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Whither metacognition

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We invited several people to make a contribution to the Special Section of LEAID on metacognition and learning. Our aim was to publish empirical papers that examine the role of metacognitive abilities and skills in a variety of decision-making and learning environments. Studies reporting creative uses and assessments of metacognitive constructs were particularly encouraged and the focus was supposed to be on:

- New methods for measuring metacognition;
- Validation studies (within a variety of learning and decision-making environments);
- Investigations of individual differences in metacognitive constructs and their role in learning.

The papers selected for this section address the three issues listed above. For example, a new method for assessing metacognition is described by Veenman, Bavelaar, and De Wolf (2014-this issue) who employed logfiles collected during students' work on a computerized task, the Otter task, that has better face validity than typical tests of cognitive abilities. The Otter task asks students to figure out how to manage an environment in a way suitable for a colony of animals to survive. It taps an element of scientific reasoning since the effective strategy requires figuring out the outcome of each intervention without the confounding effects of other variables. To the extent that decision making can be seen as metacognitive processing, Welsh, Delfabbro, Burns, and Begg (2014-this issue) also describe a new metacognitive measure. In an anchoring task, they assess the extent to which participants are affected by the presence of an anchor as they estimate the likelihood of a particular outcome of a poker-like card game. The other two studies use well-known confidence ratings procedure in a relatively new way. Kleitman and Costa (2014-this issue) describe a new statistics learning series of exercises that provide extensive feedback on both accuracy and confidence. Roebers, Krebs, and Roderer (2014-this issue) employ confidence ratings to assess metacognitive monitoring using discrimination scores – i.e., the difference in confidence ratings between correctly solved and incorrect answers – as a dependent measure.

All papers also deal with validity issues in the sense that they attempt to chart a nomological net of metacognitive constructs under study and approach this task from an individual differences perspective. To what place then will this work take us?

1. Metacognition and learning: strongly related

There can be no doubt that learning and broadly defined metacognitive processes are strongly related; all four studies provide clear evidence in support of this conclusion. Kleitman and Costa (2014-this issue) show that two metacognitive measures, confidence measures obtained as a learner works through quizzes (together with performance accuracy on those quizzes) and the prediction of the final exam mark, are the best predictors of final exam marks. They also show the importance of metacognitive measures other than confidence itself for students' learning processes overall. Of particular importance is the apparent usefulness of confidence assessments to those students who are struggling with the material — that is, they find the request to re-evaluate their answers useful. Although Welsh et al. (2014-this issue) report that anchoring susceptibility itself is not related to cognitive measures, they did find that the improvement in anchoring susceptibility over 140 trials is related to cognitive ability and other individual differences measures. Veenman et al. (2014-this issue) employed a measure of what they call 'learning performance' — a multiple-choice assessment of simulation task comprehension after its completion. This measure (but not IQ scores) did correlate with logfile-based assessment of metacognitive processing. Finally, Roebers et al. (2014-this issue) report that metacognitive monitoring measures (i.e., discrimination scores) are the best predictor of Cloze test performance. They also report that their measure of metacognitive control – i.e., correction of the previously attempted items – is a better predictor of test performance among the older children (11-year-olds) than it is among the younger ones (9-year-olds). This age-related difference in the predictability of metacognitive processes may be linked to learning but, without additional evidence, it should be seen as a maturational process. That is, older children are better at using metacognitive processes than younger children.

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2. Metacognition and Intelligence: tenuous relationship

Two papers examine the relationship between intelligence and metacognitive measures. The findings are clear: correlations are disappointingly low. In Veenman et al. (2014-this issue), from among the eight metacognitive measures based on logfiles, only one (Scroll) correlated above .30 with IQ. All other measures had low and non-significant correlations with intelligence. Again, Welsh et al. (2014-this issue) report that susceptibility to anchoring bias is not related to cognitive abilities.

These findings are not too surprising, particularly with respect to the low correlation between intelligence and the anchoring bias measure. Stanovich (2012) reports that correlations between intelligence and measures of rational thinking and biases in decision making range between .20 and .35 and often are lower than that, leading him to postulate that rationality is different from intelligence. One reason for low correlation may be the domain-specific nature of the decision making tasks since intelligence as treated in Stanovich's work is known to be a general trait. In any case, the two studies clearly point out to a need to be restrained in claiming that metacognitive skills are a measure of intelligence. Much more empirical work is needed in order to understand the nature of metacognition–intelligence relationship.

