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Abstract

The present study on insight is based on an integration of Kaplan and Simon’s (1990) information processing theory of insight, a cognitive style theory, and achievement motivation theory. The style theory is the Assimilator (rule oriented, familiarity seeking) - Explorer (novelty seeking, explorative) styles (Kaufmann, 1979). Our hypothesis was that the effectiveness of two types of search constraints (prior experience and solution hints) for solving insight problems is moderated by both cognitive style and achievement needs, and depending on optimal levels of achievement motivation for different task conditions. We tested the hypothesis in a randomized experiment in which three levels of achievement needs and one type of search constraint (solution hints were available or not available) were experimentally manipulated. In addition participants completed a cognitive style test, a measure of prior problem-solving experience (the second type of search constraint), and controls for intelligence. There were 476 participants (the mean age was 18.4 years). Results revealed two similar and significant three-way interactions between styles, achievement needs, and the two types of search constraints. The pattern of interaction supported the idea that stylistic competence for the task characteristics (with and without search constraints available), when combined with manipulated achievement needs, predicted performance in counterintuitive ways but in line with the classic achievement motivation theory. With appropriate stylistic competence for the task characteristics elevated achievement needs led to poorer performance. With less appropriate stylistic competence, performance improved with increasing motivation. Implications for information processing theory are discussed.

Keywords: cognitive style, insight, achievement motivation, information processing

An Integrated Perspective on Insight

This study examines how individual differences in cognitive style and achievement needs moderate the effects of search constraints on solving insight problems. Insight problems present the subject with a seemingly familiar situation. The initial understanding of the problem as familiar, however, typically leads to an impasse, which demands that the subject restructure his or her understanding of the situation. The new understanding should then pave the way for a novel solution, which is associated with the insightful “aha” experience. Solving these problems includes an extensive search for solutions in large problem spaces and typically also a search for the appropriate problem space. The role of *search constraints* such as experience and solution hints has been considered particularly important because these constraints reduce problem solvers’ search for a correct solution in large problem spaces and facilitate insight (Kaplan & Simon, 1990).

The process of insight has been linked to scientific discovery (Finke, 1995) and creative problem solving (Kaufmann, 1979), while lack of insight has been linked to the costs of expertise (Wiley, 1998). Research on insight has developed over several decades and mainly through a cognitive problem-solving perspective (see, for example, Bowden, Jung-Beeman, Fleck, & Kounios, 2005; Jones, 2003; Kershaw & Ohlsson, 2004; Saugstad & Raaheim, 1960; Wertheimer, 1959). Beyond this, it is noteworthy that, with the exception of abilities, individual difference constructs have rarely been taken into account, although it seems supported that problem solving tasks can be approached in different ways (Fleck, &Weisberg, 2013). Moreover, motivation has scarcely been treated in this area. To fill in some of these gaps, this study examines how one aspect of individual differences, that is the Assimilator–Explorer (A–E) cognitive styles

(Kaufmann, 1979), interacts with a motivational construct, achievement needs (Atkinson, 1974a), and search constraints such as solution hints and degree of prior experience (Kaplan & Simon, 1990) when solving insight problems.

While information processing-, achievement motivation-, and cognitive style theories are not new, the present integration is new. On the basis of the integrated theoretical framework outlined below, we hypothesized a three-way interaction on insight. We tested the hypotheses in a randomized experiment in which cognitive style interacted with achievement needs and solution hints. Three different levels of achievement needs were experimentally induced and the availability of solution hints was also experimentally varied. In a second, and similar, three way interaction hypothesis, we included a measure of prior problem-solving experience and replaced solution hints with prior experience. We tested the interaction between cognitive style, achievement needs, and prior experience. Thus, we tested two three-way interactions that were based on two different types of search constraints.

The Assimilator–Explorer Theory of Cognitive Style

Recent research has found that insight problems become difficult to solve because problem solvers are often bounded by their heuristics and automatic rule-based cognition (e.g., Kahneman & Klein, 2009; Simon, 1987). Although heuristic thinking may be highly efficient (Gigerenzer, 1999), it may also narrow search and blind the problem solver to other possibilities (Kahneman, 2011; Tversky & Kahneman, 1974). In this respect, the A-E cognitive style framework posits that there are individual differences in natural inclinations to use such rule-based, familiarity-seeking strategies.

Kaufmann (1979) found that some individuals were able to restructure and find a new approach to solve an insight task whereas others seemed bounded by experience and unable to restructure and solve the problem. On the basis of this finding, the A–E inventory was later developed and revised (Kaufmann, 1989; Kaufmann & Martinsen, 1992). This inventory measures a continuum of cognitive styles, with relatively stable tendencies to use rule-oriented and familiarity-seeking strategies at one end and tendencies to explore new types of procedures and solutions at the other end (Kaufmann, 1995; Martinsen & Kaufmann, 2000). In their style taxonomy, Riding and Raynor (1998) placed the A–E theory in the Wholist–Analyst category of style constructs along with related style theories, among them the theory of Adaptors and Innovators (Kirton, 1976).

As regards the validity of the A–E construct, the main point is of course to which extent the measure of the construct measures what the theory describes (Nunnally & Bernstein, 1994). Since validation is multifaceted (Messick, 1995), it is important to consider reliability, theoretically meaningful predictions, and convergent and discriminant validity. Several studies incorporating the above considerations have been done on the A–E styles. In previous studies (Martinsen & Diseth, 2011; Martinsen & Kaufmann, 2000), the alpha reliabilities for the A–E inventory ranged from .83 to .92, and test-retest reliabilities over three weeks and three months ranged from .70 to .83 (Martinsen & Kaufmann, 2000). Sample items are provided in the Methods section, and the complete A–E inventory was published in Martinsen & Diseth (2011).

A main idea of the A–E theory is that individuals with a strong inclination toward Assimilation apply what is known or familiar to them when solving problems (Kaufmann, 1995; Martinsen & Kaufmann, 2000). Our use of Assimilation is based on Piaget's (1976) definition of the term, which means interpreting stimuli in terms of existing schemes. In problem solving, such an approach can be useful or less useful depending on what kind of information is available in memory or in the situation. Thus, when facing insight problems, Assimilators should quickly encounter an impasse when task characteristics or information stored in memory invite them to follow misleading rules or to apply less useful solution principles. That is, Assimilators should be vulnerable to constraints in the situation and/or in memory. On the other hand, because of their orientation toward following rules and doing what is familiar, Assimilators should perform *better* on tasks in which *relevant* experience, solution hints, or solution procedures are available. That is, Assimilators should perform well on insight tasks when search constraints are available.

For those with a strong inclination toward Exploration, the ideal task environment would be one of high task novelty since Explorers enjoy going beyond existing rules and experimenting with new solutions. High novelty is the typical perception when individuals have lower levels of relevant experience or when there are no salient and facilitating rules or procedures in the task environment. Thus, Explorers should perform better when search constraints are *not* available since they excel in extensive search processes. Because of their specialized strategy use, they should perform relatively worse when the task requires utilizing existing rules and heuristics. These propositions can be tested by investigating performance on insight tasks under conditions of high and low levels of relevant experience and the presence or absence of search constraints. An Exploratory style would otherwise be better for insight problems and give a main effect for the A-E styles given the high novelty associated with insight tasks.

