (Ans. Small blood cells)
(6) Probabilistic Reasoning Test (PRT) The test was adapted from a High School textbook. It included 15 probability reasoning tasks measuring one’s ability to estimate sample space and a range of probabilities of within this space (e.g., In 3 child families, what is the probability of having 3 sons? 1/8; 1/4; 2/16; 1/16; 7/8. (Ans. 1/8).
(7) Conditional Reasoning Test (CRT). The test consisted of 12 items of conditional (deductive) reasoning (If p then q). The questions’ context was trivial: If the book’s cover is green then it is not a novel. The book is green, therefore it is not a novel (Ans. True). Participants were asked to evaluate quality (truth or falseness) of the items.

Tests 2-5 included confidence judgments, while tests 1, 6 & 7 did not. Tests 2-4 were computerized.

Procedure
The QST as timed test was administered first. It was followed by the MARCI. The remainder of the tests were intermixed and presented in blocks in a random manner. The overall testing time was 2.5 to 3 hours.
Results

Table 1 presents descriptive statistics and reliability estimates (Chronbach’s Alpha) of the thinking dispositions, personality and metacognitive beliefs measures.

Table 1: Descriptive Statistics for the Measures of Thinking Dispositions, Personality and Metacognition

<table>
<thead>
<tr>
<th>Measure</th>
<th>Mean</th>
<th>SD</th>
<th>Alpha</th>
</tr>
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<tbody>
<tr>
<td>Dogmatism</td>
<td>3.17</td>
<td>0.61</td>
<td>.70</td>
</tr>
<tr>
<td>Absolutism</td>
<td>3.22</td>
<td>0.63</td>
<td>.55</td>
</tr>
<tr>
<td>AOMT</td>
<td>4.41</td>
<td>0.52</td>
<td>.57</td>
</tr>
<tr>
<td>ITAS Proactiveness</td>
<td>3.24</td>
<td>0.46</td>
<td>.72</td>
</tr>
<tr>
<td>Openness</td>
<td>41.80</td>
<td>8.70</td>
<td>.82</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td>45.52</td>
<td>8.88</td>
<td>.87</td>
</tr>
<tr>
<td>Extraversion</td>
<td>47.30</td>
<td>8.07</td>
<td>.84</td>
</tr>
<tr>
<td>OB: Optimistic</td>
<td>52.94</td>
<td>11.95</td>
<td>.60</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measure</th>
<th>Mean</th>
<th>SD</th>
<th>Alpha</th>
</tr>
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<tbody>
<tr>
<td>OB: Pessimistic</td>
<td>32.59</td>
<td>12.67</td>
<td>.53</td>
</tr>
<tr>
<td>NFC1: Pref. for Order</td>
<td>3.77</td>
<td>0.71</td>
<td>.74</td>
</tr>
<tr>
<td>NFC2: Pref. for Predictability</td>
<td>3.38</td>
<td>0.79</td>
<td>.74</td>
</tr>
<tr>
<td>NFC3: Decisiveness</td>
<td>3.27</td>
<td>0.85</td>
<td>.74</td>
</tr>
<tr>
<td>NFC4: Discomf. w. Ambiguity</td>
<td>4.00</td>
<td>0.63</td>
<td>.60</td>
</tr>
<tr>
<td>NFC5: Closed-Mindedness</td>
<td>2.90</td>
<td>0.60</td>
<td>.60</td>
</tr>
<tr>
<td>MAI</td>
<td>3.98</td>
<td>0.51</td>
<td>.93</td>
</tr>
<tr>
<td>Memory Competence score</td>
<td>3.90</td>
<td>0.96</td>
<td>.89</td>
</tr>
<tr>
<td>Reasoning Competence score</td>
<td>4.22</td>
<td>0.79</td>
<td>.89</td>
</tr>
</tbody>
</table>