A possible reason for the low correlation between abilities and metacognition in these two studies may be also related to a failure to distinguish between fluid intelligence and crystallized intelligence. Cattell's (1987) investment theory postulates that non-cognitive processes, including metacognition, may be instrumental for the separation of crystallized abilities from fluid intelligence during development. Strong relationship between learning and metacognition in all four studies is certainly in agreement with the investment theory.

3. Some surprises

It is also clear that some non-cognitive processes, including those that are supposed to tap metacognition, are less important for learning than was previously thought. For example, mastery motivation is not predictive of test performance (Roebers et al., 2014-this issue) and many variables in Welsh et al. (2014-this issue) study do not correlate with the susceptibility to anchoring or to improvements in susceptibility. Also, a number of metacognitive measures in Kleitman and Costa (2014-this issue) study show only indirect and therefore weak relationship to statistics exam performance.

In reality, these are not big surprises since it can be expected that some noncognitive processes have no role to play in learning. The same conclusion follows from the analyses of background variables in PISA (OECD's Programme for International Student Assessment). Thus, Lee and Stankov (2013) show that motivation, learning strategies and school climate have little effect on achievement in mathematics. On the other hand, self-efficacy measures that are closely related to the confidence measures used in studies of metacognition are excellent predictors of achievement.

4. Need for improvements in measurement

There is still a long way to go before we can be satisfied with psychometric properties of measures of metacognition. Of particular concern is the issue of replicability. This follows not only because of small N's in some of the experimental studies of metacognition but also, and perhaps more importantly, because of low reliability estimates of some of the reported measures. For example, little is known about the reliability of the measures derived from logfiles in the Veenman et al. (2014-this issue) study and there is no information about the reliability of the difference scores employed in Roebers et al. (2014-this issue) study. Difference scores are known to have lower reliability than their constituent components (see Stankov & Crawford, 1996). Finally, the use of a composite of confidence and accuracy in Kleitman and Costa's (2014-this issue) study suggests that, at least in the formative assessment situations with quizzes, it may be hard to disentangle cognitive from the metacognitive processing — they may be too confounded.

5. Beyond metacognition: decision making and rationality

Although it is clear that metacognition is important for learning, the topics covered in this Special Section and also our readings of a broad literature on the role of non-cognitive processes in academic achievement (see Lee & Stankov, 2013) point to a need to move on and try to situate it within a broader range of psychological constructs. There are some constructs that have been linked to metacognition in the past but appear to be less important than previously thought. Motivation, personality traits and learning strategies belong to this group.

In our opinion, metacognition's proper place is on the 'No Man's Land' (see Stankov, 1999) between broadly defined personality and intelligence, somewhat closer to cognition and away from noncognitive processes themselves. Of particular importance are cognitive processes involved in decision making. The studies of metacognition and decision making have arisen from different traditions — i.e., educational psychology and organizational psychology. Until recently, most research in decision making has been experimental in nature whereas metacognition has been studied both experimentally and from the standpoint of individual differences. There are, however, similarities in measures being used and in the issues being addressed. Confidence ratings are common to both fields and the discrepancy between performance accuracy and confidence ratings is seen as a useful kind of information for both. However, there has been relatively little cross-talk between researchers in metacognition and decision making that use the same procedure for assessing confidence. A promising step in this direction is the work of Jackson and Kleitman (under review) which uses Koriat and Goldsmith's (1996) model to capture individual differences in the way people make decisions based on their own levels of confidence. Five habitual decision-making tendencies have been indentified: optimal, realistic, incompetent, hesitant and congruent/incongruent.

An even broader rapprochement between the two fields is likely to be fruitful. The work of Welsh et al. (2014-this issue) deals with anchoring which is only one of the biases in human reasoning. Examining other well-known biases in conjunction with measures of metacognition may be a way ahead. As mentioned above, the work of Stanovich and his associates is focused on probabilistic and scientific reasoning. Empirical studies relating metacognitive processes to these components of rationality are needed. Needless to say, methodology and insights from the studies of metacognition like the logfile measures of Veenman et al. (2014-this issue) are likely to be helpful in gaining a better understanding of measures of rationality.

6. Concluding comments

A sample of four studies of metacognition cannot provide a comprehensive coverage of the field. Nevertheless, these studies do address the three issues we wanted to cover and they do illustrate the important role of metacognition in learning, but not necessarily in intelligence. There are outstanding challenges in the area of measurement and it appears that the time is ripe for linking metacognition, the studies of decision making, and probabilistic and scientific thinking.

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