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The Influence of Mood and Motivation on Cognitive Flexibility

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Graduate Program in Psychology
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by

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Abstract

The influence of mood and motivation on cognitive processes has enjoyed a significant amount of attention in the last few decades, but due to inconsistencies in methodologies and tasks conclusions remain subject to debate. The questions addressed in this thesis are how: 1) positive mood, 2) negative mood, and 3) depressive symptoms influence or relate to cognitive flexibility using a category learning paradigm, and the final question addressed in this thesis is whether 4) regulatory focus and regulatory fit influence cognitive flexibility using a more naturalistic categorization task in which there are no correct or incorrect responses. Category learning and categorization tasks provide well-controlled and empirically validated paradigms in which to study the effects of mood and motivation on cognitive flexibility. Chapter 2 demonstrates that depressive symptoms are negatively related to complex rule-based category learning while positive mood is positively related to rule-based category learning, but positive mood and lifetime history of hypomanic symptoms contributed the most unique variance to rule-based category learning performance. Chapter 3 demonstrates that manipulated positive, but not negative, mood enhances performance on a complex rule-based category learning task, but mood does not significantly influence non-rule-based category learning. Chapter 4 demonstrates that a promotion regulatory focus results in higher low typicality exemplar ratings than a prevention regulatory focus, and additionally demonstrates that negative mood accounts for most of this effect. This represents the first series of studies to examine the influence of mood on category learning and demonstrates that positive mood enhances and is positively related to rule-based category learning.

Keywords

Affect; Category Learning; Categorization; Cognitive Flexibility; Individual Differences; Mood; Motivation; Regulatory Focus Theory; Regulatory Fit Theory, Self Discrepancy Theory.

Co-Authorship Statement

The material contained in this thesis has been obtained through collaboration with Dr. John Paul Minda. Portions of Chapter 2 have been published elsewhere and authorship is shared with Dr. Minda, however I was the first author of the paper, and as such I wrote the paper, and analyzed all associated data. Chapter 3 has been published elsewhere and authorship is shared with Dr. Minda and Rahel Rabi, however I was the first author of the paper. Rahel Rabi selected the music and film clips used in Chapter 3 and collected the data for the experiment. Sarah Devantier analyzed the main behavioral results data. Kazunaga Matsuki conducted the computational modeling. I analyzed the computational modeling outputs, prepared the manuscript for publication, and assumed responsibility for the manuscript through the peer review/publication process. The remaining written material in this thesis is solely my own work; however, Dr. Minda provided assistance with regard to the revision of the experimental papers contained in this thesis. As my thesis advisor, Dr. Minda also provided additional assistance in the revision of the general introduction and discussion.

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List of Abbreviations

ACC .... Anterior Cingulate Cortex
AIC .... Akaike Information Criterion
BAS .... Behavioral Activation System
BDI .... Beck Depression Inventory
BIS .... Behavioral Inhibition System
COVIS .... COmpetition between Verbal and Implicit Systems
DLPFC .... Dorsolateral Prefrontal Cortex
ERB .... Easy rule-based
GBI .... General Behavior Inventory
GBI-D .... General Behavior Inventory - Depression
GBI-H .... General Behavior Inventory - Hypomania
GRFM .... General Regulatory Focus Measure
HPS .... Hypomanic Personality Scale
HRB .... Hard rule-based
NRB .... Non-rule-based
PANAS .... Positive Affect Negative Affect Schedule
PFC .... Prefrontal Cortex
PSWQ .... Penn State Worry Questionnaire
RAT .... Remote Associates Test
RB .... Rule-based
RFQ .... Regulatory Focus Questionnaire
WCST .... Wisconsin Card Sorting Test

Chapter 1

1 Motivation, mood, and cognition

Plato distinguished between motivation, mood, and cognition and argued that they were separate, unrelated constructs (as cited by Scherer, 1995). This tripartite model has enjoyed a long-lasting legacy in psychological research. However with the decrease in popularity of the dominant behaviorist tradition (Skinner famously said that "The 'emotions' are excellent examples of the fictional causes to which we commonly attribute behavior", 1953, p. 160), and the rise of cognitive psychology and information-processing models of cognition, the influence of mood and motivation on cognitive processes became more popular topics of study.[1] The decades spanning from the 1980's to the present time have seen tremendous growth in research that studies the interrelationships between motivation, mood, and cognition. It is now generally accepted that these components influence and interact with one another (Gray, 1990; Lazarus, 1991a; Leventhal & Scherer, 1987; Showers & Cantor, 1985; Sorrentino & Higgins, 1986; Storbeck & Clore, 2007).

The idea that motivation, mood, and cognition may be overlapping, and not just related constructs is a more contentious viewpoint. Lazarus (1984) argues that mood cannot exist in the absence of cognition. This is because for mood to exist there must be an appraisal of a situation that informs the individual whether there is the potential for something desirable or undesirable. In this view mood and cognition are interdependent, in that mood can influence cognition, but cognition comes first. Motivation underlies cognition (and therefore also mood), because motivation provides the meaning necessary for a cognitive appraisal of a situation (see Zajonc, 1984 for a rebuttal to this viewpoint).

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[1] It must be noted that there were psychologists, scientists, and philosophers who made advances in the understanding of cognition and mood/motivation prior to the 1980's. For instance Thorndike (1911) included mention of "satisfying" and "annoying" events in his first "law of effect", and William James (1884) published work on emotion. Much earlier than that Aristotle argued against splitting these elements apart (Fortenbaugh, 1975).

The topic of this dissertation is the influence of mood and motivation on cognitive processing in three distinct but related chapters.

1.1 Definitions of mood and emotion

There is no single definition of emotion that is universally agreed upon, in fact Kleinginna and Kleinginna (1981) conducted a survey of texts and related literature and identified 92 definitions that fit into 11 different categories. However, there is overall convergence with the idea that emotions are strong, at times overwhelming affective states that one is consciously experiencing, while moods are less strong, less overwhelming, and not always subject to conscious awareness (Eckman, 1994; Forgas, 1992a; Frija, Mesquita, Sonnemans, & Van Goozen, 1991; Larsen, 2000; Morris, 1989; Panksepp, 1998; Parkinson Totterdell, Briner, & Reynolds, 1996; Watson, 2000). For instance Forgas (1992a) typifies emotions and moods according to their duration, intensity, origin, and cognitive content. He argues that emotions are intense, relatively short-lived, have a definite cause, and clear cognitive content, whereas moods are lower in intensity, longer lasting, without a definite cause, and little cognitive content. In this framework if one is experiencing an emotion one would be able to say “I feel angry/happy/sad”, but when experiencing a mood one would not be as specific and instead would express feeling “bad” or “good”.