Two previous studies on insight have supported the central hypothesis that those with low scores on the A–E inventory (Assimilators) should perform better than those with high scores (Explorers) when task-relevant experience is in the higher range. In both studies (Martinsen, 1993, 1995a) the same measure of previous experience was used to describe participants' task-relevant experience, defined as experience with mind-stretchers, drawing/painting, jigsaw puzzles, technical drawing, and more. In the first study, practical construction insight problems were included, and in the second, mathematical insight problems were used. In both studies, results revealed interactions between prior experience and the A–E styles on insight. The interactions showed that Assimilators generally performed better than Explorers under conditions of high experience whereas Explorers performed better when task-relevant experience was low, implying high perceived novelty in the task. Thus, a core idea in the A–E theory was supported and replicated across different types of insight tasks. Assimilators were better at using search constraints and Explorers were better at coping with high novelty. As further support for the idea that the A–E styles are associated with novelty seeking, Martinsen and Diseth (2011) found that a group of technically oriented staff with registered patents had significantly higher scores on the A–E inventory compared with another group of technically oriented staff without registered patents. Finally, Martinsen and Furnham (in press) found that Explorers participated more frequently in creative activities.

As regards other aspects of the A–E styles' construct validity, these must be based on criteria that have been associated with the general concept of cognitive styles. For several styles (but not all), the main criteria are that styles should be "value free," they should be unrelated to cognitive abilities and should evolve around profiles of personality traits (Martinsen, 1997; Martinsen, Kaufmann, & Furnham, 2011). The latter position is not new, and Messick (1987) maintained that style could be seen either as a bridge between personality and cognition or as accumulated personality influences on specific aspects of cognition defined by the style theory in question. To be "value free" means that both poles of a style dimension should have some kind of advantage or merit. For the A–E styles, there is a prediction of good performance for both styles on insight tasks, and the moderating conditions of high versus low levels of relevant experience illustrate the so-called “value free” aspect of the styles.

As regards the A–E styles and measures of cognitive abilities, a previous study (Martinsen & Kaufmann, 2000) included measures of crystalized, fluid, and spatial abilities. On the basis of a sample of 267 students, results showed that the A–E styles were independent of any of the intelligence measures. Bakken and Haerem (2010) also found lack of relationship between the A-E styles and fluid intelligence. In a study by Martinsen and Furnham (in press), there were low, but significant correlations between the A–E styles and measures of figural (.15) and verbal fluency (.14). Given these results, the idea has been supported that styles are not, or only weakly, related to cognitive abilities.

When studying the relationship between the A–E styles and personality, stronger and multiple relationships should be expected. In this regard, the relationship to the five-factor model is particularly important. Martinsen and Diseth (2011) found positive correlations between the A–E styles and Openness (O) and Extroversion (E), and negative correlations with Neuroticism (N), Agreeableness (A), and Conscientiousness (C). Assimilation was associated with higher scores on N, A, and C, while Exploration was associated with higher scores on O and E. In this respect, Digman (1997) showed that correlations between N, A, and C made up a second-order factor above the five-factor model, which was called “getting along.” Moreover, correlations between O and E made up another second-order factor, which was called “getting ahead.” The correlational pattern between the five factors making up the two higher-order factors appears the same as the correlations between the five factors and the A–E styles. Thus, it seems possible that the A–E styles have evolved around the two second-order factors in the five-factor model and that Assimilation is associated with a tendency to "get along," hence the familiarity orientation and rule-oriented strategy use. Exploration seems associated with a tendency to "get ahead," hence the exploratory orientation and novelty-seeking strategy use.

It should be noted that the related theory of Adaption Versus Innovation (Kirton, 1976) was recently criticized for being too strongly correlated with the five-factor model, and R^2 was found to be .50 or higher, depending on the analyses (von Wittich & Antonakis, 2011). First, the five-factor model seems to explain less variance (38%) in the A–E styles (Martinsen & Diseth, 2011). Second, and as noted above, a relatively strong style–personality relationship can be considered as theoretically meaningfull. Relatively strong style-personality relationships has been found for other style constructs also (Pacini & Epstein, 1999). Third, using a single-style measure can indeed be useful in the study of cognition since it facilitates a more parsimonious approach than what would otherwise be possible when alternatively investigating a complex interplay between several personality traits in combination with other task parameters such as search constraints on cognition. This type of approach could, for example, invite five-, six-, and even seven-way interactions in the present context, which, of course, would not be possible to interpret.

Other relevant correlates of the A–E styles (Martinsen & Kaufmann, 2000) are positive correlations with autonomy orientation (Deci & Ryan, 1985) and the achievement motive (McClelland et. al, 1953), and negative correlations with impersonal orientation (Deci & Ryan, 1985) and fear of failure (McClelland, 1985). Moreover, Diseth and Martinsen (2003) found that the A–E styles loaded on a factor along with Need for Cognition (Cacioppo, Petty, & Kao, 1984), the Deep approach to learning (Entwistle, 1997), and the achievement motive. They loaded negatively on another factor with the Strategic approach to learning (Entwistle, 1997). Bakken and

Haerem (2010) found a correlation with the intuitive style (Pacini & Epstein, 1999). Martinsen and Kaufmann (2000) found no correlation between the A–E styles and social desirability.

Based on the results above, and to conclude, we believe that the A–E styles represent a valid measure of cognitive style and that this construct has important implications for information processing in combination with other influences. Since validation is a continuous process (Cronbach & Meehl, 1955) the predictions and tests in this study can also be seen as a contribution to the nomological validity of the A–E construct.

The Present Study

Insight problems are ill-defined, novel, and complex tasks (Kaplan & Simon, 1990). In an important addendum to information processing theory, Kaplan and Simon (1990) argued that a major source of difficulty in insight problems is the need for extensive search processes in large and appropriate problem spaces. They maintained that availability of search constraints, operationalized as, for example, cues in the situation, previous experience or solution hints, facilitate such search processes. The term *search constraint* is different from other uses of the term *constraint* in the study of insight. A *search constraint* is information that may limit or reduce search in large problem spaces (Kaplan & Simon, 1990) and that facilitates finding a solution. Several studies have supported the idea that search constraints facilitate the solution of insight tasks (for example, Cushen, & Wiley, 2012; Hattori, Sloman, & Orita, 2013). Other uses of the term *constraint* (Knoblich, Ohlsson, Haider, & Rhenius, 1999; Ohlsson, 1992; Patrick et. al, 2015) describe a limitation on appropriate understanding of the problem situation. Such types of constraints are detrimental to finding solutions. We use the term *search constraint* as defined by Kaplan and Simon (1990).

The A-E styles as a component in the classic theory of achievement motivation. Above, we presented evidence that the A–E styles describe task-specific competence in handling search constraints such as prior experience and high novelty. Since the A–E styles describe task competence, it can be included in motivational theories in which task competence is an essential part of the motivational system. One such theory is the theory of achievement motivation (Atkinson, 1974; McClelland, 1985). In this theory, task competence is emphasized through the theoretical component *perceived probability of success* and posited to influence resultant (total) motivation together with the incentive value associated with success and the strength of motive arousal (Dickhäuser & Reinard, 2006; McClelland, 1985; Weiner, 1992). It is noteworthy that more recent theories have also defined competence as a core element in task motivation (Bandura, 1997; Durik, Vida, & Eccles, 2006; Eccles & Wigfield, 2002; Elliot & Dweck, 2005).

Atkinson (1974a) developed a set of formulas to facilitate formulations of hypotheses in achievement motivation theory. The level of total or resultant motivation (Tr) was inferred from theory instead of being measured. Typically, resultant motivation (Tr) has been studied in terms of choice of task difficulty, task performance, or task behavior (McClelland, 1985).