In general, the means of the measures that reflect rigidity of thinking (i.e., Dogmatism, Absolutism, and Closed-Mindedness) are at the low end of the range, while the means of the measures that reflect the opposite construct--Actively Open-Minded Thinking scale--is at the top end of the range. This indicates that people in this sample view themselves as being predominately flexible thinkers. The sample also has similar, and relatively high, means on the Proactiveness, Openness, Conscientiousness and Extraversion scales. Since the sample was comprised of university students, these findings are as expected. In addition, the mean of the Optimistic facet of the OB scale is notably higher than the mean of its Pessimistic facet, indicating that the sample view their future in an optimistic, rather than pessimistic, light. For most of the questionnaires, except Absolutism, AOMT and OB reliabilities are satisfactory and similar to the values reported elsewhere in the literature (see Leone, et al., 1999). Metacognitive and Personality measures, however, have the highest reliabilities.

The descriptive statistics and reliability coefficients for accuracy and confidence measures are essentially the same as have been previously reported in the literature (see Kleitman & Stankov, 2001, Stankov, 2000). Hence, they are not presented here but available on request. The findings, however, confirm that confidence ratings have a high internal consistency (mean of all alphas=.89), which is stronger than that revealed for accuracy scores (mean of all alphas=.57). Also, there are diverse levels of accuracy and confidence on this battery of cognitive tests. The overall confidence level is the lowest for the VRT (42.2%), and the highest for the NST (75.9%). The percentage of correctly answered questions level is the lowest for the QST (33.4%), and the highest for the PRT (75.9%).

Correlations Among Thinking Dispositions, Personality and Attitudinal Measures

Pearson product moment correlations between thinking dispositions, personality and optimism bias measures were calculated. Due to space constraints they are not presented in this paper, but are available on request. The most important aspects of this correlation matrix are:
There is a wide range of correlations between different measures of thinking dispositions (r’s range between .0 & .63). Most statistically significant correlations (both positive and negative), although different in strength, are meaningful. For instance, the ITAS correlates positively with Dogmatism, Absolutism and four out of five facets of the NFCS and negatively with AOMT scale. In contrast, the Decisiveness facet of the NFCS scale has the inconsistent pattern of correlations with other facets of the scale and the rest of thinking dispositions measures. Instead, this facet has a pattern of meaningful correlations with the personality and OB measures.

(2) Personality measures have a meaningful pattern of correlations with related measures of thinking dispositions and Optimism Bias (OB). For instance, Proactiveness has positive correlations with the Optimistic OB, the Decisiveness facet of the NFCS and other personality dimensions, especially Extraversion.

(3) The Metacognitive Awareness Inventory (Schraw & Dennison, 1994) shares substantial positive correlations with all four personality dimensions and the Optimistic score of the OB measure. They are particularly high for the Proactiveness and Conscientiousness dimensions (.51 and .57 respectively). Both MARCI scores mimic this pattern of correlations, but with notably lower correlations (range between .11 & .36).

(4) Accuracy scores have the most consistent correlations with the following measures of thinking dispositions: Absolutism, AOMT, ITAS, Closed-Mindedness, Preferences for Order facet of the NFCS (positive for the AOMT and negative for all others). Among personality measures, only Openness has a pattern of consistent positive correlations with accuracy scores. Among the metacognitive measures, only the Reasoning score from the MARCI correlates consistently and positively with all accuracy scores.

(5) Confidence ratings have a pattern of inconsistent correlations with the measures of thinking dispositions and personality. The only exception is the Closed-Mindedness facet of the NFCS that correlates negatively with 3 out of 4 confidence measures (r’s range between .13 & -.20, p<.05). Also, Openness and the Optimistic score of the OB measure share the most consistent positive correlations with the confidence scores (r’s range between .18 and .25, p<.01). Importantly, however, all metacognitive measures, but especially the Reasoning score of the MARCI, correlate consistently and positively with all confidence scores (r’s range between .15 & .25 for MAI and between .22 & .29 for the Reasoning score of MARCI, p<.01).

