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Self-Construal and Insight Problem Solving

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by

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Abstract

Self-construal research has shown that the way people view themselves impacts a variety of cognitive processes. Research has focused on two levels of self-construal: the interdependent self-construal, or when the self is represented in relation to others, and the independent self-construal, or when the self is represented independently of others. Findings from the self-construal and cognition research suggest that the interdependent self is associated with diffuse attention, while findings from the self-construal and creativity research indicate that the independent self is associated with divergent thinking important for creativity. The present study examined the effect of self-construal priming in the novel domain of insight problem solving. Insight problem solving is an all-at-once means of problem solving that is considered a measure of creativity, and is associated with diffuse attention. In the present study, participants received either an interdependent or independent prime prior to solving a set of compound remote associate (CRA) problems—a set of creative problems that can be solved either analytically or via insight. Overall, participants receiving the independent prime solved more of the CRAs. However, the expected effect of priming on the number of self-reported insight solutions did not emerge: there was no effect of self-construal prime on the proportion of solutions achieved via insight. This mixed pattern of results provides provisional support for the role of the independent self-construal in creative thinking, but does not conclusively support, nor refute a role for self-construal level in insight problem solving. Rather, further research is needed to clarify the relationship between the two.

Self-Construal and Insight Problem Solving

Philosophical investigations of the self have a long history in a variety of cultural traditions, but only recently have experimental methods been used to examine how self-construal, or people's internal representation of themselves, influences thinking (Zhu & Han, 2008). Research on self-construal has demonstrated that people have distinct levels of self-representation, which are associated with differences in cognition, motivation, and emotion (Markus & Kitayama, 1991). In general, this line of research has focused on two specific levels of self-construal: the interdependent self-construal, or when the self is represented in relation to others, and the independent self-construal, or when the self is represented independently of others (Brewer & Gardner, 1996). Using this distinction, research has shown that the independent self-construal is typically associated with a context-independent, analytic mode of thinking, while the interdependent self-construal is associated with a holistic, context-dependent mode of thinking (Kuhnen, Hanover, & Schubert, 2001). While this association between self-construal level and mode of thinking has been demonstrated in a variety of cognitive domains, the present research examines how self-construal influences performance on insight problem solving, an area of research that has not yet been explored.

Self-Construal Research

Differences in self-construal were originally associated with culture, with Easterners' conceptions of the self focused more on the interconnectedness of individuals and Westerners' conceptions of the self focused on differentiating oneself from others (Markus & Kitayama, 1991). These cultural differences are associated with differences in performance on basic cognitive tasks. Perceptually, Westerners have a bias towards perceiving salient foreground

objects when observing a visual scene, while Easterners have a bias towards context and background when viewing a visual scene (Nisbett & Masuda, 2006). This difference is reflected in Westerners' change blindness to background movements (Masuda & Nisbett, 2006) and Easters' reduced ability to recognize an object in a novel context (Masuda & Nisbett, 2001). In categorization tasks, Easterners group together objects that contextually or functionally exist together (e.g. grouping cow with grass because a cow eats grass) or look similar, while westerners are more likely to group together objects based on rule based taxonomy regardless of similarity (e.g. grouping cow with chicken because they are both animals; Norenzayan, Smith, Kim, & Nisbett, 2002). A consistent pattern of differences is shown in reasoning tasks, such that Easterners are more likely consider contextual factors when making causal attribution judgments, while Westerners are more likely to consider salient traits (Choi & Nisbett, 1998). In terms of logic, Westerner prefer rule-based, deductive logic and have trouble with discrepancies to these rules, while easterners prefer dialectical reasoning and are better at handling statements that have apparent contradictions (e.g. too humble is half proud; Peng & Nisbett, 1999). In general, the pattern that emerges is that western thought is linear and analytical, while eastern thought is more holistic and contextual.

Self-construal priming. Although originally associated with culture, recent research demonstrates that independent and interdependent self-construals can be primed in people within a single culture. For example, Gardner et al. (1999) demonstrated that self-construal can be primed by asking participants to circle pronouns in a story. The independent prime version of the story had only first-personal singular pronouns such as "I" and "me," while the interdependent prime version of the story had only first-person plural pronouns such as "we" and

"us." This priming technique shifted participants' representations of themselves towards individualistic or collectivist values consistent with prime (Gardner, Gabriel, & Lee, 1999).

Self-construal and cognition. Research examining the effects of self-construal priming on cognition has yielded results that mirror those observed in cross-cultural studies, indicating that self-construal may be mediating the observed cultural differences. Kuhnen and colleagues (2001) conducted a set of experiments to see if self-construal priming would induce the same attentional biases seen in people of Eastern and Western cultures. By measuring performance on the embedded figures tasks and picture completion tasks, the researchers demonstrated that interdependent priming increased attention towards context as measured by decreased ability to pick out embedded figures and increased ability to notice incomplete contextual elements in the picture completion task. Conversely, the independent prime resulted in an increased ability to pick out embedded figures, and reduced ability to notice missing contextual items. Based on these findings, the authors propose that the interdependent self-construal is associated with a context-dependent mode of thinking, whereas the independent self-construal is associated with a context-independent mode of thinking (Kuhnen, Hannover, & Schubert, 2001).

Lin & Han (2009) replicated these findings using flanker and compound stimuli tasks. By measuring response time, the researchers found that the interdependent self-construal prime slowed response time to targets that were flanked by incongruent stimuli (i.e. responding to a rightward pointing arrow surrounded by leftward pointing arrows), but increased response time to global letters (responding to the letter 'H' comprised of mini 'S's) indicating that this performance was influenced by context. The independent self-construal prime inoculated against flanker effects, as measured by response time, and increased response time to local letters (i.e. responding to the 'S's that comprise a global 'H'). Importantly, these researchers used the

different self-construal primes within subjects, thereby increasing the strength of these findings by eliminating the possibility of individual differences (Lin & Han, 2009).

Extending these findings to higher order cognitive processes, researchers looked at the impact of self-construal priming on causal reasoning. After priming self-construal level between groups, participants were asked to make judgments about the cause of events based on observing target events that co-occurred with superior and alternative causes. Context sensitivity was operationalized as a participant's sensitivity to alternative causes, while context independence was operationalized as insensitivity to alternative causes when making causal judgments (Kim, Grimm, & Markman, 2007). Their findings match that of the perceptual studies, such that independent priming led to context independent causal judgments, while interdependent priming led to context sensitivity to alternative causes.

Taken together, studies looking at the effects of self-construal priming on cognitive processes suggest that the independent self is associated with the processing of salient local information, while the interdependent self is associated with more holistic processing that accounts for more contextual information. One way of interpreting this pattern is that the priming of an interdependent self-construal creates a more diffuse state of attention, both perceptually and conceptually, because diffuse attention is needed to be able to integrate context. Conversely, it could also be said that the independent self-construal priming activates a more focused attention that ignores contextual elements.

Self-construal and creativity. Not all of the findings from the research fit the picture presented above however. Based on the findings that independent priming led to contrastive social comparisons, while interdependent priming led to assimilative social comparisons, Stapel and Koomen (2001) suggest a role for self-construal in creativity. They proposed that

independent priming activates a differentiation mindset important for creative thinking, while interdependent priming activates an integration mindset as measurable through divergent thinking tasks. For example, when asking participants to come up with exemplars of a category, independent priming led participants to come up with more diverse exemplars of a category (e.g. naming golf-cart as a type of automobile), while interdependent priming led to more common exemplars (e.g. sedan as a type of automobile; Wiekens & Stapel, 2008). These findings suggest that the independent self is associated with the generation of creative ideas. While these findings do not directly contradict the previously presented research, they offer an alternative explanation as to how self-construal impacts thinking.

Problem Solving Research

Problem solving research has generally focused on two different categories of problem solving: analytic and insight problem solving. These categories differ in terms of problem type, and the necessary processes required for a solution. Research on analytic problem solving has typically examined the steps used by solvers when coming up with solutions to well-define problems, like math problems. Insight problem solving research, on the other hand, has traditionally used non-routine problems to examine how solutions are arrived at in an all-at-once manner known as "insight." Research has provided behavioral evidence distinguishing these two general categories of problem solving (Novick & Basock, 2005), and evidence from neuroimaging studies has demonstrated a distinct and reliable pattern of brain activity associated with solutions arrived at through insight (versus analytical means) as indicated by self-report of the solving process (Bowden, Jung-Beeman, Fleck, & Kounios, 2005).

Problem types. Much of the difficulty faced by problem solving researchers is due to the fact that there are various different problem types that can be solved using a variety of different

strategies. A problem is defined as any situation in which a person seeks to obtain a goal, but cannot do so simply by action or obvious operations; to obtain the goal, there has to be recourse to thinking (Duncker, 1945). According to this definition, everything from math problems to figuring out what to eat for lunch can be considered a problem, but these two situations represent two different general categories of problem types.

Typical math problems can be classified as well-defined problems because the operations necessary to solve the problem, the initial state of the problem, and the solution state are clearly specified or understood (Kitchener, 1983). All games, for which the rules are known, such as chess, are examples of well-defined problems. Figuring out what to eat for lunch presents a different type of problem known as an ill-defined problem or a non-routine problem. Ill-defined problems are problems for which the necessary solving process or solution state are not clearly specified or understood (Scraw, Dunkle, & Bendixen, 1995). Most real world problems do not have a defined solution state or specified solving process, and thus can be thought of as ill-defined problems. Creative problems fall under this classification, and are defined as problems that require synthesis of problem information to generate novel or creative solutions not presented in the initial problem state (Feist, 1991). An example of a creative problem is designing a contraption that will preserve an egg if dropped from a particular height using only certain materials. Insight problems represent a specific type of creative problems that typically mislead the solver toward incorrect solving strategies, and thus require the solver to overcome deceptive information in order to arrive at the solution, often times in a flash of insight (Chronicle, MacGregor, & Ormerod, 2004).