The simplified formula for resultant motivation is Tr = (Ms - Mf) * Ps * (1 - Ps) (see Atkinson [1974a] or Rand, Lens, and Decock [1991, p. 15] for the derivation of this formula). Here, Ms is the achievement motive and Mf is fear of failure. Motive strength (Ms - Mf) can be individually measured by inventories or manipulated in experimental settings through written achievement instructions (McClelland, 1985). In the present context, motive strength is manipulated experimentally.

The probability of success (Ps) is determined by the perceived competence for the task. (1 - Ps) is the incentive value of success and is oppositely proportional to the probability of success. Based on this, the combination of Ps * (1 - Ps) together reflects *competence motivation*.

In achievement motivation theory, Ps-values have a scale from .00–1.00, where .00 represents low probability of success (or no available competence for the task) and 1.00 represents high probability for success (or high competence for the task). It can be shown that maximum competence motivation occurs when probability of success is .50 (Atkinson, 1974a).

Previous research has demonstrated that competence as intellective ability can be used as an indicator of the probability of success in academic tasks (Gjesme, 1973; Rand & Rand, 1979). However, we expand on this position as regards insight with our claim that the probability of success (Ps) must be related to both of the following characteristics in the individual and the task environment: the availability of search constraints *and* competence in utilizing such constraints. Above, we discussed how the A–E styles describe competence in utilizing search constraints. Clearly, Assimilators perform better when search constraints are present, and consequently, the probability of success (Ps) is higher for them when such constraints are present. Explorers perform better when search constraints are not present, and consequently, the probability of success (Ps) is higher for them when such constraints are not present. Therefore, the two poles of cognitive style represent indicators of different Ps in different task environments.

This means that when determining the resultant motivation associated with a task, stylistic competence must be included as a part of task competence. This also implies that effects of stylistic competence on motivation will depend on whether search constraints are available or not. Thus, when considering the phenomenon of insight, resultant motivation (Tr) can be specified as a function of motive strength (Ms - Mf), whereas Ps can be specified as a function of high versus low style scores (Assimilation/Exploration), task characteristics (availability of search constraints), and, finally, the incentive value associated with success (1 - Ps).

As a basis for our further predictions, we underline that insight problems are difficult tasks with low solution frequencies (Kershaw & Ohlsson, 2014). Because of this, it is natural to expect the *average probability of success* on insight tasks to be low. Researchers have found that insight problems, such as the nine-dot problem, or the hat rack problem and the two-string problem that we use in the experiment below, have solution frequencies in the .25–.30 range when average scores across several such tasks are included in the dependent variable (Maier, 1970; Raaheim, 1984; Kershaw & Ohlsson, 2014). In addition to this, we expect a general positive effect on the Ps value when search constraints are present (Kaplan & Simon, 1990). This means that tasks in general should be perceived as a little easier when such constraints are present and that this perception should correspond to a main effect of search constraints on performance.

In Table 1 below, we have used our adapted theory of achievement motivation to make estimations of outcomes. Here it seems that Assimilators are closer to the level of maximum competence motivation (.25) when search constraints are available (they have Ps * incentive value = .24). Explorers also have a strength of motivation (Ps * incentive value = .21) closer to the level of maximum competence motivation when search constraints are not available. It should be emphasized that Table 1 has been constructed for illustrative purposes to assist the understanding of the presented theory. The figures in the table should be considered illustrative as well.

Before we proceed, however, another important question must be answered: How does the level of resultant motivation relate to performance on insight tasks, and is there actually an optimal level of motivation for insight tasks?

Optimal strength of resultant achievement motivation and insight. Everyday thinking would imply that the stronger the motivation, the better the performance, especially on complex and difficult tasks. However, within achievement motivation theory and related areas, this has not been a standard prediction. On the contrary, the optimal-level-of-motivation-for-the-task hypothesis in achievement motivation theory claims that there are different optimal levels of resultant motivation for tasks along a simplicity–complexity continuum (Atkinson, 1974b). A moderate-to-low level of total motivation should facilitate performance on extremely difficult and complex tasks such as insight problems. This proposition is based on the inverted U-shaped distribution for the relationship between arousal and performance on complex tasks originally put forward by Yerkes and Dodson (1908).

Easterbrook’s (1958) cue-utilization theory has been proposed as a possible explanation of the inverted U-shaped relationship; Easterbrook argued that high levels of arousal should lead to restriction of the amount of information that can be processed, which would be detrimental for complex tasks. However, the arousal concept in this theory has been questioned (Hanoch & Vitouch, 2004), and another theory seeking to explain the Yerkes and Dodson (1908) law was proposed by Humphreys and Revelle

(1984), who argued that short-term memory was negatively affected by high arousal and that this may cause negative performance effects on complex tasks. Although we do not explicitly test the mechanisms involved in these theories, we take them as support for the proposition that complex and difficult tasks such as insight problems are better solved with a low level of resultant motivation.

Moreover, there is abundant anecdotal evidence associating insights in science and art with what has been called the “bed-bus-bath” phenomenon (Boden, 1990). This means that the phenomenon of insight typically occurs under very relaxed conditions. Boden provided several examples of it (p. 15), such as Archimedes having the idea of how to measure the volume of an irregularly shaped object when he was in the bath.

In addition to anecdotal evidence, two classic experimental studies showed detrimental effects of monetary incentives on insight problem performance. In the first, Glucksberg (1962) found negative effects of monetary rewards in Duncker’s candle problem. However, these negative effects were not present in an easier version of the same problem. In the second study, McGraw and McCullers (1979) showed that monetary incentives impaired performance on a set-breaking task, but not on algorithmic, rule-oriented tasks. Thus, both these studies support the hypothesis that increased strength of motivation (drive) is detrimental to solving insight problems. Moreover, from other relevant perspectives, Ostafin & Kassman (2012) found that mindfullness facilitated insight, and Cao, Hitchman, Qiu, & Zhang (2015) in a study of brain states found that increased alpha power at parieto-occipital electrode sites was associated with increased performance on insight tasks and the authors associated this with defocused attention.

Beyond these studies, and with high relevance for the present context, Martinsen (1994) found an interaction between the A–E styles and the motive to succeed on task performance. The dependent tasks were insight problems that are normally, without taking into account availability of search constraints, in favor of the Explorer style task competence. In this study, a combination of high task competence (Explorer style) and a high level of achievement motive led to the counterintuitive finding of impaired performance. High task competence (Explorers) in combination with a lower level of motive strength led to good performance on the selected insight tasks. The latter finding was interpreted as a result of too-high motivation for the task. On the other hand, lower levels of task competence (Assimilators) in combination with higher levels of motive strength led to good performance. This was interpreted as a result of optimal motivation. Similar findings were also obtained in another study (Kaufmann & Martinsen, 2006) when positive mood was manipulated, indicating a common mechanism for positive mood and achievement needs, where the latter describe anticipation of positive affect in achievement settings (McClelland et al., 1953).

Another, and more recent, study (Martinsen & Furnham, 2015) was designed to test the same idea of optimal motivation for complex and difficult insight problems. This time the dependent tasks were designed as complex word pair tasks that involved finding a single word that would form a word pair with each of three given stimulus words (complex, structured RAT tasks). The dependent tasks here were considered to be in favor of the Assimilator style. Again, a significant interaction supported our theory that high competence and low levels of motive strength, or vice versa, would result in superior performance. Assimilators performed better with motive scores in the lower range, and Explorers performed better with motive scores in the higher range.