A helpful way of thinking about these terms is to picture mood as a background to emotion (Vosburg & Kaufmann, 1999). In this conceptual framework the emotion one is feeling could be either fear or sadness, but the mood would be negative in both cases. Likewise a general positive mood serves as the backdrop to positively valenced emotions such as joy or contentment.

Throughout this thesis I distinguish between mood and emotion to reflect the distinction between mood and emotion as outlined above. This thesis is concerned with general mood states (positive and negative), not specific emotions. This treatment is based on the finding that specific emotions tend to be interrelated such that negative emotions (like fear and sadness) tend to co-occur or be reported more often within individuals, and likewise that positive emotions (like joy and contentment) also tend to be positively related (Diener, Smith, & Fujita, 1995; Feldman, 1995; Watson & Tellegen, 1985). Further, manipulating specific emotional states presents some difficulties, an issue that is described below.

1.2 Mood assessments and manipulations

There is no single standard procedure or paradigm for assessing and manipulating mood in research studies, and even a cursory review of the literature reveals an abundance of measures and methods.[2] In some studies, mood is manipulated and then assessed and compared to a control condition's mood rating to determine if the induction was effective, or assessed, manipulated, and then assessed again to determine if the mood induction significantly changed people's mood relative to their mood at the beginning of the experimental session. Mood and related individual difference variables can also be assessed but not manipulated (typically in correlational research or research where participants are split into different groups based on their responses).

Although methods of manipulating mood are seemingly only limited by one's imagination, a select few mood induction techniques have predominated the literature. One of the oldest is the Velten Mood Induction Procedure (VMIP; Velten, 1968), in which participants read 60 statements out loud that correspond to the desired/intended mood state, such as "Every now and then I feel so tired and gloomy that I'd rather just sit than do anything" to induce a depressed mood. This technique has been criticized for being subject to demand characteristics (Polivy & Doyle, 1980; as cited in Isen & Gorglione, 1983; Buchwald, Strack, & Coyne, 1981; as cited in Isen & Gorglione, 1983). Further, Isen and Gorglione (1983) reported that when mood was assessed immediately after the procedure the results indicated that the manipulation was effective, however

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[2] Rottenberg, Ray, and Gross (2007) describe the multitude of available methods as "a baffling array", p. 10. Methods not included in this discussion include, but are not limited to: affective pictures (Lang, Bradley, & Cuthbert, 2008), autobiographical recall, social recollection, and social interaction (Martin, Argyle, & Crossland, 1990), false success/failure feedback (Isen, Shalker, & Karp, 1978), facial expressions (Laird, Wagener, Halal, & Szegda, 1982), hypnotic suggestion (Bower, 1981; 1983), imagery (Wright & Mischel, 1982), empathy (Thompson, Cowan, & Rosenhan, 1980), and unanticipated reward/gift (Estrada, Isen, & Young, 1994).

after a neutral and brief (four minutes long) task participants no longer rated themselves as feeling significantly more positive or negative, suggesting that this method is not well-suited to most psychology experiments.

Film clips have been shown to be an effective method for manipulating positive and negative mood states (Gross & Levenson, 1995; see also Gerrards-Hesse, Spies, & Hesse, 1994 for a review). In contrast to the Velten Method, Isen and Gorglione (1983) reported that an amusing and brief film clip resulted in significant changes in self-reported positive mood immediately afterwards and after a brief intervening task.

Music-based mood induction techniques, in which participants listen to music that conveys a specific mood state, have been shown to have high success rates (for reviews see Gerrards-Hesse et al., 1994; Martin, 1990). One potential drawback to this method pointed out by Lecci and Wirth (1996) is that it has a limited ability to induce a specific positive or negative mood state. For instance listening to the well-known and frequently used “Russia under the Mongolian Yoke” by Prokofiev at half-speed could make one feel sad, but it could also make one feel irritated. If one is trying to isolate a specific mood it might not be the best method. In some versions of this method participants are told to use the music as a background in which to become depressed (or happy, or neutral as required).

The studies in Chapters 2, 3, and 4 of this thesis assess positive and negative mood using a validated measure, and the study in Chapter 3 manipulates mood. In Chapter 3, I elected to use a combination of music and video clips to elicit desired positive, negative, and neutral mood states. In a review, Martin (1990) reported that film and music clip inductions of mood are effective more than 75% of the time in participants based on a review of published studies. In a meta-analytic review of 11 mood induction techniques and 111 research articles Westermann, Spies, Stahl, and Hesse (1996) concluded that film and music inductions were most effective at eliciting both positive and negative mood states. I hypothesized that a combinatory approach would maximize the probability of an effective manipulation. Further, the combination of music and film clips has also been used successfully in prior research (Bower, 1987; Foti & Hajcak, 2010; Gustafson, 1987; as cited in Gerrards-Hesse et al., 1994).

1.3 Effects of mood on cognition

Research on the interrelationship between cognition and mood has been quite active.[3] Below I outline research related to the influence of mood states on attention and cognitive flexibility.

1.3.1 Positive mood findings

What is known about the influence of positive mood on cognition has been greatly augmented by the work of Alice Isen. Isen and colleagues have demonstrated that mild positive mood, the kind that arises from receiving a small, unexpected gift, watching a funny video, or listening to pleasant music can result in significant changes in performance relative to a neutral mood on tasks tapping cognitive flexibility and problem-solving (see Isen, 1999a for a review). A key finding from this research is that positive mood broadens attention and enhances cognitive flexibility. Cognitive flexibility is defined by Ashby, Isen, and Turken (1999) as the "ability to organize ideas in multiple ways and to access alternative cognitive perspectives" (p. 530).

Isen and Daubman (1984) studied the influence of positive, neutral, and negative mood states on low typicality exemplar ratings taken from Rosch (1975) and a color chip sorting task. Item examples include 'cane' for the category 'clothing', and 'camel' for the category vehicle. Positive mood participants gave higher ratings to these atypical items and were more likely to consider them members of the category than participants in the neutral mood conditions. In the sorting task participants were presented with color chips that ranged along a continuum and instructed to sort them into as many or as few

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[3] Studies reporting the effects of mood on cognitive processes have been reported in several domains, including memory (Bower, 1981; Gray, 2001; Isen et al, 1978; Laird et al., 1981; Schacter, 1996; Storbeck & Clore, 2005; Teasdale & Fogarty, 1979), attention (Frederickson & Branigan, 2005; Gasper & Clore, 2002), decision-making (Estrada, Isen, & Young, 1997; Johnson & Tversky, 1983; Wright & Bower, 1992), social judgment (Huntsinger, Sinclair, & Clore, 2009; Isbell, 2004), and creativity (Isen, Johnson, Mertz, & Robinson, 1985).

categories as they wanted. Positive mood participants created fewer categories than neutral mood participants, meaning they included a wider range of colors in their categories. Isen, Johnson, Mertz, and Robinson (1985) reported that participants who underwent a positive mood induction made significantly more unusual (less common within the sample studied) word associates than neutral mood participants to neutrally valenced words. Isen, Daubman, and Nowicki (1987) reported that positive mood participants were more likely to solve the Duncker candle problem (Duncker, 1945), and to solve more moderately difficult problems from the Remote Associates Test (RAT; Mednick, 1968) than neutral mood participants.