Insight vs. analytic solving processes. Research on problem solving using well-defined problems has yielded many theories about how problems are solved in a step-by-step manner,

and has differentiated this analytic approach from non-analytic approaches to problem solving (Pretz, Naples, & Sternberg, 2003). Generally, these theorists studied the solving of well-defined problems to examine the step-by-step process involved, showing how each step brings the solver incrementally closer to the solution. For example, the Tower of Hanoi task shown in Figure 1 below is a classic problem used in studying analytic problem solving, and the strategy involved in solving this problem can be labeled the "means-ends analysis." The means-ends analysis is an

Figure 1. Tower of Hanoi Task.

analytic problem solving approach that involves breaking down the problem into sub-problems in order to achieve the overall goal. In the Tower of Hanoi task, a person is presented with three pegs with three discs stacked on top of each other on peg 1. The pegs are stacked in order of increasing size. The goal is to get all three disks on peg 3 in the same configuration moving only one disc at a time, while never stacking a bigger disk on top of a smaller disk. With this task, the first sub-goal may be to move the top discs so that the biggest disc can be moved. The means-ends approach is just one of the approaches developed by analytic problem solving theorists, and it illustrates the basic qualities of the general analytic problem solving approach. For example, completion of each sub-goal brings the solver closer to the solution, which is typical of the step-by-step focus of analytic problem solving theories.

Unlike analytic problem solving, insight is the sudden arrival of a solution to the problem solver and is usually accompanied by a subjective "Aha!" feeling (Mayer, 1995). Insight is considered a non-analytic or non-routine approach to problem solving because there is no apparent analysis involved; the answer simply occurs to the solver unexpectedly. After the sudden arrival of the solution via insight, the problem solver is usually unable to trace the exact steps taken to reach the solution, yet has the intuitive feeling that the solution is correct (Davidson, 1995).

Metcalfe and Wiebe (1987) provided some of the earliest empirical evidence for measurable differences in the solving of analytic and insight problems. They gave participants both classic insight problems and non-insight (algebra) problems to solve while they reflected on the problem solving process. They found that a participant's subjective feelings of knowing, the ability to tell if they can accurately solve the problem, predicted performance only on non-insight problems. Also, they found that feelings of "warmth" of an approaching solution differed between insight and non-insight problems, such that solvers were not consciously aware of imminent insight solutions as they are with forthcoming analytic solutions.

Further, Schooler, Ohlsson, and Brooks (1993) demonstrated through a series of experiments that verbalizing the problem solving processes impaired insight problem solving, without affecting non-insight problem solving. By asking participants to verbalize what processes they were using while solving a problem, the researchers were able to hinder performance on insight problems compared to participants that were asked to engage in an alternative, non-verbalization distraction. This suggests that the cognitive processes that lead to insight are out of the awareness of the solver. Fleck (2008) elaborated on this finding by examining the role of memory on the solving of analytic and insight problems. She administered

different measures of short-term and working memory to her participants before giving them analytic and insight problems to solve. Analyzing the correlations between the memory measures and problem solving ability, she was able to predict analytic problem solving ability from working memory capacity. This was not the case for insight problems however. This suggests that analytic problems increase demands on working memory, thus a higher working memory capacity facilitates the solving of analytic problems, but not of insight problems. These studies provide empirical support for differences between analytic and insight problem solving, and have helped define some of the characteristics of insight problem solving.

Insight Problems. The earliest studies of insight used creative problems that were ill-defined in terms of proper solving process, tacitly emphasizing the role of the problem type on the subsequent creative solution. The problems used in this research were labeled "insight problems" based on the assumption that solver arrived at their solutions via the insight process. Insight problems usually mislead the solver to incorrect, yet intuitive approaches to solve the problem (Davidson, 2003). For example, consider the following problem:

> You have blue stockings and red stockings mixed in a dresser drawer in the ratio of 4 to 5. How many stockings must you remove in order to guarantee that you have a pair that is the same color? (Davidson, 2003, p. 157)

Because the problem presents the ratio information, it misleads the solver into approaching the problem by calculating ratios. To come up with the proper solution, it is up to the solver to approach the problem in a manner different from what originally seemed correct. The solver must ignore the ratio information, and realize that after removing two stockings, even if they are of different color, the third stocking will guarantee a pair. This process is called "restructuring," which is the re-representation of the problem information in a manner that makes it easier to

solve (Duncker, 1945). Related to restructuring, "functional fixedness" is a mental block that works against the solver's ability to restructure problem information for accurate solution. Duncker's (1945) candlestick problem is a prime example of this concept. Duncker gave participants a box of matches, a box of tacks, and a candle and asked them to attach the candle to the wall without letting the wax drip below. The correct solution to this problem requires that the participant attach one of the container boxes to the wall as a platform upon which the candle can be placed, rather than fixating on the box's function as a container for matches or tacks.

Both the candlestick problem and the stocking problem exemplify an important characteristic of classic insight problems: they require the solver to use non-prepotent information for accurate solution. The ratios in the stocking problem and the typical functionality of boxes in the candlestick problem are examples of prepotent information that hinders the solver's ability to solve the problem correctly. Because insight problems require that prepotent information is ignored, solving accuracy on insight problems is used as measure of creativity (Friedman & Förster, 2005).

Problem Solving via Insight. Later research shifted emphasis from insight problems, to insight as a solving process. This change in focus was based on the finding that classic insight problems do not reliably predict that solutions are arrived at via insight (Bowden et al., 2005). For example, it is possible to solve the stocking problem above using a trial-and-error strategy rather than using a mathematical approach. That is, the solver could determine the possible combinations of colors when pulling out one stocking at a time, and this would lead the solver to a correct solution through analytic means. Thus, while traditional insight problems require non-obvious solutions, they do not necessitate that solutions are arrived at via insight. Moreover, research has shown that even well-defined algebra problems can require insight-like

restructuring for a solution to be obtained efficiently (Dow & Mayer, 2004). For example, consider the following problem: if $x^3 = 12$, $x^6 = ?$ While it is possible to solve this problem by calculating a cube root, which is relatively difficult, a quicker solution can be obtained by recognizing that $x^6 = x^3 \cdot x^3$. Therefore, what was traditionally studied as "insight problem solving" actually confounded solving accuracy on insight problems with the insight solving process. By distinguishing these measures, researchers are able to examine factors that influence each separately. In terms of creativity, this discernment suggests that there is a difference between creative solutions and creative approach, and that one does not necessarily predict the other.

While earlier insight research used solving accuracy on classic insight problems to infer that solutions were achieved via insight, later research started examining the insight solving process through measuring self-reports of the "Aha!" experience. To this end, Bowden and Jung-Beeman (2003) developed a set of compound remote associates (CRA) problems which can be solved via insight or otherwise, and thus have established a paradigm for studying factors that affect insight. A CRA problem starts with the presentation of three target words (e.g. mile, age, and sand), and it is up to the solver to find a single solution word that combines with each target word to create three compound words (i.e. stone: milestone, stone-age, and sandstone). CRAs are advantageous for insight research because they are well-defined yet creative (participants can use an analytic matching strategy to synthesize information and generate unambiguous solutions not present in the initial problem state), can be solved relatively quickly, and allow for the use of many problems during an experimental session, thereby increasing the reliability of the findings. Importantly, previous research using CRA problems has shown that these problems are solved via insight about half of the time (Subramaniam, Kounios, Parrish, & Jung-Beeman, 2009;

Kounios, Frymiare, Bowden, Fleck, Subramaniam, Parrish, & Jung-Beeman, 2006), which allows for the examination of factors that influence whether solutions are achieved through insight or otherwise (Kounios & Beeman, 2009).

Using this paradigm, research employing cognitive neuroscience methods has provided strong support for insight as a distinct and dissociable means of problem solving. In a set of related studies, participants solved CRA problems while their brain activity was measured through EEG and fMRI. By comparing brain activity of participants when they solved a problem through (vs. non-insight) as indicated by subjective report of the insight experience, fMRI data analysis revealed distinct activity in the right hemisphere anterior superior temporal gyrus (ASTG) directly before an insight solution. Corroborating this finding, ERP data revealed a burst of gamma-wave activity in the same region right before an insight (vs. non-insight) solution (Bowden et al., 2005). These findings indicate that problem solving via insight is distinct from non-insight problem solving. Further, because the left ASTG is involved in the binding of closely related semantic associations, while the right ASTG is involved in the binding of coarsely related semantic associations (Bowden & Beeman, 1998), these findings support the notion that insight requires overcoming fixation on prepotent information.

Insight and attention. Research has also demonstrated the role of attention in creative problem solving. Ansburg and Hill (2003) examined individual differences in attentional capacities and its relation to problem solving ability. They differentiated diffuse attention, or the ability to attend to a wider array of stimuli, from focused attention, or the ability to filter out seemingly irrelevant stimuli. They gave participants a paper with a list of words to memorize (focal cues) while listening to another list of words on headphones (peripheral cues). The participants were later tested with a set of 30 anagrams that were comprised of 10 words

presented in the focal list (the list presented on paper), 10 words presented peripherally (through the headphones), and 10 that were novel anagrams. Additionally, the participants were tested with creative problems (similar to CRAs), deductive reasoning problems, and memory for focally and peripherally presented words. They found that creative problem solving accuracy was correlated with success on anagrams for which cues were presented peripherally. This result suggests that overall creative problem solving ability is associated with diffuse attention.