These findings point to three conclusions: (1) more than one dimension underlies measures of thinking dispositions; (2) there is substantial overlap between thinking dispositions and both personality and attitudinal measures; (3) there is a meaningful overlap between metacognitive and both personality and attitudinal measures. This overlap is far more substantial for the MAI questionnaire than for the both of the MARCI scores.

**SEM: The Links Between Factors that Underlie Thinking Dispositions and Cognitive and Metacognitive Factors**

All Structural Equation Model (SEM) analyses (including CFAs) were conducted on a covariance matrix using the Maximum Likelihood method from the AMOS program (Arbuckle & Wothke, 1999). The two components of the model are as follows: The exogenous part is defined by factors that mark the metacognitive level (i.e., factors that underlie thinking dispositions, personality and metacognitive beliefs measures. The endogenous part is defined by the factors that mark the observed behavioral outcomes—cognitive and metacognitive performance (i.e., factors that underlie ability and the Self-confidence factor). Two ability factors (Gf and Gc) are assumed to covary.

The main Structural Equation Model analysis was conducted at the level of latent constructs that capture variance common to several variables, not at the level of observed manifest variables. The model is, therefore, fitted in several steps: the exogenous part of the model was fitted first (via Confirmatory Factor Analyses or CFAs). Several alternative models were also fitted and
only the most parsimonious model with the best fit indices is reported here. Some measurement parameters of the accepted model (i.e., factor loadings for the different variables on the corresponding latent factors) were fixed using the unstandardized factor loadings estimates resulting from the abovementioned CFAs (as all relevant analyses are based on the covariance matrix). Then, the measurement part of the endogenous part of the model was calculated (via CFAs) and some measurement parameters were fixed on this part of the model. Finally, a structural part of the model was estimated.

**CFAs for the Measures that Define the Exogenous part of the Model**

Several nested models were fitted. None, however, had a better fit to data than the five-factor model outlined in Table 2. The relevant statistics are available on request. The model presented in Table 2 (with 4 covariances set to zero) has a good fit: $\chi^2_{115} = 277.14; \chi^2/df = 1.98$, the Root Mean Square Error of Approximation (RMSEA) equals .057 (its 90% Confidence Interval [CI] is .046-.068). The Tucker-Lewis index (TLI) is .91 and the Goodness-of-Fit index (GFI) is .93.

**Table 2: The Exogenous part of the Structural Equation Model, (N=296)**

<table>
<thead>
<tr>
<th></th>
<th>Need for Structure</th>
<th>Outward Assuredness</th>
<th>Rigid Thinking</th>
<th>Openness</th>
<th>Metacognitive beliefs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F1</td>
<td>F2</td>
<td>F3</td>
<td>F4</td>
<td>F5</td>
</tr>
<tr>
<td>Dogmatism</td>
<td>.77</td>
<td></td>
<td></td>
<td></td>
<td>.60</td>
</tr>
<tr>
<td>Absolutism</td>
<td>.80</td>
<td></td>
<td></td>
<td></td>
<td>.64</td>
</tr>
<tr>
<td>AOMT</td>
<td>-.34</td>
<td>.28</td>
<td></td>
<td>.24</td>
<td></td>
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<tr>
<td>ITAS</td>
<td>.35</td>
<td>.49</td>
<td>-.24</td>
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<td>.70</td>
</tr>
<tr>
<td>Proactiveness</td>
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<td></td>
<td></td>
<td></td>
<td>.58</td>
</tr>
<tr>
<td>Openness</td>
<td></td>
<td>.67</td>
<td></td>
<td></td>
<td>.45</td>
</tr>
<tr>
<td>Consciousness</td>
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<td>.41</td>
<td>.36</td>
<td></td>
<td>.62</td>
</tr>
<tr>
<td>Extraversion</td>
<td>-.43</td>
<td>.77</td>
<td>-.36</td>
<td></td>
<td>.55</td>
</tr>
<tr>
<td>OB: Optimism</td>
<td>.55</td>
<td></td>
<td></td>
<td></td>
<td>.30</td>
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<tr>
<td>OB: Pessimism</td>
<td>-.39</td>
<td></td>
<td></td>
<td></td>
<td>.16</td>
</tr>
<tr>
<td>NFC1: Order</td>
<td>.76</td>
<td>.23</td>
<td></td>
<td></td>
<td>.62</td>
</tr>
<tr>
<td>NFC2: Predictability</td>
<td>.74</td>
<td></td>
<td></td>
<td></td>
<td>.55</td>
</tr>
<tr>
<td>NFC3: Decisiveness</td>
<td></td>
<td>.50</td>
<td>-.26</td>
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<td>.20</td>
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<td>NFC4: Ambiguity</td>
<td>.31</td>
<td>.33</td>
<td></td>
<td></td>
<td>.31</td>
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<tr>
<td>NFC5: Closed-Mindedness</td>
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<td></td>
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<td>.54</td>
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<tr>
<td>MAI</td>
<td>.30</td>
<td>.44</td>
<td>.52</td>
<td></td>
<td>.65</td>
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<tr>
<td>Memory Competence</td>
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<td>.44</td>
<td></td>
<td>.24</td>
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<tr>
<td>Reasoning Competence</td>
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<td></td>
<td>.80</td>
<td></td>
<td>.64</td>
</tr>
</tbody>
</table>