Murray, Sujan, Hirt, and Sujan (1990) demonstrated that positive mood leads to more flexible category use using a task similar to that used by Isen and Daubman (1984). Participants were asked to sort cards with the names of popular television show characters on them. Positive mood participants were able to generate more distinct categories when instructed to focus on differences, but also generated fewer categories when asked to focus on similarities compared to a neutral mood control group. The groups did not differ on the task when instructions did not make reference to similarities or differences. In a second study participants were asked to focus on similarities or differences between pairs of television shows. The uniqueness of the features listed by participants was rated in addition to the number of distinct attributes listed. Positive mood participants listed more features when asked to focus on differences, fewer features when asked to focus on similarities, and overall made more unusual responses than participants in a neutral mood. Positive mood participants were also more likely than neutral mood participants to make a creative first response. Finally in a third experiment the authors did not limit the time allowed to make categorizations and while positive and neutral participants made the same number of categorizations, the categorizations made by positive mood participants were rated as more creative and this difference in creativity persisted throughout the task, indicating that positive mood participants were creating more creative features from the beginning of the task and not simply when they had exhausted more typical responses.

More recently Fredrickson and Branigan (2005) reported that participants in specific positive emotion conditions were more likely to classify based on overall similarity than neutral emotion participants on a global-local triad classification task, indicating that positive emotions broaden attention, providing converging evidence for the effects of positive moods and emotions. However in contradiction to this Gasper and Clore (2002) reported a similar study but found no difference between positive and neutral mood conditions. Johnson, Waugh, Frederickson (2010) reported that genuine smiles were associated with faster responses to global stimuli relative to local stimuli, again suggesting that positive mood broadens attention, but their experimental mood manipulation did not result in any differences between conditions. Baumann and Kuhl (2005) reported that positive mood led to improved performance on a similar global-local processing task. However instead of simply asking participants to judge which stimuli were more similar (as in Frederickson & Branigan, 2005, and Gasper & Clore, 2002), participants were asked to make global responses on some trials and local responses on others, requiring participants to shift their attention between the two responses. Positive mood participants displayed faster reaction times than participants in a neutral mood on local trials even though participants overall made faster responses to global trials, indicating that positive mood allowed participants to shift their attention between trials more flexibly.

There is also evidence that positive mood enhances careful thinking when needed. Physicians who received a small gift performed better on a clinical diagnostic reasoning task than physicians who did not receive a small gift. Specifically, physicians in whom positive mood was induced solved the case faster, were more flexible (i.e. demonstrated less anchoring), but did not show evidence suggesting that they made their decisions using superficial processing (Estrada et al., 1997).

The research reviewed above makes a strong case for the idea that positive mood broadens attention and enhances cognitive flexibility. In light of these results it is tempting to surmise that positive mood has an overall beneficial impact on cognitive processing. However several studies demonstrate that the impact of positive mood on cognitive processing is not universally beneficial. In a review of the extant literature

Mitchell and Phillips (2007) conclude that positive mood has a detrimental influence on executive functioning.

Spies, Hesse, and Hummitzsch (1996) reported that a positive mood manipulation resulted in impaired working memory ability using simple and complex word span tasks. Positive mood participants showed greater impairment on the complex span task compared to neutral mood participants. Oaksford, Morris, Grainger, and Williams (1996) reported that a positive mood manipulation resulted in reduced performance on a variant of the Wason card selection task, as well as performance on the Tower of London task, two tasks requiring convergent thinking. In contrast Phillips, Bull, Adams, and Fraser (2002) reported that positive mood participants were only impaired on the Tower of London task when participants were older, in young adults performance was not impaired. Phillips et al. (2002) reported that positive mood participants were slower than neutral mood participants on a complex Stroop task that required alternating between reading the color name and naming the display color, but were unimpaired on a classic Stroop task that did not require alternation. On fluency tasks, positive mood participants outperformed neutral mood participants when asked to list as many unusual uses for a cup as possible, but performed equivalently to the neutral mood condition on a letter fluency task and an alternating task in which participants were asked to alternate between listing words that began with the letter “M” and then naming a type of vegetable. The authors interpret this pattern of results as indicating that positive mood impairs task switching. Finally Dreisbach and Goschke (2004) reported that a positive mood manipulation improved performance on tasks requiring flexibility and switching, but found performance was impaired on a task where previously relevant stimuli served as distractors relative to a neutral mood condition. This indicates that positive mood can enhance switching to novel stimuli, but impair switching when ignoring previously relevant information is required. Overall this research demonstrates that findings on positive mood are complex and varied, but indicate that positive mood might impair certain aspects of executive functioning.

Research by Rowe, Hirsh, and Anderson (2007) neatly demonstrates the benefits and trade-offs associated with broadened attention and enhanced cognitive flexibility. The authors reported that manipulated positive mood improved performance relative to a neutral mood condition on RAT performance. RAT performance correlated negatively with performance on an attentional flanker task that required narrowed visual selective attention. Thus, the better participants did on the RAT, the worse their performance on the attentional flanker task. The distance of the flankers from the target was varied such that on some trials the flankers were spaced close to the target (near distance), on some trials the flankers were spaced less closely to the target (medium distance), and on some trials the flankers were spaced further away from the target (far distance). Positive mood participants responded more slowly than negative and neutral mood participants across all flanker trials, but this effect was strongest on incompatible trials. Further, neutral mood participants did not display effects of flanker compatibility at the far distance, while positive mood participants did.

1.3.2 Remaining questions in positive mood research

What should be clear from the above literature review is that positive mood broadens attention and enhances cognitive flexibility (sometimes at the cost of faster responding when narrowed attention is required). Isen (2001) summarized related research on positive mood by stating that:

> ...as long as the situation is one that is either interesting or important to the decision maker, positive affect facilitates systematic, careful, cognitive processing, tending to make it both more efficient and more thorough, as well as more flexible and innovative. (p. 75)

However some researchers have argued that positive moods detract from careful, systematic processing (Bless, Bohner, Schwarz, & Strack, 1990; Mackie & Worth, 1989; Schwarz & Clore, 1983). Mackie and Worth (1989) argue that positive mood acts as a cognitive load that reduces either the ability or the motivation to engage in careful, systematic processing and fosters the use of low effort heuristics. Bless et al. (1990) argue that positive mood encourages heuristic processing that is not necessarily careful, whereas negative mood encourages careful, systematic processing. In the mood/feelings-as-information theory positive mood acts as a cue that indicates the absence of threat (Schwarz & Clore, 1983). In the absence of threat, people are less motivated to maintain rigorous problem-solving processing and more likely to rely on heuristics. In contrast negative mood indicates the presence of threat or a problem, and consequently people are more motivated to use systematic, careful, and detail-oriented strategies (Schwarz & Clore, 1983).