Based on these findings, researchers identified resting-state brain activity related to patterns of attention that make a person more prone to solving problems using insight (Kounios, Fleck, Green, Payne, Stevenson, Bowden, & Jung-Beeman, 2008). In this study, the researchers used EEG to monitor resting brain activity of participants before having them solve a set of anagrams and having them report if each was solved through insight. The researchers divided participants into low insight (LI) and high insight (HI) groups using a median split based on the ratio of correctly solved anagrams through insight to correctly solved anagrams without insight. Analyzing the EEG data, the researchers found that the resting state brain activity of HI group showed less occipital alpha-band activity, which is indicative of less inhibition of the visual system, thus leading to more diffuse visual attention. Also, the LI group had more occipital beta activity, consistent with heightened focused attention. This provided further support to the behavioral data presented by Ansburg & Hill (2003), and highlights the importance of attention in creative problem solving and insight.

Self-Construal and Problem Solving through Insight

After reviewing the problem solving literature and the various findings yielded from self-construal research, it is possible to synthesize these results to make predictions for the role of self-construal in insight problem solving. As outlined above, problem solving research has

distinguished analytic and insight problem solving on the basis of both problem type and the processes underlying the generation of a solution. Though insight problem solving is typically characterized as the generation of non-obvious solutions to ill-defined problems arrived at through insight, research has shown that the insight problem solving ability is not necessarily indicative of the insight solving process. Research has revealed that differences in creativity (Ansburg & Hill, 2003) and attention (Kounios et al., 2008) explain differences in performance and approach in the solving of insight problems. These findings imply that self-construal priming may be another way to invoke changes in cognition that can impact insight problem solving. Yet, the various findings in the self-construal literature give somewhat contrasting views. Consider the findings from the creativity and self-construal research which suggests a role for the independent self in the generation of creative ideas (i.e. Wiekens & Stapel, 2008). Because insight problems require non-obvious, creative solutions, these findings lead to the prediction that independent priming would facilitate the generation of creative solutions as measured by an increase in solving accuracy on insight problems. Further, because insight is considered a creative problem solving approach, this research could also be used to make the prediction that the independent prime would increase the number of solutions arrived at via insight.

On the other hand, research in the self-construal and cognition literature suggests different predictions based on the ability of self-construal priming to impact attention. As outlined before, research indicates that non-focused, diffuse attention is associated with creative problem solving (Ansburg & Hill, 2003) and problem solving through insight (Kounios et al., 2008). The findings from the perception and causal reasoning studies indicate that interdependent self-construal priming induces a more diffuse attention state, while the

independent self is associated with focused attention. Thus, these studies lead to the prediction that interdependent priming will increase solving accuracy on insight problems, and facilitate creative problem solving approach as measured through insight. Because independent priming activates a focused attention state, these studies also predict that independent priming would hinder performance on insight problem solving, and induce a bias towards an analytic problem solving approach as measured through fewer solutions arrived at via insight.

Table 1 summarizes the predictions made by the two lines of self-construal research. The self-construal and cognition literature suggests that the interdependent prime would facilitate insight problem solving ability and increase the number of insight solutions by inducing a diffuse attention state, while the independent prime would have the opposite effect. In contrast, the creativity and self-construal research suggests that the independent self-construal prime will facilitate insight problem solving performance, and possibly increase the number of insight solutions by activating a differentiation mindset associated with creativity.

Self-Construal and Cognition		Self-Construal and Creativity	
Independent Prime	Interdependent Prime	Independent Prime	Interdependent Prime
↓	↓	↓	↓
Focused Attention	Diffuse Attention	Differentiation Mindset/Creativity	Integration Mindset
↓	↓	↓	↓
Lower solving accuracy on insight problems and lower proportion of insight solutions	Increased solving accuracy on insight problems and higher proportion of insight solutions	Increased solving accuracy on insight problems and possible increase in proportion of insight solutions	No predictions for the interdependent prime on insight problem solving

Table 1. Predictions mferred from the separate lines of self-construal research.

The Present Experiment

To test the predictions made by the different lines of self-construal research, the present study measured solving accuracy, response time, and the proportion of insight solutions while participants solved CRA problems before and after self-construal priming. A post-prime increase in solving accuracy would indicate a facilitation effect of that particular prime on the insight problem solving ability. Similarly, a decrease in response time would indicate a facilitation effect of that prime on solving ability. An increase in the proportion of insight solutions after priming would indicate a change in problem solving approach towards non-analytic means. Thus, it is possible to test predictions from the different lines of self-construal research. An increase in solving accuracy following the independent prime would support findings from the creativity and self-construal research which suggest that the independent prime activates a differentiation mindset associated with creativity. However, an increase in solving accuracy and proportion of insight solutions following the interdependent prime would indicate that the interdependent prime activates a diffuse attention state associated with creative problem solving and the insight solving process.

Methods

Participants

One hundred and thirty-one native English-speaking undergraduates (89 female, 42 male) at a Catholic university in the Northeast participated in the study for course credit. Exclusion criteria based on nationality and culture were used to control for the effects of chronic self-construal. Only participants that were born and lived continuously in the United States were allowed to participate.

Design

Participants were randomly assigned to one of two priming conditions (independent or interdependent). Participants completed five practice CRAs, a section of 15 CRA problems that served as the baseline covariate measure, and two sections of 15 CRA problems, each of which were preceded by a self-construal prime of the same type. The two post-prime sections of CRA problems served as the within subjects factor. During testing, the proportion of accurate solutions, response time for accurate solutions, and whether or not the solution was solved via insight were recorded as the dependent measures. Each dependent measure was analyzed using a mixed model ANCOVA with the prime condition as the between subjects factor, the two post-prime sections as the within subjects factor, and baseline as the covariate.

Materials

Self-construal prime. To manipulate participants' self-construal, the method developed by Gardner et al. (1999) was used. The participants were presented with one of two versions of a set of passages on paper (see Appendix A). The passages were taken from a recent study by Oyserman and colleagues (2009). The two versions of the priming passages differed only in

respect to the pronouns, such that the independent version of the passages contained only first person singular pronouns (i.e. "I" and "me"), while the interdependent version of the passages contained only first person collective pronouns (i.e. "we" and "us"). The participants were asked to circle all of the pronouns found in the passage.

CRA problems. To assess participants' tendency to solve creative problems through insight, a subset of the CRA problems developed by Bowden and Jung-Beeman (2003) was presented on a computer screen. Only the CRA problems that were solved by 50% of participants or more in the original study were used (see Appendix B). This left a subset of 60 CRA problems from which 50 were randomly selected for use in a given testing session (5 practice, 15 baseline, and two post-prime sections of 15 CRAs).

Twenty-statements-task. The twenty-statements-task (TST; Kunn & McPartland, 1954) is a qualitative measure of self-construal that was administered to the participants at the end of the testing session as a manipulation check of the self-construal prime. This task required participants to answer the question "who am I?" with twenty different answers on a sheet of paper. This task has been used in previous research to measure how people regard their sense of self by using a standard coding scheme to measure relative amounts of independent and interdependent self descriptions (Gardner et al, 1999). Responses were coded as independent if they describe a personal attribute (trait, ability, physical descriptor, or attitude—e.g., "I am smart"), and as interdependent if they describe a role in a relationship (e.g., "I am a daughter") or membership in a social group (e.g., "I am an American citizen").

Self-construal scale. The self-construal scale (SCS; Singelis, 1994) is a quantitative measure of self-construal that was administered after the TST as an additional manipulation check. The SCS is made of 2 subscales that measure feelings and attitudes comprising

independent and interdependent self-construals as separate dimensions. The SCS consists of 30 items that are answered on a 7-point Likert type scale from 1 = *disagree strongly* to 7 = *agree strongly*, half of which measure attitudes associated with the independent self-construal, while the other half measures attitudes associated with an interdependent self-construal. The SCS and scoring instructions are provided in Appendix C. Though the SCS has been shown to posses adequate internal reliability, construct validity, and predictive validity, intercorrelations between this quantitative measures and the qualitative measure of TST has been shown to be low (Grace & Cramer, 2003). Thus it may be necessary to use both to adequately measure the priming manipulation.

Relational-interdependent self-construal scale. The relational-interdependent self-construal (RISC) scale is another quantitative measure specific to the type of interdependent self-construal more prevalent in Western cultures (Cross, Bacon, and Morris, 2000). RISC is when the self is viewed in relation to a person's relationships, and this is different from the collectivist interdependent self-construal—when the self is viewed in relation to broader group membership—which is more prevalent in Eastern cultures. The RISC is comprised of 11 items are answered on a 7-point Likert type scale from 1 = *disagree strongly* to 7 = *agree strongly* (See Appendix C). Because RISC scale was designed as a response to some of the shortcomings of the SCS in that it is a more culturally specific, it was administered after the SCS in hopes that it might be a better measure of the priming manipulation.

Biographical questionnaire. After all the tasks were completed, the participants were asked to fill out a paper questionnaire. The purpose of the questionnaire was to assess the level of acculturation of the participant. The questionnaire asked the participants their country of origin, their nationality, the ethnicity they identify with, their first language, what languages they

speak, number of years lived in America, lived abroad, and whether they consider themselves multi-cultural or not.