Correlations
<table>
<thead>
<tr>
<th></th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need for Structure</td>
<td>1</td>
<td>-</td>
<td>.48</td>
<td>-.35</td>
<td>-</td>
</tr>
<tr>
<td>Outward Assuredness</td>
<td>1</td>
<td>-</td>
<td>.45</td>
<td>.43</td>
<td></td>
</tr>
<tr>
<td>Rigid Thinking</td>
<td>1</td>
<td>-.23</td>
<td></td>
<td>.43</td>
<td></td>
</tr>
<tr>
<td>Openness</td>
<td>1</td>
<td></td>
<td>.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metacognitive</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All loadings and correlations are significant with $p<.01$.

The interpretation of the factors is as follows: **Factor 1: Need for Structure.** The factor is clearly defined by two sub-scores of the NFCS: Need for Order and Need for Predictability. The factor
also has a substantial positive loading from the Consciousness scale and negative loading from the Extraversion scale. The Intolerance to Ambiguity Scale and Discomfort with Ambiguity sub-scores of the NFCS have small, yet significant, positive loadings on this factor. This factor clearly reflects a desire for structure, and some dislike of ambiguity and spontaneity. **Factor 2: Outward Assuredness.** The highest loadings on this factor come from Proactiveness, Extraversion, the Decisiveness facet of the NFCS, and Positive OB score. **Factor 3: Rigid Thinking.** This factor is defined by positive loadings from the Dogmatism and Absolutism scales, and a negative loading from the Actively Opened-Minded Thinking scale. The Intolerance to Ambiguity Scale and Discomfort with Ambiguity sub-scores of the NFCS also have meaningful positive loadings on this factor. Thus, this factor indexes dislike of ambiguity and closed-minded, rigid way of thinking. **Factor 4: Openness.** High loadings here come from the Openness to Experience dimension of personality, Closed-Mindedness facet of the NFCS (with negative loading) and the MAI measures. The Decisiveness and Extraversion measures have small, yet significant negative loadings on this factor. This factor, hence, reflects an open-minded, objective way of thinking and a slight tendency to hesitation. **Factor 5: Metacognitive Beliefs: Memory and Reasoning Competence.** As expected, the factor was defined by substantial loadings from the two scores of the Memory and Reasoning Competency Inventory (MARCI). However, the Metacognitive Awareness Inventory (Schraw & Dennison, 1994) does not load on this factor. Instead, the inventory has significant loadings on the Need for Structure, Outward Assuredness, and Openness factors.

The bottom part of Table 3 (see below) displays correlations between the factors. The strongest correlation is between Need for Structure and Rigid Thinking factors. It suggests that these two factors may be linked, underlying, perhaps, some sort of inflexible thinking motivated by intolerance of ambiguity. Also, the Outward Assuredness, Openness and Metacognitive Awareness factors correlate meaningfully with each other. Finally, Openness shares notably smaller, yet significant, negative correlations with the Need for Structure and Rigid Thinking factors.