1.3.3 Thesis question 1

The question my thesis seeks to address from the above-reviewed context is: does manipulated positive mood enhance performance on a category learning task that benefits from cognitive flexibility?

1.3.4 Negative mood findings

In light of the body of research showing that positive mood broadens attention and enhances creativity and problem-solving, one might assume that negative mood should result in the opposite pattern of results. However there is a relative scarcity of research that supports this conclusion when one focuses on studies involving the manipulation of a general negative mood state akin to the positive mood manipulations used in most positive mood research.

The most commonly cited reference in support of the idea that negative mood narrows attention is an experiment by Gasper and Clore (2002). Gasper and Clore (2002) reported that participants in a manipulated negative mood condition (induced via writing about a life event that made them feel “sad and negative”) demonstrated a narrowed focus of attention as measured by the number of local triad classifications on a global-local classification task compared to positive and neutral mood condition participants (who wrote about “life events that made them feel happy and positive” and an “average, normal typical weekday” respectively). However this finding has not to my knowledge been replicated. Johnson et al. (2005) conducted a similar study and failed to replicate this finding. Gable and Harmon-Jones (2010) manipulated sadness and found that it led to *broadened* attention relative to a neutral mood condition on a global-local reaction time task, with sad mood participants exhibiting longer response times to local response trials.

While null results cannot serve as conclusive evidence that an effect does not exist, it is noteworthy that several other failures to find comparable negative mood results have been reported in studies looking at positive, negative, and neutral mood states. Isen et al., (1987) included manipulated negative mood by having participants view a likely fear-provoking film clip depicting World War II death camps and did not find any difference between the negative and neutral mood conditions on RAT performance, despite participants in the negative mood condition reporting significantly higher negative mood ratings than participants in the neutral mood condition. It is hard to imagine that this film clip did not evoke sufficiently strong responses in participants. In this study there was a nonsignificant trend for negative mood participants to assign higher ratings to atypical items than neutral mood participants which also goes against the idea that negative mood narrows attention. This trend was also found in the sorting study where participants sorted color chips. Murray et al. (1990), and Hirt et al. (1996), who reported significant positive mood findings, did not find any differences between negative mood participants and the neutral mood control condition. Rowe et al. (2007) also failed to find any difference between their negative and neutral mood conditions on either RAT performance or flanker task performance, again in spite of a successful sad versus neutral mood induction, and in spite of "booster" repetitions of the mood induction procedure as well as the presence of valenced music playing throughout the study. Dreisbach and Goschke (2004) did not report any differences between negative and neutral conditions on a task tapping executive function. Indeed two meta-analyses have failed to find an association between negative mood and creativity (Baas, De Dreu, & Nijstad, 2008; Davis, 2009). Despite the relative lack of confirmatory published results, the hypothesis that negative mood narrows attention persists, with researchers citing the few studies that have published that support this hypothesis. Baumann and Kuhl (2005) reported that people primed with negatively valenced words before each trial of a global-local response task were slower to respond to global trials than people primed with neutral words. Oaksford et al. (1996) reported that negative mood participants performed less well on a variant of the Wason card selection task than neutral mood participants, however there was no performance decrement between conditions on the Tower of London task.

1.3.5 Anxiety

The idea that negative mood reduces cognitive flexibility and narrows attention is likely largely due to the clearer and better-supported findings that focus on anxiety. For instance the Easterbrook hypothesis (Easterbrook, 1959) is commonly cited as evidence that negative affect narrows attention. Easterbrook (1959) hypothesized that "emotional arousal acts consistently to reduce the range of cues that an organism uses, and that the reduction in range of cue utilization influences action in ways that are either organizing or disorganizing, depending on the behavior concerned" (p. 183).

However Easterbrook's work was concerned with high arousal negative states including fear and anxiety, not a general negative mood state or sadness. Likewise research by Tucker and colleagues (Derryberry & Tucker, 1994; Tucker & Williamson, 1984) reports that threatening situations constrict the scope of perceptual attention. In a series of studies Mikulincer, Kedem, and Paz (1990a) reported that state and trait anxiety was negatively related to low typicality exemplar ratings, indicative of narrowed conceptual attention. However Fredrickson and Branigan (2005) compared global-local triad selections between participants who viewed video clips that elicited anger/disgust, anxiety/fear, and a neutral mood state. Although the mood manipulations were effective, no differences in responses between these specific negative states and neutral conditions was found. Thus while research on the influence of anxiety on cognition is better supported than that for the influence of negative mood on cognition, findings are equivocal.

1.3.6 Major depression and depressive symptoms

Major depression is comprised of multiple symptoms including depressed mood and/or reduced interest or pleasure in activities, along with weight changes, sleep disturbances, slowed or disturbed motor and cognitive responses (e.g. psychomotor retardation or agitation), decreased energy/increased tiredness, increased guilty feelings, increased feelings of worthlessness, diminished ability to focus or think, and thoughts of suicide. Increased sad mood or anhedonia are necessary symptoms for diagnosis of major depression according to the fourth edition of the Diagnostic and Statistical Manual of

Mental Disorders by the American Psychiatric Association (DSM-IV; APA, 1994; and DSM-IV-TR; APA, 2000).

Major depressive disorder has been connected to a range of cognitive impairments (see Austin, Mitchell, & Goodwin, 2001 for a review). While the range of cognitive deficits is broad, studies have consistently reported executive function impairments (Austin, Ross, Murray, O'Carroll, Ebmeier, & Goodwin, 1992; Austin et al., 1999; Elliot, Sahakian, McKay, Herrod, Robbins, & Paykel, 1996; Merriam, Thase, Haas, Keshavan, & Sweeney, 1999; Murphy et al., 1999). In particular, depressed patients are argued to be impaired on tasks requiring cognitive flexibility (see Fossati, Ergis, & Allilaire, 2002 for a review). For instance depression has been linked with poor performance on the Wisconsin Card Sorting Task (WCST; Austin et al., 1999; Merriam, Thase, Haas, Keshavan, & Sweeney, 1999). However Fossati, Ergis, and Allilaire (2001) reported that depressed patients were unimpaired on a modified version of the WCST, but showed deficits in concept generation. The authors suggest that depression might impair hypothesis-testing abilities as well as cognitive flexibility. Other research has reported deficits in working memory (Christopher & MacDonald, 2005).