Procedure

After filling out the informed consent, participants were instructed on how to make insight judgments using standard language developed by previous researchers (Kounios et al., 2008). Insight was explained to participants as occurring when the solution pops into awareness suddenly (i.e., an "Aha!" moment), as opposed to resulting from deliberate, conscious effort. The participants were further told that they might not be sure how they came up with the answer when insight occurs, but they should be relatively confident that it is correct without having to mentally check it, as though the answer came into mind all at once. They were told that the feeling does not have to be overwhelming, but should resemble what was just described. The experimenter further discussed insight with the participant until a common understanding was accomplished.

The experimental session consisted of three sections of CRA problems presented on a computer screen. At the beginning of the first section, the participant was instructed on how to solve the CRA problems followed by 5 practice problems. For each CRA problem the participant indicated by button press that they were prepared to begin working on a problem, thereby initiating the display of a CRA problem. For each problem (e.g., pine, crab, sauce), participants attempted to produce a solution word (e.g., apple) that could be combined with each of the three problem words to form a common compound or phrase (pineapple, crabapple, applesauce). The participants were given 30 seconds to come up with a solution for each CRA problem. When participants achieved a solution, they made an immediate button press indicating that they had solved the problem. This was so that response time could be recorded.

Then the participants were asked to type the solution. Finally, the participant pressed one of two buttons to indicate whether or not the solution had been achieved by insight. After a 2-s inter-trial interval, a "Ready?" prompt appeared; when ready, participants initiated the next trial with a button press.

The participants were instructed to complete the first section of 15 CRA problems. After finishing the first section, the participants were instructed to complete the first page of paper packet, which contained the first self-construal prime. Once finished, the participant initiated the second section of 15 CRA problems. After finishing the second section, participants filled out the second page of the paper packet that contained the second prime (same prime type but with a different passage). Self-construal primes were re-administered between CRA sections because prior research has indicated that these priming manipulations have a small effect size (Oyserman & Lee, 2008). As a further manipulation to see how transient self-construal priming is, half of the participants received a third self-construal prime prior to starting the self-construal manipulation checks. This allowed for the comparison of SCS measures of participants primed directly before the self-construal measures, with those that received the final prime before the last CRA section.

Once the participants finished all the CRA sections on the computer, they were instructed to complete the remaining pages of the paper packet, which contained all the post-test manipulations checks (i.e. TST, SCS, and RISC) along with the biographical questionnaire. Once all the participants in an experimental session completed all the tasks, they were debriefed as to the nature of the experiment and dismissed.

Results

Baseline

To control for individual and group differences at baseline, all the dependent measures were analyzed using a mixed model ANCOVA with baseline measures as the covariate. To ensure that there were no between group differences at baseline, a MANOVA was conducted on all the dependent measures using priming condition as the fixed factor. Results from this overall analysis indicate no significant group differences at baseline, $F(3, 119) = 0.291, p = 0.83$, and effect size measures indicate that only 0.7% of the overall variance in the dependent measures could be attributed to priming condition, $\eta_p^2 = 0.007$. Planned comparison one-way ANOVAs for each dependent measure confirmed the results obtained in the MANOVA: solving accuracy, $F(1, 129) = 0.02$, $p = 0.90$; response time, $F(1, 121) = 0.01$, $p = 0.93$; proportion insight solutions, $F(1, 129) = 1.51$, $p = 0.22$.

Solving Accuracy

Figure 2 depicts the covariate-adjusted means of the solving accuracy for the interdependent and independent primed participants as a function of test section. Overall, independent participants solved a higher proportion of CRA problems than did the interdependent participants. Additionally, it appears that participants' performance on the CRAs improved across sessions, regardless of the priming condition.

These impressions were confirmed by the ANCOVA, which revealed a main effect of prime condition, $F(1, 129) = 4.25, p = 0.04$, $\eta_p^2 = 0.032$. On average, participants primed with an independent self-construal prime solved a higher proportion of CRA problems ($M = .51$, $SE=$

.01) than participants primed with the interdependent prime (M = .47, SE= .01). There was also a main effect of post-prime section, F (1, 129) = 4.46, p = 0.04, η_p^2 = 0.034. Participants solved

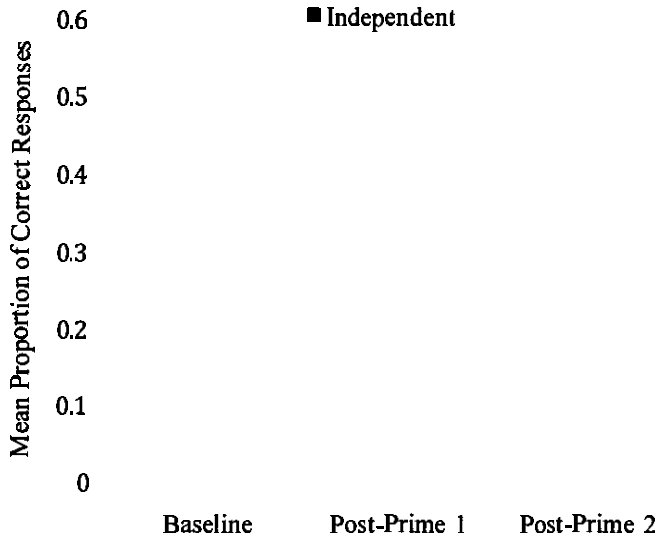

Figure 2. Solving accuracy of prime group across test section.

more problems during the second post-prime section (M= .50, SE= .01) than during the first post-prime section (M =.49, SE= .01) indicating general improvement for both groups across post-prime conditions. However, the interaction of prime condition and post-prime section did not reach significance F (1, 129) = 0.01, p = 0.90, η_p^2 = 0.00. Because the CRA problems may be solved either analytically or via insight, the difference in accuracy does not, in and of itself, indicate that the independent prime facilitates insight problem solving all together. However, were the prime to facilitate creative problem solving ability without affecting the problem solving process (as measured by insight), this pattern of results would be consistent with the prediction that independent priming leads to divergent thinking (Wiekens & Stapel, 2008) that facilitates CRA problem solving. Thus, the analysis of the proportion of solutions achieved via insight (see below) will aid the interpretation of these accuracy differences.

To see if priming significantly affected problem solving performance compared to baseline, planned comparisons of mean baseline accuracy to the mean solving accuracy across the two post-prime sections were conducted for each prime group separately. Though neither the paired sample *t*-test for the independent group nor the interdependent group reached significance, $t(64) = -1.15, p = 0.26$ and $t(65) = 1.23, p = 0.22$ respectively, both group's pre- and post-prime means showed a trend in the predicted direction. The independent post-prime mean ($M = .51$, $SD = .02$) was above their baseline mean ($M = .49$, $SD = .02$), while the interdependent post-prime mean ($M = .48$, $SD = .02$) was below their baseline mean ($M = .50$, $SD = .02$). The small effect size of prime condition revealed by the ANCOVA above may explain why these tests did not reach significance, since self-construal priming can only account for 3.2% of the overall variance in the accuracy scores.

It is possible that these differences are due to a difference in effort, such that participants may have simply attempted more or less problems, thereby altering the likelihood that a correct solution is achieved. To see if the accuracy results were due to a change in the number of problems attempted, indicative of a change in effort by the participant, a final ANCOVA was conducted on the number of problems attempted regardless of accuracy (i.e. excluding all cases in which the participant timed out before generating a solution). The analysis revealed no main effect for prime condition, $F(1, 129) = 1.22$, $p = 0.27$, no main effect of post prime section, $F(1, 129) = 0.98$, $p = 0.32$, and no significant interaction, $F(1, 129) = 0.05$, $p = 0.83$. These results indicate that the between group difference in solving accuracy was not related to differences in the number of problems attempted.

Response Time

Computer failure resulted in the loss of response time data for 6 participants. Figure 3 depicts the covariate adjusted average median response times to correct solutions of the remaining 125 participants. In the figure it appears that the response time for the independent participants decreased from the first to second post-prime section, while the interdependent participants show an increase. However, the ANCOVA did not reveal a main effect for prime condition, $F(1, 123) = 0.015, p = 0.90$, nor a significant interaction, $F(1, 123) = 0.80, p = 0.37$, but a significant main effect for post-prime section, $F(1, 123) = 12.91, p < .001$, $\eta_p^2 = 0.096$.

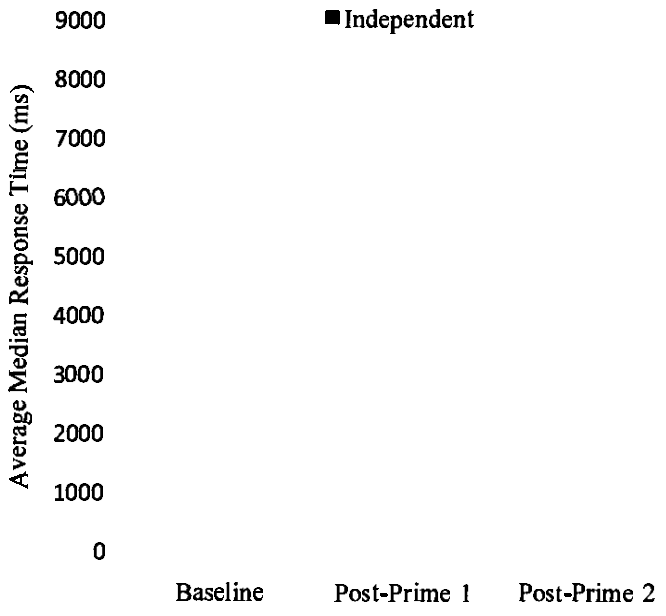

Figure 3. Response time for prime group across test section.