On the basis of the above findings, we consider it a pertinent hypothesis that insight problems are better solved under conditions of low resultant motivation as defined by the influences of task competence and task characteristics in combination with the strength of aroused achievement motive.

Bringing it all together. In this study, we have posited a new theory based on an integration of three central psychological theories. To further illustrate our integration, we have extended the simplified formula for resultant motivation on the basis of our theory above by adding the interaction of the A–E cognitive styles and task characteristics to the achievement motivation equation:

$$(Ms - Mf) * [PsCs * (1 - PsCs)] * Tc$$

In this equation, (Ms-Mf) is achievement motive strength, PsCs - is the probability of success associated with high versus low style scores (Assimilation – Exploration), (1 – PsCs) is the incentive value of success for the style in question, and Tc- describes task characteristics/availability of search constraints – no availability of search constraints. We have used this equation to show the estimation of resultant motivation and performance implications in Table 1.

Insert Table 1 about here

When we integrate what is discussed above about the A–E style competencies, availability of task constraints, and motivation, a three-way interaction hypothesis can be presented for each of our two types of included search constraints:

H1: There is a three-way interaction between the A–E styles, motivation, and solution hints.

The direction of this interaction should be as follows: In the hint condition, Assimilators should have an overall decrease in performance as a consequence of the motivation-arousing experimental conditions, while Explorers should have an overall increase in performance because of the experimental motivation conditions. In the no-hint condition, this pattern of interaction should be opposite to the pattern of interaction in the hint condition: When their motivation increases, Explorers should decrease their performance, while Assimilators should increase their performance when motivation increases.

A similar hypothesis was formulated for our second search constraint, prior experience:

H2: There is a three-way interaction between the A–E styles, motivation, and the level of previous problem-solving experience.

The direction of this interaction should be as follows: When experience is high, Assimilators should have an overall decrease in performance as a consequence of the experimental motivation-arousing conditions, while Explorers should have an overall increase in performance because of the motivation conditions. When experience is low, this pattern of interaction should be opposite to the pattern of interaction when experience is high: When their motivation increases, Explorers should decrease their performance, while Assimilators should increase their performance when motivation increases.

Method

To test the hypotheses, we conducted a randomized experiment including manipulated motivation, two kinds of search constraints, and the A–E styles. We used three written experimental achievement instructions (low, medium, and high) to manipulate the degree of motive strength (McClelland, Atkinson, Clark, & Lowell, 1953). Such instructions have been validated as manipulations of the need for achievement motive, and have been used to manipulate the level of motivation in a number of studies (McClelland, 1985). Our three achievement instructions were designed on the basis of the traditional procedure for such instructions. As search constraints, we included both a measure of previous problem-solving experience and experimentally varied solution hints.

Controls for intelligence were included because intelligence is important for problem solving and insight (Ash & Wiley, 2006; Davidson, 1995; Gilhooly & Murphy, 2005; Raaheim, 1984, 1988; Sternberg, 1985). Additionally, we included gender as a control variable since gender differences in earlier studies have had a significant effect on insight (e.g., Kaufmann & Martinsen, 2006), perhaps due to males having more experience with tools used in practical construction insight tasks.

Finally, we included two post-treatment measures to exclude alternative interpretations of experimental manipulations and findings. The possibility of anxiety arousal was assumed to be greater under the achievement (high motivation condition) than under the other two conditions because of an emphasis on evaluation. We therefore included a measure of state anxiety from the State–Trait Anxiety Inventory (Spielberger, 1983). We also included a measure of intrinsic motivation because intrinsic motivation has been found to have a favorable effect on creativity and insight (e.g., Amabile, 1983, 1996). The probability of arousing intrinsic motivation (Deci & Ryan, 1985) was assumed to be greater under the low motivation condition than under the other two conditions due to the low emphasis on evaluation and the nature of the dependent tasks. Beyond the aforementioned measures, we are not aware of any measure that can directly assess resultant motivation, so we have not included any manipulation check for it. Achievement instructions to manipulate resultant motivation in previous research have been validated through scores from projective TAT protocols (McClelland, 1985), but such testing were not considered to be an acceptable manipulation check in the current context.

Participants

The participants were 476 students (298 females and 178 males) from senior high schools in Norway who volunteered to participate. The mean age was 18.4 years. Virtually all the students in the selected classes participated.

Instruments

A-E inventory. The revised 30-item A–E inventory (Kaufmann & Martinsen, 1992) was used. The scale is continuous, and Explorers have high scores and Assimilators low scores. Each item has a 5-point response scale. The coefficient alpha was .88, in line with previous studies using the inventory (e.g., Martinsen & Diseth, 2011; Martinsen & Kaufmann, 2000). Two sample items are:

> "I prefer situations in which you have to stick to options that are tried and true" (reversed scoring).
>
> "I quite like situations in which it is necessary to break with conventional wisdom."

Cognitive abilities**.** Two measures of cognitive abilities were included. As a measure of crystallized intelligence, half the WAIS vocabulary (18 items; Wechsler,

1955) was used. The subjects were given 10 minutes to complete this test. Coefficient alpha was .69. A 20-item standardized number series test (Mønnesland, 1985) was used as a measure of fluid intelligence. Participants were given six minutes to complete this test. Coefficient alpha was .88.

Prior problem-solving experience. A questionnaire that was used in previous studies (Martinsen, 1993, 1995a) was included so that the availability of internal search constraints could be compared with the effects of external search constraints (solution hints). The items included questions about the subjects' level of experience in six activities considered to be particularly relevant for solving insight problems (experience with mind-stretchers, drawing/painting, jigsaw puzzles, technical drawing, mathematical problem solving, problem solving in science tasks). Each item was rated on a 4-point frequency response scale that ranged from 0 to 3, and then the sum score was used. We considered this to be a formative measure since relatively independent activities were added to a composite measure of relevant experience for the present insight problems.

Insight problems. Three classic insight problems were employed. Two tasks (the hat rack and two-string problems) were chosen on the basis of their taxonomic classifications as insight and construction problems (Greeno, 1978; Weisberg, 1995), and the third problem (the ring problem; Raaheim, 1961) was chosen for its similarity with the hat rack and two-string problems.

In the two-string problem (Maier, 1970), the task is to tie together two strings that are hanging down from the ceiling. The strings are too far apart to be reached by simply stretching out both arms. In our version of this problem, the available tools were a cup, a screwdriver, and a box of thumbtacks. The correct solution is to tie one string or both strings to one of the tools (e.g., the cup), push the string into a pendulum movement and to grab it when it comes within reach. Two points were given for this solution. Subjects were given one point for a good attempt at a solution, which was defined as any effort that would bring at least one of the strings closer to the other without being held by the hands. In practice, one such solution would be to use the thumbtacks as a means to affix one or both strings to a wall to get them closer to each other.

In the hat rack problem (Maier, 1970), the task is to use two sticks and a C-clamp to make a solid rack on which to hang a heavy coat. The correct solution is to wedge the sticks between the floor and the roof, or between two walls, with the C-clamp tightened on the junction between the two sticks. The handle of the C-clamp functions as a peg. Two points were given for this solution. Here subjects were also given one point for a good try, that is, for making a construction that was fairly, but not sufficiently, stable. In practice, such a solution would involve placing one stick on the floor and attaching the other vertically to its middle with the C-clamp tightened at the junction between them.