While studies that examine the cognitive abilities of patients who have been diagnosed as clinically depressed are most informative about major depression, another commonly used practice is to measure depressive symptoms in non-depressed university/college students, most often using the Beck Depression Inventory (BDI; Beck, 1967). BDI cut-off scores are used to create depressed and no/low-depression groups. This method has been criticized by researchers who argue that major depression and elevated depressive symptoms in students are qualitatively different (Coyne & Gotlib, 1983; Gotlib, 1984).

Gotlib (1984) reviews research showing that in non-clinical populations measures of depression and anxiety tend to be highly interrelated, to the extent that it is difficult to find participants who score highly on depression but not anxiety, and vice versa (e.g. Hollon & Kendall, 1980; Strack, Blaney, Gannelen, & Coyne, 1985). To test this prediction Gotlib (1984) administered the BDI to 475 university students, along with other measures of depression, measures of dysfunctional attitudes, hostility, maladaptive attitudes, anxiety, distress, and assertiveness. There were moderate to high positive intercorrelations between the BDI and all of the other measures, with the exception of assertiveness (which was negatively correlated with BDI scores). Students who scored highly on one measure tended to score high on the others. Given these results Gotlib (1984) argued that the BDI might be measuring general psychological distress, and not depression specifically. Depressive symptoms in university students have been characterized as mild and transient (Coyne, 1994). For instance Deardorff and Funabiki (1985) reported that out of 63 students with elevated BDI scores (above 9) only 6 were diagnosed with major depression in a clinical interview conducted 1 to 4 weeks later.

So what does the BDI assess, if it is not assessing major depression? Gotlib (1984) suggests that in non-clinical university student populations "the BDI may be measuring a construct or emotional state considerably broader than depression" (p. 20). Kendall, Hollon, Beck, Hammen, & Ingram (1987) argue that depressive symptoms in non-clinical populations could represent "a variety of dispositional qualities, responses to stressful life events or other transitory happenings" (p. 292). Watson and Clark (1984) suggest the BDI taps into what they refer to as *negative affectivity* (NA), which is described as an individual difference variable that encompasses the tendency to respond to experiences with negative emotion, and to view the self negatively. Anxiety as well as "anger, scorn, revulsion, guilt, self- dissatisfaction, a sense of rejection, and, to some extent, sadness" (Watson & Clark, 1984; p. 465) are included in the description. People higher in NA are more likely to experience negative mood states and low self esteem than people lower in NA. The NA dimension is hypothesized to be relatively stable over time. This dimension is distinct from positive emotions and is not meant to indicate the lack of positivity, but rather the presence of negativity.

However some researchers argue that there is a continuum between sub-clinical depressive symptoms and major depression (Enns, Cox, & Borger, 2001; Flett, Vredenberg, & Kramses, 1997; Hankin, Fraley, Lahey, & Waldman, 2005; Lewinsohn, Solomon, Seeley, & Zeiss, 2000; Vredenburg, Flett, & Krames, 1993). For instance Vredenburg et al. (1993) argue that the use of the BDI and student populations is valid, and that high levels of depressive symptoms in student populations corresponds theoretically with clinical depression. The authors argue that many other measures correlate highly with depression questionnaires because they share a depression component. Further, the authors cite research showing that even in depressed patients, there are high intercorrelations between different measures, meaning that both groups demonstrate evidence of a general distress component.

There is also evidence that non-clinical samples who score highly on depressive symptom measures perform more poorly on tasks tapping executive functioning. For instance Smith, Tracy, and Murray (1993) reported that university students and adult patients with higher than averaged depressive symptoms were slower to learn a categorization task that required a flexible, rule-based strategy, but unimpaired on a task that could be learned via similarity.

1.3.7 Remaining questions in negative mood and depression research

Due to conflicting and limited results, it remains unclear whether general negative mood narrows attention or impairs cognitive flexibility relative to a neutral mood. Research on anxiety is generally clearer. Research on depression also seems more conclusive in that many studies report that patients with major depression demonstrate executive function impairments, but some researchers argue that depression broadens attention and promotes creativity. For instance Gable and Harmon-Jones (2010) argue that depression might broaden attention, and cite studies by Andreasen (1987), and von Hecker and Meiser (2005) as evidence for this viewpoint.

Andreasen (1987) studied 30 creative writers, 30 age, sex, and education-matched controls, and the first-degree family members of each group. Writers had significantly higher rates of bipolar disorder than the control group, and the relatives of the writer group had higher rates of major depression than the relatives of the control group. The relatives of writers were significantly more likely than the relatives of non-writers to have produced a significant creative accomplishment, such as producing an opera or patenting an invention. While these results partially support the hypothesis that depression is related to creativity Andreasen (2008) notes that:

> There are also many examples of anecdotal accounts indicating that, creative individuals who have suffered from mood disorders find them to be disruptive and counterproductive. Among the writers in the Iowa Workshop study [Andreasen, 1987], essentially all of them reported that they were unable to work creatively during periods of depression or mania. During depressive episodes their cognitive fluency and energy were decreased, and during manic periods they were too distractible and disorganized to work effectively. (p. 254)

However the work of von Hecker and Meiser (2005) provides some experimental evidence that depressive symptoms could be related to broadened attention (and possibly to subsequent creativity although that was not shown). University students who reported higher levels of depressive symptoms performed the same as students with lower levels of depressive symptoms on a word recognition task, but students with higher levels of depressive symptoms were more likely to correctly remember the color of the frames around the words, indicating that they noticed non-essential elements of the task.

Thus there is disagreement concerning the effects of depression on cognitive processing, and past research has used so many different tasks with different populations that it is hard to make comparisons across studies. However much research points to the idea that depression impairs flexibility and hypothesis testing, while some research hints at the possibility that depressive symptoms broaden attention (or is at least related to de-focused attention).

1.3.8 Thesis questions 2 and 3: negative mood and depressive symptoms

The second question my thesis seeks to address from the above-reviewed context is: does manipulated negative mood impair performance on a category learning task that benefits from cognitive flexibility?

The third question my thesis seeks to address from the above-reviewed context is: are depressive symptoms negatively related to performance on a category learning task that benefits from cognitive flexibility?

1.4 Rationale for chapters 2 and 3: the category learning paradigm

In order to address the above three questions Chapters 2 and 3 of my dissertation contain experiments that employ a category learning paradigm to study the influence of mood (positive and negative), and depressive symptoms on cognitive flexibility and hypothesis-testing abilities. In the past two decades a large amount of research has been conducted with well-defined category sets that can be classified as either rule-based (RB) or non-rule-based (NRB). This research has made it possible to create category sets that require or benefit from certain processes and not others. Category learning also provides a theory of category learning that can help to motivate mood research and make predictions about the findings. The COmpetition between Verbal and Implicit Systems (COVIS) theory of category learning (Ashby, Alfonso-Reese, Turken, & Waldron, 1998) is based on neuropsychological research and argues that there are separate category learning systems, one that is verbal, and one that is nonverbal. Table 1.1 below shows how the learning tasks used in this dissertation are theoretically related to the COVIS systems, as well as the key attributes of each type of learning task.