Participants average median response times increased from the first post-prime section (M = 7234.82, SD= 208.64) to the second post-prime section (M= 7397.70, SD= 280.15) indicating an overall increase in solving speed. To tease apart some of these results, and to see if priming significantly affected response time compared to baseline, planned comparison of average

median baseline response time to the average median response time across the two post-prime sections were conducted for each prime group separately. Neither paired sample *t*-test reached significance: $t\,(61) = 0.80, p = 0.43$ for the independent group, and $t\,(62) = 1.91, p = 0.06$ for the interdependent group. Further, both the independent and interdependent groups showed decreases in mean response time from baseline (from $M = 7640.93$, $SD = 3606.12$ to $M = 7275.67$, $SD = 2424.10$, and from $M = 8168.93$, $SD = 3369.99$ to $M = 7355.81$, $SD = 2509.57$, respectively).

Insight Solutions

The primary dependent measure assessing insight was the proportion of correctly solved problems on which the participants reported arriving at the solution via insight. ANCOVA of this measure revealed that there is no main effect of prime condition, $F\,(1, 129) = 0.023$, $p = 0.88$, no main effect of post-prime section, $F\,(1, 129) = 3.34$, $p = 0.07$, and no interaction, $F\,(1, 129) = 0.007$, $p = 0.93$. However, careful examination of the data revealed that this lack of effect may be due to the fact that participants were not distinguishing between insight and non-insight solutions; certain participants reported solving all of the CRA problems via insight. By excluding participants that reported solving all of the problems via insight on two or more sections of CRA problems, the data from 41 participants were removed from the analysis. Figure 4 depicts the covariate adjusted means for the remaining 90 participants. As shown in Figure 4, it appears that the independent group showed a decrease in the proportion of solutions arrived at via insight, while the interdependent group showed an increase. However, ANCOVA revealed no main effect of prime condition, $F\,(1, 88) = 0.35$, $p = 0.56$, no main effect of post-prime section, $F\,(1, 88) = 1.44$, $p = 0.23$, and no interaction, $F\,(1, 88) = 0.39$, $p = 0.54$. These

results suggest that self-construal priming had no measurable impact on problem solving approach as measured by self-report measures of the insight experience.

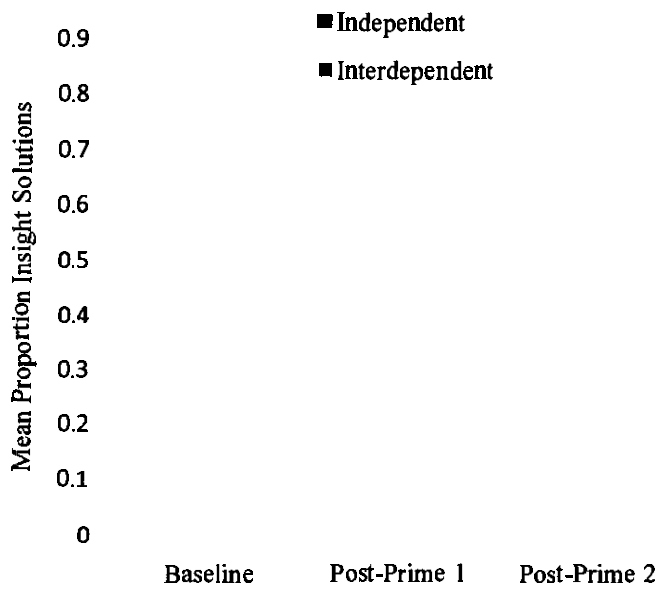

Figure 4. Proportion insight solutions for prime group across test section.

Planned comparisons of mean baseline proportion of insight solutions to mean proportion of insight solutions across post-prime sections were conducted for each prime group separately to see if there was a change in proportion from baseline. Though the independent group showed a decrease from baseline (M= .76, SD= .19) to post-prime (M= .71, SD= .20), this difference did not reach significance, t (40) = 1.45, p = 0.15. The interdependent group showed a slight increase from baseline (M = .70, SD= .20) to post-prime (M = .71, SD= .19), but this too did not reach significance, t (48) = -0.33, p = 0.74.

Post-Test Measures

To examine the efficacy of the priming manipulation and the transience of this effect, each of the three post-test self-construal measures were analyzed with separate ANOVAs, using

priming condition and number of primes (two or three) as fixed factors. The means used in these analyses are shown in Table 2. Because eleven participants did not complete the TST properly (they either left it blank, or answered using the same response repeatedly), they were excluded from the analyses, leaving 120 participants. Further, because the TST score was the proportion of responses that were either interdependent or independent, the TST score for either self-construal level is one minus the TST score of the other self-construal level. Thus, only the interdependent TST score was used for analyses because the scores are redundant. Table 2 illustrates that each of the quantitative manipulation check measures (i.e. the two SCS subscales and the RISC) followed a consistent pattern, suggesting that having an additional prime prior to the manipulation checks led to lower scores on each of these measures.

Dependent Variable	Prime Condition	Primes	Mean	Std Error	95% Confidence Interval	
	Interdependent	3	0.52	.043	0.43	0.60
TST		2	0.52	.048	0.43	0.61
Interdependent	Independent	3	0.43	.044	0.34	0.52
		2	0.51	.046	0.41	0.60
	Interdependent	3	4.72	.109	4.50	4.93
SCS		2	4.98	.120	4.74	5.22
Interdependent	Independent	3	4.69	.112	4.47	4.91
		2	4.94	.116	4.71	5.17
	Interdependent	3	4.87	.112	4.64	5.09
SCS		2	5.31	.124	5.07	5.56
Independent	Independent	3	5.15	.115	4.92	5.38
		2	5.16	.119	4.92	5.39
	Interdependent	3	5.19	.151	4.89	5.49
RISC		2	5.35	.167	5.02	5.68
	Independent	3	5.03	.156	4.72	5.34
		2	5.67	.161	5.35	5.99

Table 1. Marginal means of self-construal manipulation checks.

ANOVA of the proportion of interdependent TST answers revealed no main effect of prime, $F(1, 119) = 1.32, p = 0.25$, no main effect of prime number, $F(1, 119) = 0.80, p = 0.37$, and no interaction $F(1, 119) = 0.69, p = 0.41$. However, the ANOVAs for each of the quantitative self-construal measures provided confirmed the pattern noticed in Table 2: receiving an additional prime prior to the quantitative measures resulted in lower scores on each of these measures. ANOVA of the SCS interdependent subsection revealed no main effect of prime, $F(1, 129) = 0.02, p = 0.89$, a near significant main effect of the number of primes, $F(1, 129) = 3.68, p = 0.06$, and no interaction, $F(1, 129) = 0.13, p = 0.72$. Similarly, ANOVA of the SCS independent subsection revealed no main effect of prime, $F(1, 129) = 1.08, p = 0.30$, a near significant main effect of the number of primes, $F(1, 129) = 3.84, p = 0.052$, and no interaction, $F(1, 129) = 2.04, p = 0.16$. Lastly, ANOVA of the RISC scale revealed no main effect of prime, $F(1, 129) = 0.08, p = 0.78$, a near significant main effect of the number of primes, $F(1, 129) = 3.57, p = .06$, and no interaction, $F(1, 129) = 1.96, p = .16$. The results from the ANOVAs on the quantitative measures indicate that an additional prime, regardless of type, decreased scores on each of these measures. While this pattern of results does not show congruence between prime type and score on the self-construal measure, previous studies have shown an effect of self-construal prime on a cognitive task without showing effects on the self-construal measures (Oyserman & Lee, 2008).

The TST measure, however, shows a pattern of means that is more congruent with prime condition, especially when participants received a third prime. Thus, a final comparison of mean TST interdependent scores was conducted between prime groups, but including only participants that received a third prime prior to the post-test measures. Though the difference did not reach significance, $t(62) = 1.804, p = .18$, the mean scores were consistent with prime condition, such

that the interdependent group had a higher mean score than the independent group (M = .52, SD = .05 and M = .43, SD= .05 respectively).

Discussion

The goal of the current study was to assess the effects of self-construal priming on insight problem solving. Overall, participants receiving the independent prime solved more of the CRAs. However, the expected effect of prime on self-reported use of insight did not emerge: there was no effect of self-construal prime on the proportion of solutions achieved via insight. There are several interpretations consistent with this mixed pattern of results: 1) The self-report measure of insight was not reliable enough to capture the effect of self-construal prime on problem solving process. 2) The effect of the independent prime on solving accuracy reflects an increase in the ability to solve insight problems without altering the solving process used by the participant. 3) The positive effect of the independent prime on solving accuracy may reflect a motivational effect of the prime on insight problem solving ability.

Analysis of the proportion of insight solutions provides support for the first interpretation. The proportions of insight solutions obtained in the current study were well above the proportions obtained in previous research using CRA problems, which have indicated that participants achieved solutions via insight about half of the time (Subramaniam et al., 2009; Kounios, et al., 2006). Thus, it is possible that participants were not distinguishing between insight and non-insight solutions, leading to the disproportionally high rates of insight solutions. Support for the other two interpretations comes from findings yielded in the self-construal literature.