**CFAs for the Measures that Define the Endogenous Part of Model**

Previous results indicate that the exogenous part of the model should have three factors: (1) Fluid Intelligence (Gf) (defined by the Quantitative Switching, Verbal Reasoning, Nonsense Syllogisms, Esoteric Analogies, Probability Reasoning and Conditional Reasoning accuracy scores); (2) Crystallized Intelligence (Gc) (defined by the Verbal Reasoning, Esoteric Analogies and General Knowledge accuracy scores); and (3) a Self-confidence Factor (defined by the four confidence scores; see Stankov, 1999). This model was fitted. As expected, the two ability factors shared a positive correlation (.45). Also, the Self-confidence trait shares small, yet significant, positive correlations with the Gf and Gc factors (.25 and .21 respectively). This three-correlated-factor model (with a few minor modifications) had a good fit to data: $\chi^2_{35}=68.41$; $\chi^2/df=1.95$, the RMSEA=.057 (with .036-.077 90% CI). The TLoI=.94 and GFI=.96.

**Structural Part of the Model**

All regression coefficients from the endogenous factors on the exogenous factors were calculated to estimate the structural part of the model. The results are presented in Table 3 (see below). The model has a good fit to data: $\chi^2_{376}=527.21$, $\chi^2/df=1.40$, GFI =.90 and TLoI =.94, RMSEA=.037 (its 90% CI is .029-.044). The last column of the table presents the amount of the variance that was explained for each exogenous construct by the model.

The model explained 26% of variability of the Self-confidence, 28% of the Gc and 47% of the Gf factors. The results indicate that only the Metacognitive Beliefs factor (defined by MARCI) is
predictive (with a positive beta) of Self-confidence. The Metacognitive Beliefs factor, however, has correlations with the Outward Assuredness and Openness factors (see Table 2). This suggests that both these factors have an indirect effect on Self-confidence. The Metacognitive Beliefs factor is also predictive of both factors that mark Intelligence, but especially Gf factor (with the positive betas). In contrast, the Rigid Thinking factor predicts both ability factors with the negative betas. Similarly, the Outward Assuredness factor also has a negative effect on the ability factors. This latter finding, however, needs to be treated with caution. This is because the measures that define the Outward Assuredness factor (i.e., Extraversion, Proactiveness, Optimism score of the OB, and the Decisiveness facet of the NFCS) did not hold consistent negative correlations with the accuracy scores. The highest negative correlations were between the Extraversion scale and accuracy scores of the Nonsense Syllogisms and Conditional Reasoning tests and they were very weak (-.13 and -.15 respectively). Hence, there will be no further discussion of this particular finding.

Table 3: Standardized Betas pertaining the Structural Part of Model (*p<.05; **p<.01)

<table>
<thead>
<tr>
<th></th>
<th>Need for Structure</th>
<th>Outward Assuredness</th>
<th>Rigid Thinking</th>
<th>Openness</th>
<th>Metacognitive Beliefs (MARCI)</th>
<th>Variance explained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gf</td>
<td>-.13</td>
<td>-.46**</td>
<td>-.21*</td>
<td>-.06</td>
<td>.73**</td>
<td>47%</td>
</tr>
<tr>
<td>Gc</td>
<td>-.05</td>
<td>-.32**</td>
<td>-.19*</td>
<td>.20</td>
<td>.41**</td>
<td>28%</td>
</tr>
<tr>
<td>Confidence</td>
<td>.06</td>
<td>.05</td>
<td>.03</td>
<td>.10</td>
<td>.42**</td>
<td>26%</td>
</tr>
</tbody>
</table>

Discussion

These studies yet again demonstrated that confidence ratings have high reliability estimates which exceed those of accuracy. Additionally, a robust Self-confidence factor emerged. This factor was defined by the confidence judgments that people assign to items in a battery of rather diverse cognitive tests. This factor is claimed to reflect important aspects of metacognition and it is typically viewed as a marker of its regulative, self-monitoring aspect (see Stankov, 1999). Little has been known, however, about the nature of the Self-confidence factor due to a lack of information about its psychological correlates.