In the ring problem (Raaheim, 1961), the task is to get hold of a gold ring at the bottom of a narrow well that is three meters deep. It is so narrow and deep that it is impossible to reach the ring or dive for it. Subjects are told to use some tools that might be of help: a three-meter-long tube with the same diameter as the ring, a pair of scissors, a knife, a piece of wood, and a nail. The correct solution is to cut a wood plug, put it into one end of the tube, hammer the nail into the plug, bend the nail into the shape of a hook, and finally to fish up the ring. This solution was given two points. One point was given for a good try, i.e., pressing one end of the pair of scissors into the tube and then using the resulting (not completely satisfactory) hook to fish up the ring.

The average polychoric correlation for the three tasks was .22. The scores were used as a composite based on their taxonomic classification (Greeno, 1978; Weisberg, 1995). Six minutes were allowed for each task.

Post-treatment measures. As discussed above, a measure of state anxiety from the State–Trait Anxiety Inventory (Spielberger, 1983) was included. The alpha for this 10-item measure was .89. A measure of interest was also included; we developed this measure on the basis of theories of intrinsic motivation (Deci & Ryan, 1985; Harter, 1990). The measure was used to check whether the low-motivation condition was more intrinsically motivating than the other two motivation conditions. The alpha for the interest measure was .86.

Experimental Treatments

Achievement instructions. We formulated three instructions to create three different levels of achievement needs or motivation strength. The procedure were adapted based on principles developed by McClelland et al. (1953) (see also Atkinson & Birch, 1974). In the low-motivation condition, subjects were informed that the experimenter was interested only in finding out whether the insight problems, presented as puzzle tasks and described as typical leisure-time activities, were interesting for this age group of students. The respondents were informed that whether they could actually solve the problems was not considered very important. They were also informed that the analyses of the answers would focus on the results for the several hundred participants in the study and not individual performances. The timing of the tasks was explained as necessary in order to create equal conditions. Finally, subjects were informed that they were to answer a questionnaire about their level of task-related interest at the end of the session. This control condition was considered to be relaxed. It was called the low-motivation condition, or simply *low* in the following results section.

In the medium-motivation condition, subjects were instructed to perform as well as they could (formulated as an imperative) on the set of problem-solving tasks, which were described as typically used in research, and within the time that was available. Subjects were then informed that they were to answer a questionnaire about their reactions to the dependent tasks at the end of the session. This was called the medium-motivation condition, or simply *medium* in the following results section.

Participants in the high-motivation condition were told that their performance on the problem-solving tasks would inform them about their level of ability and that they did not have much time available for each task. The selected tasks were described as frequently used by researchers in order to test certain abilities. Subjects were additionally told that at the end of the session, they were to fill in a questionnaire where they would evaluate their own performance. This was constructed to be a typical achievement condition called the high-motivation condition, or simply *high* in the following results section.

Solution hints. Solution hints served as one type of search constraint, thus improving the structure of the dependent insight problems. Solution hints were tested in pilot studies, and hints that produced increased solution frequencies were selected for the present study. The hint for the two-string problem was: Can you in one way or another create a movement in one of the strings without holding it permanently? The hint for the hat rack problem was: Try if you can to also use the ceiling for your construction. The hint for the ring problem was: Try if you can to make a tool with a hook to fish out the ring.

Procedure

The testing took place in groups in ordinary classrooms during school hours. The materials were presented in writing and administered by trained research assistants. The subjects volunteered and were debriefed and encouraged to ask questions at the end of the session.

The A–E inventory, the experience questionnaire, and the vocabulary and number series tests were administered prior to the experimental treatments and the dependent tasks. After the task resolutions, the state measures of affects were administered. With reference to these measures, the subjects were asked to report their emotional states during the process of problem solving. In the motivation instructions, the subjects were informed about the number of problem-solving tasks and the time available for each (six minutes).

The solution hints were administered to about half the participants in each of the three motivation conditions. The result was a three-by-two factorial design. The participants were randomly assigned to each of the six experimental conditions through prior random mixing of the booklets containing the written instructions and test materials.

Results

The variables were generally within the range of the normal distribution. Correlations, means, and standard deviations for the included variables can be seen in Table 2.

Insert Table 2 about here

A few missing data were handled by listwise deletion in each of the analyses below. The difference in performance in the hint versus the no-hint condition was significant (t (466) = 5.36, p = .000; hint: M = 3.29, SD = 1.59, no-hint: M = 2.49, SD = 1.68). This indicated that availability of solution hints facilitated performance and thus that an anticipated main effect was obtained. As seen in Table 1, there was also a significant correlation between the measure of prior experience and performance (r = .12), indicating a main effect for the other search constraint as well. The general level of task difficulty can be further illustrated through the fact that only 8.5% received 5 points and 3.4 % received 6 points when hints were not provided. In the hint condition, 7.7% received 5 points and 10.3% received 6 points.

To investigate any unintended effects of the experimental motivation instructions, the post-experimental measures of state anxiety and interest were used as dependent variables. The data were analyzed using regression analysis, where the experimental motivation instructions were coded as contrasts to represent an ordinal variable. They were coded as the difference (see Cohen & Cohen, 1983) between low and medium + high (low-motivation contrast) and the difference between medium and high (high-motivation contrast). A third variable was coded to represent the difference between the no-hint and hint conditions.

To exclude interpretations of the effects of the motivation instructions as being other than motivational, we analyzed effects of the these instructions on state anxiety and interest and found no significant effects on these variables. R^2 on state anxiety was .018 (F(5, 459) = 1.69, p = .135). R^2 on interest was .002 (F(5, 458) = .158, p = .98).

Hypothesis 1: The Interaction Between A–E Styles, Search Constraints (Hints), and Motivation

The first interaction hypothesis involved the A–E styles and the two types of experimental conditions: the motivation instructions and the hint–no hint conditions. We anticipated *decreased* performance for Explorers and *increased* performance for Assimilators as a consequence of increased motivation in the no-hint condition. We expected the opposite performance pattern in the hint condition. The hypothesis of the interaction between the motivation conditions, the A–E styles, and the hint–no hint conditions was tested using hierarchical regression analysis (Aiken & West, 1991; Cohen & Cohen, 1983; Pedhazur, 1982). Scores on the A–E scale were centered.

Insert Table 3 about here

As shown in Table 3, the results of this interaction analysis were significant. The results also showed that it was the contrast between the low-motivation condition and the other two motivation conditions that had the more important impact on the significant interaction. The pattern of the interaction can be seen in Figure 1, and supported Hypothesis 1.

Insert Figure 1 about here

Figure 1 shows that in the hint condition, Assimilators had an overall decrease in performance as a consequence of the motivation-arousing conditions, while Explorers had an overall increase in performance because of the motivation conditions. In the no-hint condition, this pattern of interaction was opposite to the pattern of interaction in the hint condition: When their motivation increased, Explorers increased their performance, while Assimilators decreased their performance when motivation increased.

As a further test of the interaction, controlling for cognitive abilities and gender in research involving insight and cognitive styles was important. Consequently, the test of the posited interaction was also carried out when gender and the two measures of intelligence were first entered in hierarchical regression analysis. The interaction involving the experimental conditions and the A–E styles was still significant.