Table 1.1. Category learning terminology and theoretical structure

COVIS System	Verbal system	Nonverbal system
Learning Tasks	Rule-based (RB)	Non-rule-based (NRB)
Key Attributes of the learning tasks	Verbalizable; taps cognitive flexibility, rule-selection, hypothesis-testing; requires the separation of stimulus dimensions.	Nonverbalizable; does not tap cognitive flexibility, hypothesis-testing; requires the integration of stimulus dimensions.

The verbal system in COVIS is mediated by a circuit that goes from the anterior cingulate cortex (ACC) and the prefrontal cortex (PFC) to the head of the caudate nucleus, and then goes back to the PFC. This model implicates the PFC for working memory and explicit reasoning, the ACC for rule selection, and the basal ganglia for rule switching. Working memory and executive attention are crucial cognitive components of the verbal system. Category sets that are RB are learned best by the verbal system because they draw upon explicit reasoning, working memory, rule selection, and rule-switching. One key feature of RB category sets is that the optimal rule that distinguishes category exemplars between the categories is verbalizable. RB category sets can differ in terms of how complex the verbal rule is, from simple unidimensional rules, to multi-dimensional rules that require conjunctive or disjunctive reasoning. Unidimensional verbal rules are the most salient and easy to learn, and as complexity of the rule increases beyond conjunctions the category set may still be able to be described with a verbalizable rule, but it is unclear whether participants will rely on explicit reasoning processes and verbal rules to categorize stimuli (Ashby & Maddox, 2005). For participants to achieve high or perfect accuracy on a RB category learning task, participants must select and test rules held in working memory while they are being tested. When a rule is tested and found not to lead to correct feedback, the rule should be abandoned so that a new rule can be tested. The use of a new rule requires one to select a new possible rule, and then turn one's attention away from the old rule to the new rule. More recently the medial temporal lobes, specifically the hippocampus, were also added to the COVIS model's verbal system, because while rules can be held in working memory for short periods of time, rules must also be consolidated and stored in longer-term memory (Ashby & Valentin, 2005).

According to Ashby et al. (1998) the verbal category learning system is most likely to be influenced by mood, depressive symptoms, and motivation, as will be discussed later on in this introduction. This is because mood, depressive symptoms, and motivational states have been found to influence the same cognitive processes that are used in rule-based category learning tasks.

The nonverbal system is mediated by the basal ganglia, with a focus on the striatum due to its role in dopamine reward-based feedback and because most of the visual cortex extends directly onto the tail of the caudate nucleus (Ashby et al., 1998). Within the striatum the putamen is closely connected with motor output and the caudate nucleus is associated with cognitive behavior. Ashby et al. (1998) hypothesize that for every categorization decision made a unit in the prefrontal cortex is activated by the striatum and the strength of activation is indicative of the nonverbal system's confidence that the response was correct. With repeated trials and activations the category responses become associated with the stimuli. Feedback is immediate and the dopamine released into the striatum causes synapses that have been activated recently to be strengthened (Ashby & Maddox, 2005). The integration of relevant stimulus information prior to making a categorization decision is crucial for successful nonverbal learning to occur. This integration of information is nearly impossible to describe accurately using a verbal rule and the learning is thought to be procedural in nature (Ashby, El, & Waldron, 2003; Maddox, Bohil, & Ing, 2004). COVIS predicts that early learning relies on the verbal system, but if the category structure is not verbalizable, responding eventually switches to the nonverbal system (Ashby et al., 1998).

COVIS specifies that both systems are active and in competition with one another during learning. Eventually one system will come to dominate the response output in a particular category-learning task. The system that comes to dominate responding is the one that receives the most correct feedback. The verbal system is hypothesized to dominate all early responding while the nonverbal system takes longer to learn categories and thus longer to dominate responding.

1.4.1 Rationale for studying depressive symptoms and category learning

As noted above, the COVIS model's verbal system involves a circuit that extends from the PFC and ACC, the head of the caudate nucleus, and goes back to the PFC (Ashby et al., 1998). Depression represents an example of a condition that is associated with reduced activity in frontal brain regions that overlap with the verbal category learning system (Henriques & Davidson, 1991), and consequently an opportunity to evaluate the COVIS theory of category learning as well as theories of how depression influences cognitive processing.

Ashby et al. (1998) hypothesized that depression should be related to impaired RB and possibly NRB category learning. The possibility of NRB impairment is due to the psychomotor agitation/disturbance found in some depressed patients (APA, 2011). Motor disturbances are mediated by the basal ganglia and thus the nonverbal system may be affected in some cases (Ashby et al., 1998). Only one set of studies has examined the influence of depressive symptoms on category learning. Smith et al. (1993) reported that participants higher in self-reported depressive symptoms performed more poorly on a RB category learning task than participants lower in depressive symptoms. Depressive symptoms were not related to NRB category learning.

Chapter 2 addresses the potential relationships between self-reported depressive symptoms, hypomanic and worry symptoms, trait approach and avoidance motivation, and RB and NRB category learning performance in two studies. While Smith et al. (1993) studied the relationship between depressive symptoms and category learning, no prior research (to the best of my knowledge), has explored factors other than depressive symptoms (e.g. hypomanic and worry symptoms, approach and avoidance motivation) in this context.

Experiment 1 looks at the relationship between depressive symptoms and category learning, and is the first study to examine this relationship using a complex, RB categorization task, and the first to explore potential relationships between hypomanic symptoms, approach and avoidance motivation and category learning. This experiment's original contribution to knowledge is that depressive symptoms are negatively related to a complex, RB learning task but unrelated to an easier, RB learning task or a NRB learning task.

Experiment 2 uses more complex category sets to further study the potential relationships between these variables and RB and NRB category learning performance. This experiment's original contribution to knowledge is that depressive symptoms are negatively related to performance on a complex, RB category learning task that benefits from cognitive flexibility, but unrelated to performance on a NRB category learning task that does not benefit from cognitive flexibility. Further, this study demonstrates that history of hypomanic symptoms is negatively related to RB category learning. This experiment also makes a further unique contribution to knowledge that is described below.