Self-Construal and Creativity

Wiekens and Stapel (2008) demonstrated that self-construal priming influences performance in a divergent thinking task, such that independent (vs. interdependent) priming led to more diverse answers when participants were asked to generate examples of a category. Their study was based on findings showing that independent priming is associated contrastive self to other comparisons, or a differentiation mindset, while interdependent priming is associated with assimilating the self with others, or an integration mindset (Stapel and Koomen, 2001). The authors claim that thinking of the self as individualized and different leads to thinking "different," and that this is an important process for the generation of creative thought (Wiekens & Stapel, 2008). Wiekens and Stapel (2008) further propose that this effect may explain why individuals working alone are better at coming up with more unique ideas than people working in groups, giving applicability to the theorized connections between self-construal and creative thinking.

The solving accuracy from the present study support this theory in as much as solutions to CRAs are a measure of divergent thought, and suggests that insight problem solving is another domain of creative thought that is influenced by self-construal manipulations in a manner similar to how it affects the generation of divergent ideas. However, results from the analysis of the proportion of insight solutions indicate no effect of self-construal prime. This suggests that CRA solving accuracy is a more reliable measure of creativity than self reports of insight solutions, or that the independent self-construal may be associated with overall insight problem solving performance without influencing the underlying process involved.

Assuming that performance on CRA is a more reliable measure of creative problem solving than self reports of insight solution, the findings from the present study provide some support to the idea that the independent self is associated with creativity. The role of the independent self in creativity comes from findings revealed by studies that have examined self-construal in relation to creative and conforming behaviors. For instance, Ng (2003) used structural equation modeling (SEM) to examine the relationship between culture, self-construal, and creativity and conformity measures. The researcher showed that collectivist cultures, through activation of an interdependent self-construal, increases motivations for conformity to others, while individualistic cultures activate an independent self-construal which increases motivations to be creative and different in relation to others. Further, these assocations predicted scores on the Torrance Test of Creative Thinking (Torrance, 1974), giving the model good statistical fit (Ng, 2003). The results from the SEM reflect the findings from the divergent thinking research, suggest that creativity and conformity are inversely related to each other, and indicate that self-construal level impacts creativity and conformity measures in opposite ways.

While the results from the present study provide some support to the findings yielded from the self-construal and creativity research, the degree to which this line of research informs the underlying mechanisms involved is yet undertermined. The differentiation mindset provides a good theoretical explanation as to why the independent self engages in thinking that is related to creative solutions, but it provides relatively inadequate explanation for the underlying cognitive processes involved. The lack of a mechanistic explanation provided by this line of research leaves open the possibility that there may be motivational factors at play.

Self-Construal and Motivation

One of the most well established lines of self-construal research examines the impact of self-construal priming on social motivations and values. Because of the inherently social nature of self-construal (Brewer & Gardner, 1996), this line of work has had great success in revealing specific ways that self-construal level interacts with other intrapersonal factors to explain complex social dynamics (Lalwani & Shavitt, 2009), and also provides additional explanations for the results of the present experiment. A recent investigation of the effect of self-construal priming on self-presentational goal activation demonstrated that independent priming led to increased self-deception enhancement (a form of socially desirable responding that presents an inflated view of one's capability and intelligence), while interdependent priming increased impression management (a form of socially desirable responding that presents oneself as normatively appropriate; Lalwani & Shavitt, 2009). Interestingly, the researchers demonstrated that the self-deception enhancement associated with independent priming improved performance on a test of general knowledge (Trivial Pursuit questions), but not if the participants had the opportunity to self-affirm their self worth, which reduced the motivation for self-presentational goal pursuit (Lalwani & Shavitt, 2009). Though the researchers did not systematically control for intelligence, these findings suggest that the motivations activated by self-construal priming are strong enough to affect performance on knowledge based tests, which highlights another potential factor that may be at play in the current experiment. Thus, it could be that the motivation to appear competent and intelligent associated with independent priming was underlying the increased solving accuracy over the interdependent group. Though this interpretation is not supported by analyses of the number of CRA problems attempted (assuming that an increased motivation would lead participants to attempt more problems), it still points to

the possibility that more macro-level social emotive processes can mediate the effects of self-construal priming on tests of cognitive performance. Thus, looking at interactive roles of other complex social motivations as mediators of self-construal priming on insight problem solving is a promising direction for future work.

Self-Construal and Cognition

Regardless of whether the pattern of current results is attributable to effects of the independent prime on motivation or on "undetectable" processes involved in insight problem solving, the results from the present study are inconsistent with the larger body of work that has examined the role of self-construal in various cognitive domains. This body of work has suggested that the independent self is associated with a focused, context-independent mode of thinking, while the interdependent self is associated with more diffuse, context-dependent thinking (Kuhnen, et al., 2001). Because insight research has demonstrated that diffuse (vs. focused) attention is related to insight (Kounios et al., 2008), the self-construal and cognition studies predict that the interdependent, rather than the independent prime would facilitate insight problem solving. Despite this discrepancy, there are a few interpretations regarding the role of attention that can explain why the results of the present study do not match the findings from previous work.

Self-construal and attention. Based on results showing how the interdependent self-construal is more sensitive to context, it was assumed that being able to process various contextual elements implies diffuse attention. However, closer examination of the methods employed in these studies indicates that the scope of attention required for these experiments is largely constrained by the experimental stimuli used. In the perceptual studies, participants were responding to relatively small visual stimuli, making unnecessary the need for a wider attentional

capacity to perceive all the local elements at once. For example, the studies of Kuhnen and colleagues (2001) used test stimuli that were presented to the participants on paper, presumably small enough to preclude the need for a diffuse attention state. Even in the causal reasoning studies, the attentional capacity was constrained to giving judgments about only two causes, making it easy to attend to both (Kim et al., 2007).

Thus, one possible reason why the results of the present study do not support findings from the self-construal and cognition may be due to the fact that self-construal does not affect attentional capacity per se, but how attended information is processed: synthetically or analytically. This interpretation reconciles the notion of context dependence/independence as suggested by the cognition researchers, with the notion of integration/differentiation mindsets as proposed by Stapel and Koomen (2001). Put differently, it is that the interdependent self is associated with the binding or synthesizing of whatever information is presented, whether it is visual or conceptual, rather than a wider attentional net. Conversely, the independent self is associated with the differentiation of available information, visual or otherwise, rather than a sharpened attentional focus. Moreover, while many of the findings from the previous research can be explained by either theoretical explanation, adding the construct of attention does not add to the explanatory power of how self-construal impacts cognition.

This interpretation can explain the results obtained in the current study. During the presentation of each CRA problem, three target words are presented to the participant at once. If the above interpretation is correct, then the interdependent primed participants may be more prone to relating the target words to each other, rather than discriminating a novel solution word that relates to each target word in a distinct and unrelated manner. While this error was not analyzed systematically in relation to priming condition, post-test verbal reports of participants

and inspection of incorrect solutions indicates that some participants were relating the target words rather than finding a unique solution.

Correlational support for this interpretation also comes from a variety of studies that show how the interdependent self-construal is associated with the inability to decompose the contextual elements into their constituent parts (see Nisbett & Masuda, 2006, for a review). Additionally, one of the core assumptions of self-construal theory is that the interdependent self-construal is associated thinking in terms of interconnectedness, while the independent self-construal is associated with thinking in terms of disconnect from others. This new interpretation thus provides explanation for the results yielded from the present study, without detracting from interpretations of previous results found in the self-construal and cognition literature.

CRA problems. Further investigation of the source of difficulty in CRA problems offers another explanation as to why the results of the present study seemingly go against the self-construal and cognition literature, and opens the possibility for an advantage of the interdependent prime on a task that requires synthesizing problem information. Such is the case with the original remote associates test (RAT) developed by Mednick (1962). RAT problems consist of three target words that are associated with a single solution word, but unlike the CRAs, the association between the target and solution is not limited to linguistic morphology. Associations between targets and solution in the RAT can also be based on synonymy, semantics, or by some other relation, consequently making them ill-defined in terms of a sufficient solving strategy that could be used for every problem. CRA problems were developed based on the RAT, but as an attempt to constrain the types of associations allowable between targets and solution in order to disambiguate a unique, one word solution, and to make for a problem set that is well-defined in terms of an analytic solving strategy (Bowden & Jung-

Beeman, 2003). In doing so, however, they developed a task that possibly requires context independence in the processing of association types.

Semantic associations between words are generally based on some meaningful connection relating the two concepts (e.g. banana is associated with yellow because bananas are yellow), however the rules of English morphology work more as a discrete combinatorial unit system in that the combination of two words into a compound word can create a word with a completely new meaning (e.g. a hushpuppy is neither a 'hush' nor a puppy). Though it is not always the case that the two words comprising a compound word are unrelated, the rules allowing for their combinations are different from rules of semantic association. For CRA problems, this means that the solver must use one type of association, rather than allowing the target words to trigger any and all types of associations, most of which would work against the solution. This interpretation is in line with the cognition literature that associates focused processing with independent priming, and is supported by research that has shown that independent self-construal is associated with the ability to filter out processes irrelevant to the task at hand (Hannover, Pohlmann, Springer, & Roeder, 2005). This interpretation explains the solving accuracy findings with a processes oriented explanation, and makes a prediction for the interdependent prime as a facilitator of the processes required by the RAT. Because solving RAT problems does not require processing of any specific type of relationship, the interdependent prime might perform better on these tasks than the independent prime.