Finally, to more formally test the slopes in the significant interaction, simple slope analyses were carried out within the hints and no-hint conditions, and the contrast between the low motivation and mean of the other two motivation conditions was used as a predictor, while the A-E style dimension was the moderator. Supporting the present hypothesis, the slopes for motivation were negative and significant for Explorers (higher scores on the A–E inventory) at two standard deviations above the mean on the A–E inventory (*simple slope* = -.94, *SE* = .473, t (230) = 1.985, p = .04 (one-tailed)) in the no-hint condition. For Assimilators, the slopes for motivation were positive and significant at one standard deviation below the mean (*simple slope* = .488, *SE* = .226, t (230) = 2.39, p = .016 (one-tailed)) on the A–E inventory. In the hint condition, the motivation slopes for Explorers were positive at two standard deviations above the mean (*simple slope* = .57, *SE* = .317, t (226) = 1.805, p = .036 (one-tailed)). For Assimilators, the motivation slopes were negative and significant at one standard deviation below the mean (*simple* *slope* = -.527, *SE* = .201, *t* (226) = 2.62, *p* = .004 (one-tailed)). These findings supported the hypotheses formulated in the introduction, and our previous studies.

Hypothesis 2: Interaction Between Previous Experience, A–E Styles, and Motivation

To test the second hypothesis, we replaced the hint–no hint variable in the analyses above with the other search constraint, prior experience. In all other ways the data were coded and analyzed as described above. Scores on the A–E inventory and prior problem-solving experience were centered.

Table 4

As can be seen in Table 4, the results from hierarchical regression analysis also showed that this interaction was significant. In this test it was the combined effect of the low- and high-motivation contrasts that created the significant interaction, while each of them alone was significant only in one-tailed tests. When gender, vocabulary, and number series were included in the analysis, the interaction was relatively unaffected. The pattern of interaction can be seen in Figure 2.

Insert Figure 2 about here

As seen in Figure 2, the pattern of this interaction was generally in correspondence with the interaction including the hint–no hint variable analyzed above. However, in Figure 2 the slope for Assimilators was flatter instead of decreasing, because of the motivation instructions when the subjects have higher levels of experience. This deviation from the expected pattern may have been caused by the increased task structure due to the solution hints that half the sample received. Still, performance increased more for Explorers than for Assimilators as a consequence of increased motivation when the level of experience was very high. There were no higher-order interactions involving experience, the hint–no hint conditions, the A–E styles, and the motivation instructions.

Simple slope analyses were then conducted, and simple slopes were calculated at two standard deviations above and below the means on the A–E scale and the measure of experience. Thus, the hypothesis was tested focusing on extreme scorers, an approach that can be necessary to overcome the frequently encountered low-power problems associated with interaction analysis (see Aguinis, 2004). In these analyses it turned out that the slope for the low motivation contrast was positive and significant for Explorers with a high level of experience (*simple slope (1)* = 1.115, *SE* = .512, t (442) = 2.178, p = .015 (one-tailed)), while the simple slope for the high-motivation contrast was not significant. This means that under conditions of lower competence in utilizing internal search constraints, and where internal task constraints were available, increased motivation had a positive and significant effect upon performance.

Stronger motivation seemed to not have any additional effect on performance. When analyzing simple slopes for Explorers with low levels of experience, the simple slope for the low- and high-motivation contrasts were both negative and significant (*simple slope (1)* = -1.072, *SE* = .545, t (442) = 1.968, p = .025 (one-tailed); *simple slope (2)* = -.789, *SE* = .454, t (442) = 1.736, p = .042 (one-tailed)). This implies that under conditions of low levels of prior experience, which theoretically represent optimal conditions for the Explorer type of competence, increased motivation led to lower levels of performance.

When simple slope analyses were carried out for Assimilators with high levels of prior experience, the simple slope for the low-motivation contrast was negative but not significant, while the simple slope for the high-motivation contrast was negative and significant (*simple slope (2)* = -.992, *SE* = .504, *t* (442) = 1.969, *p* = .025 (one-tailed)). This means that high levels of motivation impaired performance for Assimilators when the level of prior experience was high. In other words, increased motivation had a negative effect when competence in utilizing search constraints was high and internal search constraints were present.

Finally, simple slopes were analyzed for Assimilators with low levels of experience. While the slopes for the two motivation contrasts were both positive, they were not significant in these analyses, although there was a tendency toward significance for the first contrast (*p* = .063).

To explore the three-way interaction between experience, styles, and motive instructions further, we used the data from the three no-hint motivation conditions since these conditions were unaffected by the external search constraints (hints). The results showed that the interaction was significant at the 10% level. Inspection of the pattern of this interaction showed that the interaction now corresponded more closely with the one including the hint–no hint variable, with decreasing performance for Assimilators due to increasing motivation under the condition of higher levels of experience.

Discussion

In this study, the theory of A–E cognitive styles (Kaufmann, 1979, 1995; Martinsen, 1995b; Martinsen & Kaufmann, 2000) was integrated with classic conceptualizations of achievement motivation and optimal motivation for the task (Atkinson, 1974a, b), and with information processing theory where solution search in large problem spaces and availability of search constraints play prominent roles (Kaplan & Simon, 1990). Central conceptions in this integration were that the cognitive style distinction in question describes heuristic competencies related to the utility of search constraints in problem-solving tasks and that these types of competencies have motivational implications that interact with other types of motivational determinants. We also emphasized the hypothesis of optimal motivation for the task, stating that different types of tasks may be better solved with different levels of aroused resultant motivation. We based our predictions on this theory and tested two hypotheses; one included solution hints as a search constraint and the other included prior problem-solving experience as a search constraint.

When considering the two significant three-way interactions, it can be concluded that the results provided strong support for the theory. The interactions were also significant when important control variables were included. It was primarily the contrast between the control condition and the average of the two other motivation conditions that was significant when solution hints were used as search constraints. This contrast can be interpreted as describing an increase from a low-level to an elevated motivational state. Consequently, it seems well supported that the A–E styles describe different kinds of heuristic competencies in utilizing search constraints and that these competencies have motivational implications and interact with motive strength and search constraints in a predictable way. The present findings replicated and extended the findings from previous studies (Kaufmann & Martinsen, 2006; Martinsen, 1993, 1994, 1995; Martinsen & Furnham, 2015), where different tasks, samples, and designs were used. Thus, it seems that there is a complex and dynamic interplay between individual differences in cognitive style, motivational processes, and the effectiveness of search constraints in insight. In future studies of insight, it may be usefull to control for the influence of the A–E styles describing important heuristics or competencies, with implications for the effectiveness of search constraints in insight. Moreover, it seems equally important to control for motivational influences since these seem to moderate the effectiveness of both cognitive styles and search constraints.

Beyond these considerations, we admittedly did not have a formal account of the mechanisms involved in too-high motivation for the task, and further research is necessary to shed light on this issue. However, from the pattern of findings in the two interactions, it seems that increased motivation may push people from a primary mode of information processing associated with their style disposition to a secondary mode of processing associated with the other style disposition.

Limitations

While our previous studies on the present issue have been based on measured motives, this study emphasized experimental achievement manipulations. We may, of course, ask whether these had the intended effects since we included no direct measure of total resultant motivation. To measure resultant motivation seems usually not done in this field. Despite this, our motivation manipulations were based on a long tradition of research, and were designed to vary the level of achievement needs for participants in the three experimental motivation groups. Our reasoning was based on McClelland et al.'s (1953) theory and findings, similar findings by French (1955), and a study by Smith (1966). On the basis of TAT pictures, McClelland et al. (1953) found that achievement instructions increased the level of achievement imagery. French (1955) also found that ego-involving instructions increased the level of need for achievement scores in her test on insight. On the other hand, Smith (1966) did not find any significant effects on need for achievement from a set of experimental instructions, but found that achievement and multi-incentive instructions increased the mean level of performance on arithmetic tasks compared with the mean level of performance in a relaxed condition.