1.4.2 Rationale for studying positive and negative mood and category learning

Ashby, Isen, and Turken's (1999) dopamine hypothesis of positive mood posits that mild to moderate positive mood is associated with enhanced cognitive flexibility due to an increase of dopamine in the frontal cortical areas of the brain, specifically the PFC and the ACC. These brain regions overlap with the COVIS model of category learning's verbal system. Category learning involves a combination of rule learning, selective attention, inhibition of response, sensitivity to feedback, and often requires the learner to engage in hypothesis-testing, making it well suited to the study of mood and cognitive processing. Many of these functions require cognitive control and flexibility (Markman, Maddox, & Baldwin, 2007). Furthermore, there is a strong body of evidence implicating working memory and executive function in learning RB categories (see DeCaro, Thomas, & Beilock, 2008; Grimm, Markman, Maddox, & Baldwin, 2008; Maddox, Baldwin, & Markman, 2006; Minda, Desroches, & Church, 2008). No prior research has looked at the relationship between positive and negative mood states on category learning performance, or the influence of positive and negative mood states on category learning performance.

Chapter 2's Experiment 2 is the first study to look at the relationship between current self-reported mood state and category learning performance. This chapter's original contribution to knowledge is that self-reported positive mood is positively related to RB category learning, but unrelated to NRB category learning. Further, this study shows that when positive mood is taken into account, the relationship between self-reported depressive symptoms and RB category learning performance is no longer significant.

Chapter 3 looks at the influence of manipulated positive, neutral, and negative mood states on RB and NRB category learning performance, and is the first experiment to study the influence of manipulated mood states on category learning performance. This chapter's original contribution to knowledge is that positive mood enhances performance on a RB category set that benefits from cognitive flexibility. This has implications for category learning research and for research on positive mood.

1.5 Motivation and cognition

As noted earlier, motivation has been argued to underlie cognition (Lazarus, 1991a). Without motivation, there would be no impetus to act (Carver & Scheier, 1998). Derryberry and Tucker (1994) argued that motivational states can affect conceptual, as well as perceptual attention, with approach states broadening and avoidance states narrowing attention. This hypothesis has been extended by researchers studying the influence of regulatory focus on cognitive processing.

In regulatory focus theory (Higgins, 1997, 1998) people are theorized to have distinct motivational orientations that are derived from the approach and avoidance systems and exist orthogonally to them, meaning that each system involves both approach and avoidance motivation. The promotion system prepares an individual to approach positive outcomes (gains) and avoid the absence of positive outcomes (non-gains) in the environment. The prevention system prepares an individual to approach potential positive outcomes (non-losses) in the environment and avoid potential negative outcomes (losses). Promotion goals are centered around and driven by nurturance needs, while prevention goals are centered around security needs (Higgins, 1997). These distinct needs engender different strategies of goal pursuit: promotion-focused individuals prefer to use eager, risky strategies while prevention-focused individuals prefer to use vigilant, conservative strategies (Crowe & Higgins, 1997).

Due to the fundamental nature of these self regulatory systems, all people have a promotion system and a prevention system. However one system or the other can come to dominate people's self regulation goals. This is thought to be due to the emphasis placed on ideals or oughts by an individual's caregivers, role models, and peers across time (Higgins, 1987). This long-term, sustained focus is referred to as *chronic* regulatory focus, and has been found to be relatively unchanging over time (Higgins, 1998). These chronic systems can interact with the constraints and affordances of various situations and tasks, which can also be construed as promotion or prevention-focused. In addition to chronic regulatory states, it is possible to manipulate people's dominant regulatory focus momentarily, and this temporary focus is referred to as *situational* regulatory focus.

The nurturance needs (e.g. advancement, growth, accomplishment) of promotion-focused people motivates them to achieve states that reflect their ideal selves (i.e. their hopes, wishes, and aspirations), whereas the security needs (e.g. protection, safety, responsibility) of prevention-focused people motivates them to achieve states that reflect their ought selves (i.e. their duties, obligations, and responsibilities). When one is in a promotion focus and achieves a goal that is in line with their ideal self (gain), they feel cheerfulness-related emotions, and when they fail to achieve a goal (non-gain), they feel dejection-related emotions. When one is in a prevention focus and achieves a goal in line with their ought self (non-loss) they feel quiescent-related emotions (e.g. calm/serene), and when they fail to achieve a goal in line with their ought self (loss), they feel agitated-related emotions (e.g. anger/fear). During goal pursuit, the inferences people make about their relative success/failure also influence their emotional state (Higgins, 1998; Higgins, Shah, & Friedman, 1997). Higgins (2001) specifies that people "can be in a promotion state of eagerness or a prevention state of vigilance without currently experiencing emotions" (p. 208). Thus motivational state (non-emotional) interacts with emotional experiences.

Idson, Liberman, and Higgins (2000) measured the chronic regulatory focus of participants before they completed an anagram solving task. Participants were given either success or failure feedback. Participants with a chronic promotion focus reported feeling happier than participants with a chronic prevention focus following success feedback, and participants with a chronic prevention focus reported feeling more anxious than participants with a chronic promotion focus following failure feedback. Similarly, participants with a chronic prevention focus reported feeling more relaxed following success feedback than participants with a promotion focus, and participants with a promotion focus reported feeling more dejected than prevention focus participants following failure feedback.

Like mood states, regulatory focus has been found to influence conceptual breadth. In an experiment by Crowe and Higgins (1997) participants were asked to do a sorting task using lists of exemplars taken from Rosch (1975). Participants first sorted a list of 12 high and moderate typicality fruits into subgroups according to any one dimension that was plausible to the participant, and this task was repeated using a list of twelve vegetables that were also high and moderately typical category exemplars. Following this participants were asked to record as many other dimensions that could be used to sort the vegetables, excluding the one they had already chosen. Regulatory focus was manipulated by informing participants that they would get to do a liked (promotion condition) or disliked (prevention condition) activity based on their performance on the sorting task. Participants with a promotion focus sorted along dimensions that created more subgroups than participants with a prevention focus. Prevention-focused participants were also more likely to choose the same dimension across the two sorting tasks (i.e. they were more likely to perseverate). When participants were asked to list other dimensions that could be used to sort the categories, there was a trend for participants in the promotion condition to list more dimensions. The authors interpreted the results in a signal detection framework. In this framework a promotion focus is concerned with ensuring "hits" and avoiding errors of omission, whereas a prevention focus is concerned with insuring correct rejections and avoiding errors of commission. However this study can also be interpreted to suggest that participants with a promotion focus have a broader conceptual focus than participants with a prevention focus.