Allwood and Granhag (1999) suggested that to understand confidence ratings we need to analyze their context, and the processes which take place in this context. The work reported in this paper rests on the assumption that the confidence ratings which people assign to their answers during test-taking reflect certain metacognitive processes central to the decision-making processes involved in this activity. These processes are the result of a dynamic interplay between individual perceptions of degree of uncertainty, knowledge of strategies that one must execute to reduce this uncertainty, and perception of one’s own competence to execute these strategies. Hence, Kleitman and Stankov (2001b, 2003) hypothesized that people’s perception of their competence in their memory and reasoning cognitive abilities should be is linked to the confidence estimates that people assign to their answers.

To investigate this hypothesis, a self-concept measure, the Memory and Reasoning Competence Inventory (MARCI) was developed based on the work of Marsh et al. on the Self-concept construct (Marsh, 1986, 1987; Marsh & Shavelson, 1985). The low correlation between the memory and reasoning scores of the inventory, coupled with inter-loadings with opposite signs on questions aimed at the internal comparison between these two fundamental cognitive abilities (see Kleitman & Stankov, 2006), provide indirect support for the Internal/External (I/E) Frame of Reference Model (see Marsh et al., 1992). Importantly, the results demonstrated that Self-
confidence was indeed affected by these domain-specific measures of Self-concepts. However, the question still remained regarding the standing of confidence ratings in relation to people’s general perception of the way in which they deal with uncertainty. Moreover, the status of MARCI in relation to these beliefs needed clarification.

Thus, this study employed thinking dispositions measures said to assess individual differences in information processing and judgment, the mechanisms and strategies which people use to deal with uncertainty. Relevant personality and attitudinal measures were also included. A comprehensive battery of instruments was employed in this study to explore the factorial structure of these constructs. The results demonstrate that there are at least four factors that account for individual differences in these measures: the Need for Structure, the Outward Assuredness, the Rigid Thinking and the Openness. In addition to these four factors, a separate Metacognitive Beliefs factor emerged. It was defined by the two scores of the Memory and Reasoning Competency Inventory (MARCI). When assessed together with thinking dispositions measures, a broad measure of metacognitive awareness--the Metacognitive Awareness Inventory (Schraw & Dennison, 1994)--became a marker of the Openness, Outward Assuredness and Need for Structure factors rather than being a marker for the Metacognitive Beliefs factor. On the other hand, the Metacognitive Beliefs (or MARCI) factor, although it meaningfully overlapped with other measures, was clearly distinct.

Thus, these results clearly contradict the unidimensional model of cognitive closure (see Kruglanski et al., 1997). They are, however, consistent with the multidimensional position (see Neuberg et. al., 1997), with the decisiveness extending beyond intolerance of ambiguity and the need for closure constructs. The results do not support the way in which some authors treat thinking dispositions. For instance, Stanovich and colleagues (see Sa et al., 1999; Stanovich & West, 1997, 1998) employ the Thinking Dispositions composite which is formed by summing up the scores of tests of cognitive flexibility (e.g., Actively Open-Minded Thinking scale) and subtracting the sum of the scores of inflexible thinking (e.g., Absolutism, Dogmatism). However, as is evident from these results, a more complex structure underlies the measures that reflect people’s attitude towards uncertainty. In particular, the tests that mark the rigid, inflexible thinking and openness/reflective trends did not define opposite ends of the same latent factor. Instead, they defined two largely separate factors: Rigid Thinking and Openness.