In line with results from studies like these, Atkinson and Birch (1974) argued that the overall level of motivation could be increased using achievement instructions like the ones that we have presently used. However, there was also the alternative hypothesis that expectancy of evaluation and salient time constraints, both of which are part of achievement instructions, may arouse test anxiety (Hagtvet, 1989), which in turn inhibits performance. On the basis of this possibility, the expectation that the experimental motive manipulations in our study would differentially increase the level of aroused motivation should not be taken for granted, although the main trends in previous evidence have pointed in that direction. When investigating this possibility, however, we found no evidence supporting the idea that state anxiety scores would be differentially affected by the six conditions.

Although the A-E style construct is measured by means of a self-report inventory, assumedly with the same limitations that have been associated with self-report in general (Butcher, Bubany, & Mason, 2013), the present findings nevertheless were in line with predictions and supported our theory. It can also be noted that while the style construct itself has been questioned in previous research (McKenna, 1984; Von Wittich & Antonakis, 2011) we believe that the present findings add to to the A-E style construct's validity.

Conclusion

On basis of the present findings, it seems beneficial for our understanding of insight to integrate individual differences in cognitive style and achievement motivation theory with information processing theory.

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Table 1. Illustrative example on resultant motivation estimation for insight problems based on the simplified formula for achievement motivation and where task environment characteristics and cognitive style implications have been added to the theory/resultant motivation eqation. In this table we have included characteristics of the task environment (availability of search constraints), scores on the A–E inventory, probability of success based on high/low style scores (PsCs), incentive value of success (1 - PsCs), the product of PsCs and incentive value (competence motivation), and resultant motivation using the values of 1, 2, and 3 (figures chosen to keep resultant motivation in the .00–1.00 range) to describe low, medium, and high levels for motive strength (Ms - Mf). We assumed an optimal level of motivation when task constraints were not available to be .25 and .40 when task constraints were available (implying that task complexity became somewhat lower and tasks a little easier). We modeled the positive main effect of search constraints by adding .10 to the Ps values in the condition with available search constraints.

Insight problem task environment (Tc)	**Style (high and low scores; Assimilator/ Explorer)**	**PsCs**	**(1 - PsCs) Incentive value**	**Competence motivation: Ps * (1 - Ps)**	**Resultant motivation dependent on motive strength (1, 2, and 3 * (PsCs * (1-PsCs))**	**Assumed optimal motivation**	**Performance dependent on motive strength (1, 2, 3) * competence motivation**
No search constraints available (high-novelty condition)	Assimilator	.10	.90	.09	.09, .18, .27	.25	Low, better, high
	Explorer	.30	.70	.21	.21, .42, .63	.25	High, lower, low
Search constraints available (increased-familiarity condition)	Assimilator	.40	.60	.24	.24, .48, .72	.40	Low, better, low
	Explorer	.20	.80	.16	.16, .32, .48	.40	Low, better, high

Table 2

Correlations, Means, and Standard Deviations for Study Variables

	M	SD	1	2	3	4	5	6	7	8	9	10
1. Gender	-	-										
2. Vocabulary	17.29	3.95	.067									
3. Number series	13.73	3.88	.312**	.276**								
4. Hint–no hint	-	-	-.049	.028	.012							
5. First contrast (low vs. the other two)	-	-	.023	.006	.011	-.007						
6. Second contrast (medium vs. high)	-	-	.019	-.023	-.027	.002	-.013					
7. A–E styles	101.7	16.28	.125**	.036	.029	.014	-.048	-.032				
8. Experience	6.8	2.96	.045	-.056	.016	-.016	.027	-.033	.108*			
9. Interest	22.48	7.05	-.033	.034	.007	-.024	-.014	.015	.034	-.001		
10. State anxiety	18.9	5.86	-.312**	-.116*	-.169**	-.103*	.053	.050	-.161**	-.104*	.020	
11. Insight performance	2.89	1.68	.228**	.197**	.217**	.237**	-.025	-.079	.092*	.115*	-.033	-.256**

Note. ** Correlation is significant at the 0.01 level (two-tailed). * Correlation is significant at the 0.05 level (two-tailed). (C) = Centered variable. N = 459–468. For gender, females = 1, males = 2. For hint–no hint, no hints = 1, hints = 2.

Table 3

Summary of hierarchical regression analysis of the A–E styles (centered), the two contrasts for the experimental motivation contrasts, and solution hints. First contrast was difference between low motivation and the other motivation conditions. Second contrast was between medium and high motivation. The dependent variable was performance on insight tasks. N = 463.

Variable	Step 1	Step 2
First contrast	-.013	-.008
Second contrast	-.079	-.077
Hints	.229**	.235**
AE	.093*	.101*
Low motivation contrast * hints	-.056	-.062
High motivation contrast * hints	.037	.041
Low motivation contrast * AE	.003	.003
High motivation contrast * AE	.014	.013
Hints * AE	.036	.045
Low mot. contr * hints * AE		.156**
High mot. contr. * hints * AE		-.020
R^2	.073	.098
R^2 increment		.025**
F	3.992**	4.468**

Note: * p<.05. **p<.01

Table 4

Summary of hierarchical regression analysis of the experimental motivation contrasts, the A–E styles (centered), and prior problem-solving experience (centered). First contrast was difference between low motivation and the other motivation conditions. Second contrast was between medium and high motivation. The dependent variable was performance on insight tasks. N = 454.