Task Demands

Another possible reason for the apparent discrepancies between the findings yielded from the cognition and creativity lines of research is the type of dependent measures examined by each group of researchers, and the processes they were used to infer. The cognitive studies of

self-construal generally used analysis of tightly controlled quantitative behavioral measures (e.g. RT and solving accuracy) to infer how information was being processed as input. Using the perception studies as an example, quicker response time to a local (vs. global) letter was used as support for showing that the participant had a bias toward perceiving the local element of the compound letter (Lin & Han, 2009). However, studies of creativity used analysis of qualitative measures from behavioral output as indices of the creative processes involved in the generation of creative ideas (Wiekens & Stapel, 2008). Thus, comparing the results from these two lines of research is confounded by the stage of information processing that is being examined, and does not preclude the idea that self-construal priming has qualitatively different effects on input and output processes. The differential effects self-construal priming on perception and behavior is exemplified by the fact that independent self-construal priming leads to self-evaluations that emphasize differences and distances from social others (Gardner et al., 1999), while the same priming leads to a projection of presentational effects towards social others in behavioral studies (Lalwani & Shavitt, 2009). In terms of the present study, the CRA problems provided a more controlled and easily quantifiable measure than what was used in previous self-construal and creativity studies, yet the task is still output oriented since participants were required to generate solutions to problems. This makes it difficult to compare our results to some of the more traditional studies of self-construal and cognition.

This explanation also sheds light onto the relative difficulty of the task used in the present study compared to previous self-construal and cognition studies. While it could be argued that Kim's et al. (2007) self-construal and causal reasoning study is an example of a higher order cognitive process that was influenced by self-construal priming, the task in their study required the participants to make simple judgments based on passive viewing of causal scenarios.

Compared to solving CRA problems, causal reasoning judgments potentially require much less mental effort, and are unconstrained by the necessity of a correct response.

The relative difficulty of CRA problems may explain the small effect sizes obtained in the present experiment. Though there were no floor effects to indicate that the CRAs were too difficult to obtain group differences, it still is possible that the difficulty of the task overpowered any effect of priming. Further, a recent meta-analysis of self-construal priming studies showed that the pronoun circling priming technique used in the present study has moderate to low effect sizes, on average, in studies of cognition ($d \leq 0.5$; Oyserman & Lee, 2008). However, inspection of the cognition studies used for this component of the meta-analysis revealed that most of the studies were either studies of the effects of priming on perception that have been reviewed here, or studies looking at the impact of priming on social cognition tasks (see Appendix A in Oyserman & Lee, 2008). Though social cognitive processes may be more complex than basic perceptual processes, a salient self-construal has more task relevance to, and a stronger, more nuanced effect on social cognition tasks (Stapel & Van der Zee, 2006). Therefore, the small effect sizes obtained in the present experiment may be attributable to the difficulty of the task, and points to the possibility of other socio-emotive processes confounding the effects of self-construal priming.

Future directions

While findings from the present study did not fit any particular self-construal theory completely, the discrepancies between the findings highlighted problems in the literature that need further clarification. For example, current analyses suggest that attention is not an intervening variable that moderates the effects of self-construal priming on cognition. While this seems to go against a large body of established research, careful examination of the constructs

equivocated with attention shows that attentional capacity explanations of self-construal may have been confounding the type of processing with the breadth of processing. Further, examination of the test items indicates that the CRA problems require a different sort of association process that fit in with a context independent explanation of cognition. However, due the relative difficulty of this task compared to other studies of self-construal and cognition, the effect sizes obtained in the current study are fairly small. Possible confounds that may have mediated the observed effects include motivational issues that are powerful enough to improve performance in ways that would otherwise only come from intelligence.

In discussing the how the current research modifies, is explained by, and extends current work in the self-construal literature, the present study also provides a number of directions for future work. One line of work that is lacking in empirical evidence is the degree to which the differentiation-integration paradigm as an explanation of creative performance carries over to other tasks. Further, it is necessary to show the limits and constraints of such a theory, in order to show more specifically how self-construal priming affects cognition. For instance, if the creative task tested involves synthesizing information, would we expect more creativity out of the interdependent prime group? Lastly, there is a necessity for a more operationalized definition of focused and diffuse attention as it pertains to self-construal priming because so much of the research has been based on this assumption. While the current study suggested no role for attention in self-construal priming, it does not rule out the possibility that self-construal cannot modulate attention at a more basic perceptual level.

Conclusion

In summary, the present study demonstrated the influence of self-construal priming on the higher order cognitive domain of insight problem solving. Results provide provisional support for the idea that the independent self is associated with a differentiation mindset that facilitates CRA problem solving ability, while the interdependent self is associated with an integration mindset that work against CRA solving ability. However, analyses of insight solutions do not necessarily confirm this interpretation. Critical analysis of prior self-construal and cognition studies suggests that the attention modulating properties of self-construal priming were not underlying the observed effects, but offer other explanations such as the congruence of processing mindset with processes required by CRA problems. Future work will further examine the congruence/incongruence of self-construal priming effects on prime appropriate tasks to fully outline the role of self-construal on cognition, and to unify the various descriptive explanations that have been proposed as to the nature of self-construal priming effects.

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Appendix A
Self-Construal Priming

From: Oyserman, D. Sorensen, N. Reber, R., & Chen, S. (2009) Connecting and separating mindsets: Culture as situated cognition. *Journal of Personality and Social Psychology 2,* 217–235.

Instructions

Below are two versions of the general task instructions, once for the paper version, and once for the computerized version. Instructions are followed by each of the specific priming paragraphs used in Oyserman, Sorensen, Reber, & Chen. Note that the original prime is the visit to the city version, which is from Gardner and Gabriel, 1999. This paragraph is presented first.

Please read the paragraph on the next page carefully and circle all the PRONOUNS found within the paragraph. The pronouns may be singular (e.g. he, she, etc.) or plural (e.g. they, their, etc). Please take your time.

Please read the paragraph on the next page carefully and click on all the PRONOUNS found within the paragraph. The pronouns may be singular (e.g. he, she, etc.) or plural (e.g. they, their, etc). Please take your time.

Passages

Passage 1

Interdependent. We go to the city often. Our anticipation fills us as we see the skyscrapers come into view. We allow ourselves to explore every corner, never letting an attraction escape us. Our voices fill the air and street. We see all the sights, we window shop, and everywhere we go we see our reflections looking back at us in the glass of a hundred windows. At nightfall we linger, our time in the city almost over. When finally we must leave, we do so knowing that we will soon return. The city belongs to us.

Independent. I go to the city often. My anticipation fills me as I see the skyscrapers come into view. I allow myself to explore every corner, never letting an attraction escape me. My voice fills the air and street. I see all the sights, I window shop, and everywhere I go I see my reflection looking back at me in the glass of a hundred windows. At nightfall I linger, my time in the city almost over. When finally I must leave, I do so knowing that I will soon return. The city belongs to me.

Passage 2

Independent. I love to watch the sunset across the lake. Each night during the summer, I drive my car over to the beach near my house where I relax my body and watch the colors paint the canvas in the sky. I like to bury my hands in the cool sand and stare into the golden ball of fire as it sinks into the water. The heat that warmed my face slowly fades away and leaves my body with a cool chill. The bright colors in the sky above me hurt my eyes but the scene is too beautiful to look away. Slowly, the light fades completely and I am immersed into the growing darkness. As I get up, I brush the sand off my body and think to myself, how fortunate I am to experience such a beautiful site everyday. The night rests upon me and I return home to fall asleep to wait for a new day.

Interdependent. We love to watch the sunset across the lake. Each night during the summer, we drive our car over to the beach near our house where we relax our bodies and watch the colors paint the canvas in the sky. We like to bury our hands in the cool sand and stare into the golden ball of fire as it sinks into the water. The heat that warmed our faces slowly fades away and leaves our bodies with a cool chill. The bright colors in the sky above us hurt our eyes but the scene is too beautiful to look away. Slowly, the light fades completely and we are immersed into the growing darkness. As we get up, we brush the sand off my bodies and think to

ourselves, how fortunate we are to experience such a beautiful site everyday. The night rests upon us and we return home to fall asleep to wait for a new day.

Passage 3

Independent. On summer weekends I like to go to the beach. I bring a blanket and my radio and lots of sunscreen. I always remember to bring my sunscreen. Before I swim I rub it on so my skin won't get burned. When I get to the beach, I set my stuff up quickly. Then I run into the water. I love to swim out to the diving dock and jump off the highest board. I have a small boat and love boating on the lake. After the swim, I love lying on my blanket, and reading a good book or I have some ice-cream. I always have fun at the beach, and I always look forward to another day.

Interdependent. On summer weekends we like to go to the beach. We bring a blanket and our radio and lots of sunscreen. We always remember to bring our sunscreen. Before we swim we rub it on so our skin won't get burned. When we get to the beach, we set our stuff up quickly. Then we run into the water. We love to swim out to the diving dock and jump off the highest board. We have a small boat and love boating on the lake.

After the swim, we love lying on our blanket, and reading a good book or we have some ice-cream. We always have fun at the beach, but we are always tired by the end of the day.

Passage 4

Independent. I get up early in the morning and wash my face with ice cold water. Then I quickly go to the cows, which I have to milk. I gather eggs from my hens, and cook myself a delicious breakfast. There is always a lot work for me to do. I have to clean the pigsty and the cowshed. In the afternoon, I love to take my horse for a ride through the fields. The wind runs through my hair and sometimes I see deer. In the evening I feed all animals again,

before I go inside and make my dinner. My hands and feet hurt a little from the tiring work. When I leave, I am happy but ready for sleep.