Importantly, these different factors underlying thinking dispositions define conceptually different constructs which were shown to have different predictive power in relation to cognitive and metacognitive measures. In particular the two ability factors were affected by the Rigid Thinking factor and not by the Openness and Need for Structure factors. The Rigid Thinking factor is defined by the markers of dogmatic, absolute and ‘closed-minded’ thinking styles and dislike of ambiguity. This construct is essentially the same as the one reported elsewhere in the literature (see Baron, 2000; Schultz & Searleman, 2002). People who score highly on this factor tend to favor their own point of view and see it as the only right one. As expected, these flawed thinking processes lead to an adverse outcome—a poor performance on reasoning tests. However, this thinking style has no impact on people’s perception of the quality of their performance (i.e., the Self-confidence factor). Neither the Need for Structure factor, nor the Openness factor predicts Intelligence or Self-confidence.

In relation to the Openness factor, this result is puzzling. This factor is defined by the Openness to Experience personality dimension which is sometimes called “Intellect” (see Ashton, et al., 2000). People who score highly on this measure are analytic, knowledgeable, curious and have broad interests (ibid). Supporting this suggestion, the Closed-Mindedness sub-scale of the NFCS
loads together with this measure and has a negative loading. This factor was indicative of an open-minded, objective way of thinking marked by a slight tendency to hesitation. In this sample of university students, participants tended to report uniformly high tendencies toward openness to experience and flexibility in thinking. This probably resulted in restriction of the response range. Thus, the finding requires further scrutiny. Notably, however, the general confidence level was not related to people’s dislike of uncertainty (as measured by the Intolerance to Ambiguity construct), nor by the psychological mechanisms that people employ to cope with it (i.e., Need for Structure and Rigid Thinking).

Most importantly, in agreement with earlier findings (see Kleitman & Stankov, 2001b, 2003) people’s perception of the competency of their basic cognitive abilities was still predictive of the Self-confidence factor. That is, Metacognitive Belief factor defined by the MARCI was predictive of Self-confidence. This finding suggests that in order to understand the nature of Self-confidence not only do we need to consider it within the relevant decision-making processes, but these processes need to be precise and specific. In a context of test-taking, these processes were not general metacognitive tendencies or beliefs, but beliefs that specifically reflect people’s perceived competence to execute the processes employed in test-taking—memory and reasoning.

This study provides interesting data which furthers understanding of the nature of these beliefs themselves. Namely, people’s perception of competence of their basic cognitive abilities was related to the Outward Assuredness and Openness factors. Given the nature of these factors these findings are not surprising. That is, people who score highly on Openness factor tend to be analytic and knowledgeable. Thus, this type of person should indeed consider the competency of their primary cognitive abilities to be high. Consequently, this factor has indirect implications on the general Self-confidence factor. The nature of the Self-Assuredness factor is somewhat different. That is, the Optimism Bias measure had a substantial loading on this factor. The measure reflects both a general attitude and a self-deception in the direction of favoring the desired outcomes (e.g., success, health). This tendency of wishful thinking is combined with a higher level of self-assuredness and a general orientation toward success (as measured by the Proactiveness scale). It was also linked to a higher level of self-assertiveness and outspokenness (as measured by the Extraversion scale). Hence, there are theoretical reasons as to why people who score more highly on this factor might be prone to hold higher beliefs in the competency of their fundamental cognitive abilities. Thus, although this factor has no direct effect on Self-confidence, it has an indirect effect on it via the inflated beliefs in one’s own cognitive abilities.

In conclusion, these results once again show that Self-confidence is a genuine psychological trait reflecting metacognitive processes that take place during decision-making involved in test-taking. The results support the hypothesis that people’s beliefs about the quality of cognitive abilities that they employ when dealing with uncertainty in test-taking situation are predictive of the general level of confidence in their answers. These relationships extend beyond beliefs and tendencies to deal with uncertainty as well as other broader measures of metacognition that were considered here. However, certain thinking dispositions have an impact on beliefs that people hold about themselves in relation to their memory and reasoning abilities. Overall, these results provide a solid basis for our understanding of the nature of confidence ratings. The results also once again stress the importance of domain specific Self-concepts for understanding of what might seem to be an ‘elusive’ psychological construct.
References