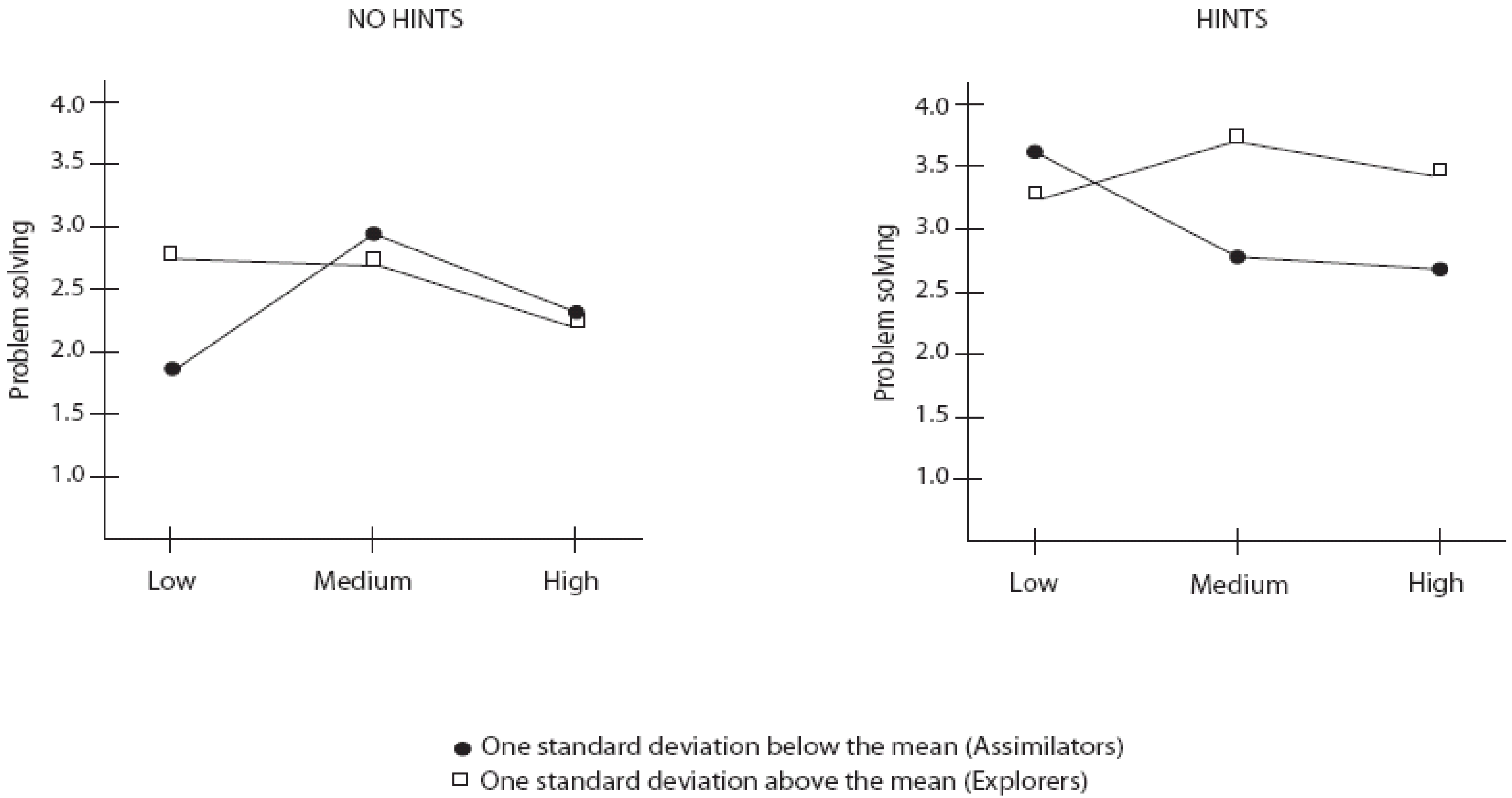
Variable	Step 1	Step 2
Low motivation contrast	-.027	-.041
High motivation contrast	-.075	-.079
AE	.096*	.100*
Low motivation contrast * AE	.015	.026
High motivation contrast * AE	.009	.014
Prior experience	.122*	.142*
Low motivation contrast * prior exp.	.063	.054
High motivation contrast * prior exp.	-.006	-.012
AE * prior exp.	-.076	-.070
Low mot. contr * AE * prior exp.		.088+
High mot. contr * AE * prior exp.		.098+
R^2	.041	054
R^2 increment		.013*
F	2.09*	2.29

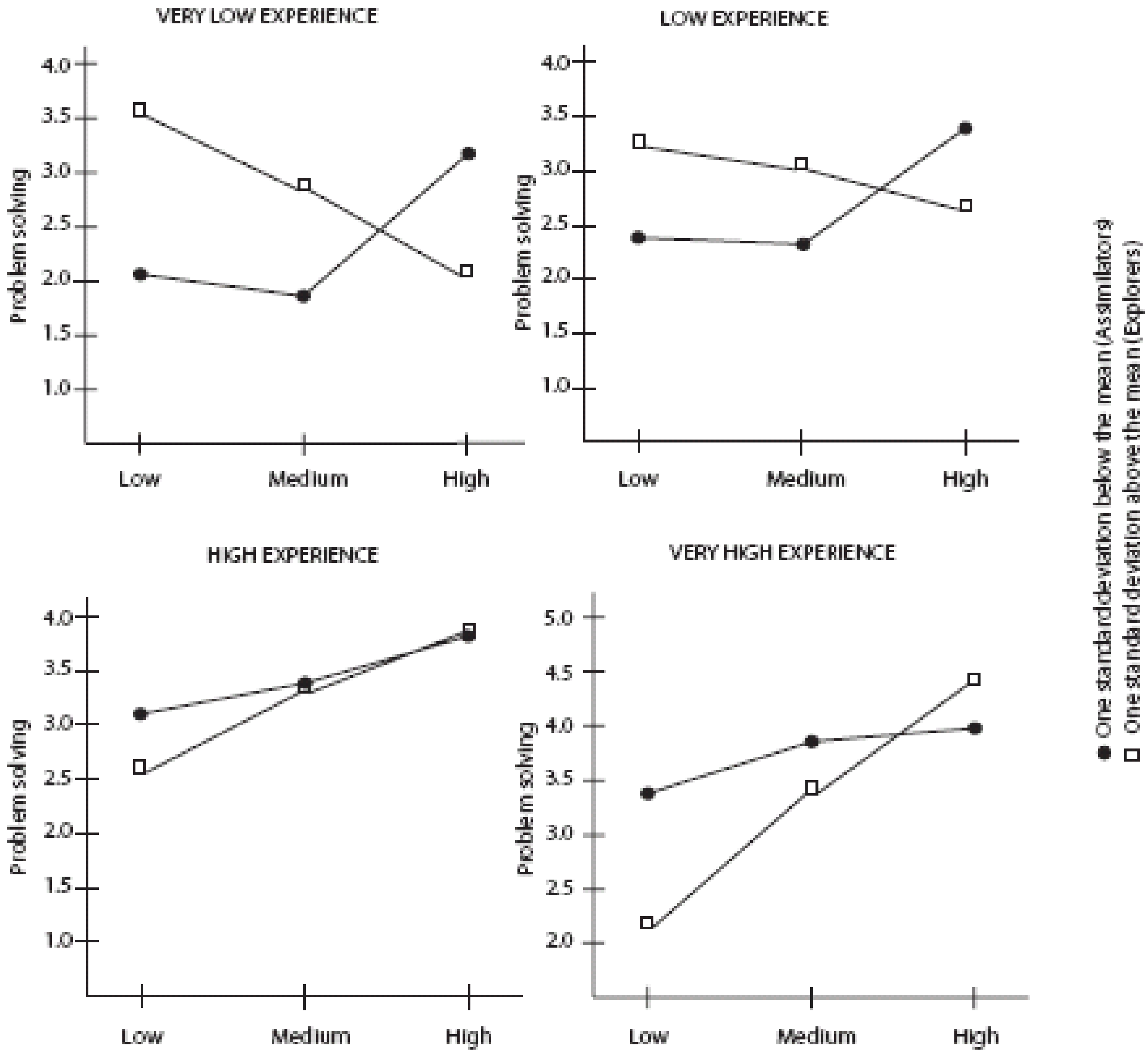
Note: + p<.05 (one-tailed). * p<.05 (two-tailed). **p<.01 (two-tailed).

Figure captions:

Figure 1. Interaction plot of A–E * motivation instructions in the hint and no-hint conditions. The plot points for the A–E styles are at one standard deviation above and below the mean.

Figure 2. Interaction plots of the A–E styles * motivation instructions at four levels of experience. The plot points for the A–E styles are at one standard deviation above and below the mean. For experience, the plot points are at one and two standard deviations above and below the mean.


NO HINTS
HINTS
Problem solving
4.0
3.5
3.0
2.5
2.0
1.5
1.0
Low
Medium
High
One standard deviation below the mean (Assimilators)
One standard deviation above the mean (Explorers)


VERY LOW EXPERIENCE
LOW EXPERIENCE
HIGH EXPERIENCE
VERY HIGH EXPERIENCE
Problem solving
Low
Medium
High
One standard deviation below the mean (Assimilators)
One standard deviation above the mean (Explorers)