Interdependent. We get up early in the morning and wash our faces with ice cold water. Then we quickly go to the cows, which we have to milk. We gather eggs from our hens, and cook ourselves a delicious breakfast. There is always a lot work for us to do. We have to clean the pigsty and the cowshed. In the afternoon, we love to take our horses for a ride through the fields. The wind runs through our hair and sometimes we see deer. In the evening we feed all animals again, before we go inside and make our dinner. Our hands and feet hurt a little from the tiring work. When we leave, we are happy, but ready for bed.

AppendixB

Normative Data on CRA Problems

From: Bowden, E.M., & Jung-Beeman, M. (2003). Normative data for 144 compound remote associate problems. *Behavior Research Methods, Instruments, & Computers*, 35, 634–639.

Remote Associate Items	Solutions	% of participants solving item in 30 sec	mean solution time (ms)	standard deviation
cottage/swiss/cake	*cheese*	64%	10847	7037
cream/skate/water	*ice*	90%	4117	3579
loser/throat/spot	*sore*	82%	6315	4062
show/life/row	*boat*	79%	10300	7224
night/wrist/stop	*watch*	97%	6266	5826
duck/fold/dollar	*bill*	92%	6582	4280
rocking/wheel/high	*chair*	87%	5840	5364
dew/comb/bee	*honey*	100%	4115	2142
fountain/baking/pop	*soda*	92%	5496	3296
preserve/ranger/tropical	*forest*	85%	9733	6075
aid/rubber/wagon	*band*	69%	6510	4620
flake/mobile/cone	*snow*	79%	8684	7020
cracker/fly/fighter	*fire*	85%	6115	3868
safety/cushion/point	*pin*	74%	5001	2839
cane/daddy/plum	*sugar*	97%	5449	4917
dream/break/light	*day*	56%	7906	6722
fish/mine/rush	*gold*	74%	9072	6830
political/surprise/line	*party*	90%	8787	5200
measure/worm/video	*tape*	87%	8364	5236
high/district/house	*school*	74%	8896	7748
sense/courtesy/place	*common*	67%	9245	8108
worm/shelf/end	*book*	85%	6759	6252
flower/friend/scout	*girl*	67%	11427	7702
river/note/account	*bank*	79%	10532	5878
print/berry/bird	*blue*	77%	13236	7940
date/alley/fold	*blind*	85%	7059	5420
opera/hand/dish	*soap*	62%	7920	6450
cadet/capsule/ship	*space*	74%	5459	3956
fur/rack/tail	*coat*	79%	7996	6760
stick/maker/point	*match*	21%	12195	8152
hound/pressure/shot	*blood*	72%	6975	5319
fox/man/peep	*hole*	64%	7059	4796
sleeping/bean/trash	*bag*	82%	6801	6360
food/forward/break	*fast*	82%	7731	5770
shine/beam/struck	*moon*	62%	6167	4932

peach/arm/tar	*pit*	67%	10014	7967
water/mine/shaker	*salt*	85%	7852	3371
palm/shoe/house	*tree*	51%	13895	7899
basket/eight/snow	*ball*	72%	10866	7176
nuclear/feud/album	*family*	85%	9476	5468
sandwich/house/golf	*club*	82%	9098	4955
sage/paint/hair	*brush*	69%	9879	6869
french/car/shoe	*horn*	69%	12583	8708
boot/summer/ground	*camp*	54%	4458	2322
mill/tooth/dust	*saw*	51%	7135	5453
main/sweeper/light	*street*	64%	7696	5648
pike/coat/signal	*turn*	64%	12552	9680
wagon/break/radio	*station*	51%	14568	8773
dress/dial/flower	*sun*	51%	7778	5720
eight/skate/stick	*figure*	59%	5550	4175
down/question/check	*mark*	54%	11351	7099
carpet/alert/ink	*red*	59%	11022	8142
master/toss/finger	*ring*	51%	14676	7167
hammer/gear/hunter	*head*	56%	8132	5185
knife/light/pal	*pen*	62%	9187	7141
way/board/sleep	*walk*	64%	11450	8435
blank/list/mate	*check*	51%	6115	2572
mouse/bear/sand	*trap*	72%	7626	6270
cat/number/phone	*call*	54%	11736	7004
keg/puff/room	*powder*	62%	6436	4326
type/ghost/screen	*writer*	54%	9372	7084
wet/law/business	*suit*	59%	11240	8457

Appendix C

Self-Construal Scale (SCS) and Scoring Instructions

From: Singelis, T. M. (1994). The measurement of independent and interdependent self-construals. *Personality and Social Psychology Bulletin, 20*, 580-591.

INSTRUCTIONS

This is a questionnaire that measures a variety of feelings and behaviors in various situations. Listed below are a number of statements. Read each one as if it referred to you. Beside each statement write the number that best matches your agreement or disagreement. Please respond to every statement. Thank you.

1=STRONGLY DISAGREE	4=DON'T AGREE OR DISAGREE	5=AGREE SOMEWHAT
2=DISAGREE		6=AGREE
3=SOMEWHAT DISAGREE		7=STRONGLY AGREE

____1. I enjoy being unique and different from others in many respects.

____2. I can talk openly with a person who I meet for the first time, even when this person is much older than I am.

3. Even when I strongly disagree with group members, I avoid an argument.

____4. I have respect for the authority figures with whom I interact.

5. I do my own thing, regardless of what others think.

____6. I respect people who are modest about themselves.

____7. I feel it is important for me to act as an independent person.

____8. I will sacrifice my self interest for the benefit of the group I am in.

____9. I'd rather say "No" directly, than risk being misunderstood.

____10. Having a lively imagination is important to me.

____11. I should take into consideration my parents' advice when making education/career plans.

____12. I feel my fate is intertwined with the fate of those around me.

____13. I prefer to be direct and forthright when dealing with people I've just met.

____14. I feel good when I cooperate with others.

____15. I am comfortable with being singled out for praise or rewards.

____16. If my brother or sister fails, I feel responsible.

____17. I often have the feeling that my relationships with others are more important than my own accomplishments.

____18. Speaking up during a class (or a meeting) is not a problem for me.

____19. I would offer my seat in a bus to my professor (or my boss).

____20. I act the same way no matter who I am with.

____21. My happiness depends on the happiness of those around me.

____22. I value being in good health above everything.

____23. I will stay in a group if they need me, even when I am not happy with the group.

____24. I try to do what is best for me, regardless of how that might affect others.

____25. Being able to take care of myself is a primary concern for me.

____26. It is important to me to respect decisions made by the group.

____27. My personal identity, independent of others, is very important to me.

____28. It is important for me to maintain harmony within my group.

____29. I act the same way at home that I do at school (or work).

____30. I usually go along with what others want to do, even when I would rather do something different.

SCORING

The attached scale contains the original 12 independent items (#s 1, 2, 9, 10, 13, 15, 18, 20, 22, 25, 27, and 29) and 12 interdependent items (#s 3, 4, 6, 8, 11, 16, 17, 19, 21, 23, 26, and 28) from Singelis, 1994. Six additional items have been added to improve internal reliabilities of the original scale: independent (#s 5, 7, and 24) and interdependent (#s 12, 14, and 30). Cronbach Alpha reliabilities with the 15 items have been ranging from the high .60's to the middle .70's. It is felt that these reliabilities are adequate considering the broadness of the construct and the wide range of thoughts, feelings, and behaviors assessed by the scale. Items more focused on a single aspect of self would yield higher internal consistency but would threaten the validity of the measure.

To score the scale, add each subject's scores (1 to 7) for the independent items and divide by 15 to give the mean score of the items. Then, do the same for the interdependent items. *Each subject receives two scores*: one for the strength of the independent self and one for the interdependent self. My research has shown that these two aspects of self are *separate* factors, not opposite poles of a single construct. Therefore, each aspect of self needs consideration.

AppendixD

Relational-Interdependent Self-Construal (RISC) Scale and Normative Data

From: Cross, S. E., Bacon, P.L., & Morris, M. L. (2000). The relational-interdependent self-construal and relationships. *Journal of Personality and Social Psychology, 78*, 791-808.

INSTRUCTIONS

Beside each statement write the number that best matches your agreement or disagreement. Please respond to every statement. Thank you.

1=STRONGLY DISAGREE	4=DON'T AGREE OR DISAGREE	5=AGREE SOMEWHAT
2=DISAGREE		6=AGREE
3=SOMEWHAT DISAGREE		7=STRONGLY AGREE

Item	Corrected item/total r
My close relationships are an important reflection of who I am.	0.68
When I feel very close to someone, it often feels to me like that person is an important part of who I am.	0.69
I usually feel a strong sense of pride when someone close to me has an important accomplishment	0.54
I think one of the most important parts of who I am can be captured by looking at my close friends and understanding who they are.	0.64
When I think of myself, I often think of my close friends or family also.	0.63

If a person hurts someone close to me, I feel personally hurt as well.	0.53
In general, my close relationships are an important part of my self-image.	0.69
Overall, my close relationships have very little to do with how I feel about myself.*	0.54
My close relationships are unimportant to my sense of what kind of person I am.*	0.52
My sense of pride comes from knowing who I have as close friends.	0.56
When I establish a close friendship with someone, I usually develop a strong sense of identification with that person.	0.6

Note. $N = 4{,}288$. Response scale ranges from 1 *(strongly disagree)* to 7 *(strongly agree)*.

* Reverse-keyed item