The theory that a promotion focus is related to broadened attention compared to a prevention focus has been bolstered and expanded in subsequent research by Förster and colleagues (Förster & Higgins, 2005; Friedman & Förster, 2005). Förster and Higgins (2005) measured the chronic regulatory focus of participants and had them complete a global/local processing task. In this task participants are shown one of eight composite letters that is composed of smaller letters on each trial. Participants were asked to make a key press on a blue response key when they saw the letter "L" and a key press on a red response key when they saw the letter "H". The location of the target letters was varied such that they appeared on the local or global level of the stimuli. The small (local) and composite (global) letters always mismatched so that the target was always only on either the local or global level. Participants with a chronic promotion focus responded faster to global targets whereas participants with a chronic prevention focus responded faster to local targets. Friedman and Förster (2005) induced approach (promotion) and avoidance (prevention) motivational states and then had participants perform a measure of attentional flexibility (a Stroop task in Experiment 1 and a working memory 2-back task in Experiment 2). Participants in promotion conditions performed better than participants in prevention conditions. These results indicate that a promotion focus is associated with broadened attention and increased cognitive flexibility while a prevention focus is associated with narrowed attention and reduced flexibility.

Regardless of whether the focus is chronic or situational in nature, regulatory states interact with the environment. That is, a regulatory state can either can fit or not fit with the reward structure of a task. In both cases, if one has a promotion focus (chronic or situational) and is in an environment that highlights gains, the subject is said to be in a state of *regulatory fit*, because looking for possible gains in the environment matches with an environment where gains are possible. If one has a promotion focus but the environment highlights losses, then the subjects is said to be in a state of regulatory mismatch because looking for possible gains in the environment does not match with an environment where only losses are possible. Likewise if one has a prevention focus and the environment highlights losses this creates a state of regulatory fit because looking for possible losses in an environment matches an environment where losses are possible. Finally if one has a prevention focus and the environment highlights gains, this creates a state of regulatory mismatch because looking for possible losses in the environment does not match with an environment where only gains are possible.

While the above mentioned studies are informative regarding the influence of regulatory focus states on attentional and conceptual breadth and flexibility, more recent research argues that regulatory fit, and not simply focus, influences these factors. Markman and colleagues (Maddox et al., 2006; Grimm et al., 2008) have put forward the hypothesis that regulatory fit enhances cognitive flexibility. The authors define cognitive flexibility as “an increase in an individual’s ability or willingness to try different strategies across trials to achieve some stated goal, as opposed to utilizing gradual incremental changes in strategy” (Maddox et al., 2006, p. 1378). Across several studies they reported that regulatory fit improved performance on category learning tasks that benefitted from broad shifts in strategy and suffered on tasks that did not benefit from trying new strategies and abandoning old ones, relative to a regulatory mismatch condition. Grimm et al. (2008) also reported that participants experiencing a match between their situational focus and the reward structure of the task performed better on different a category learning task that benefitted from cognitive flexibility and worse on a task that did not benefit from flexibility. Additionally they have used well known measures of cognitive flexibility, including the WCST (Maddox, Filoteo, Glass & Markman, 2010), and the RAT (Markman et al., 2007), and have again showed that a match between the situational focus and the task reward structure results in enhanced performance relative to a mismatch.

While the body of work outlined above is compelling, the paradigm consistently used to support these results relies on setting up a situation in which explicit gains/non-gains (promotion) and non-losses/losses (prevention) are set up on two levels: situational regulatory focus and the reward structure of the task. The tasks participants complete always have correct and incorrect responses and participants receive feedback after they make each response. The feedback participants receive after each trial is critical to creating conditions of regulatory fit and non-fit. Prior research on regulatory focus effects also commonly uses tasks in which there is a correct or incorrect response, and where feedback occurs. The issue this poses is that it is unclear whether these effects will be found in more naturalistic situations in which there are many possible correct responses, or in which one's response is not necessarily correct or incorrect.

One study has used a different paradigm to study regulatory fit effects on cognitive processes. Memmert, Unklebach, and Ganns (2010) measured chronic regulatory focus using the General Regulatory Focus Questionnaire (GRFM; Lockwood, Jordan, & Kunda, 2002), and manipulated situational focus using approach and avoidance-priming mazes (Friedman & Förster, 2001). They reported that participants who experienced a fit between their chronic focus and their situational focus were more likely to notice an unexpected character in an inattentional blindness task. They hypothesized that regulatory fit led to broadened attention relative to regulatory mismatch (Memmert et al., 2010).

Given that regulatory fit effects have largely been reported using a framework of gains and losses, I wanted to see whether regulatory fit effects would be found on a task where there was no correct or incorrect response and no explicit trial by trial feedback, as this is a more frequently occurring situation in everyday life, where there are multiple possible good choices and no clear feedback about whether one has made a good decision or not. Thus in the current study I use a different categorization task as a measure of cognitive flexibility, one that does not involve correct or incorrect responses and where feedback is not necessary. The paradigm I use to manipulate regulatory fit versus mismatch is derived from prior research by Memmert et al. (2010). Unlike Memmert et al. (2010) I use a different measure of chronic regulatory focus, and a different situational focus manipulation. The GRFM has been used in several studies looking at regulatory focus and fit (Keller & Bless, 2006; Memmert et al., 2010, Plessner, Unkelbach, Memmert, Baltes, & Kolb, 2009), however it has been reported to correlate more strongly with positive and negative mood, and approach and avoidance motivation than another commonly used measure of chronic regulatory focus (Summerville & Roese, 2008). For these reasons I employ the Regulatory Focus Questionnaire (RFQ; Harlow, Friedman, & Higgins, 1997), which was not found to correlate with positive and negative mood, or approach and avoidance motivation (Summerville & Roese, 2008).

The task I use is based on the work of Rosch (1975). In the original study participants were asked to rate the goodness of fit of a number of category exemplars to several different categories. Some category exemplars were considered a better fit to a given category than others. For instance, participants endorsed the exemplars “apple” and “orange” as extremely good members of the fruit category, whereas “prunes”, “coconut” and “olive” were considered less good members of the category. This work showed that people seem to have ideas of what makes a given exemplar a better or worse member of a category, and challenged the view that people use necessary and sufficient features in making categorization decisions.

The exemplars and categories from Rosch (1975) have been used as a measure of conceptual breadth or cognitive flexibility in prior research (Isen & Daubman, 1984; Mikulincer et al., 1990a; Price & Harmon-Jones, 2010), by comparing people’s ratings of low typicality items. Atypical/low typicality items are thought to tap cognitive flexibility because assigning a higher than average rating to a low typicality item means one is able to see features of the exemplars that connect them to the category and find different relationships between the exemplar and category that are less obvious, despite being plausible. In contrast high typicality items do not require as much flexibility because the aspects or features of the exemplar that relate to the category easily come to mind. For instance in the category "vehicle", it is easy to agree that a "car" is a good example. However the exemplar "camel" requires a greater degree of flexibility, more flexibility than "car". Past research has found that participants with higher state or trait anxiety are less inclusive in their ratings of atypical category exemplars (Mikulincer et al., 1990a), whereas participants in a positive mood (Isen & Daubman, 1984), or a low intensity approach state (Price & Harmon-Jones, 2010), assign higher ratings to atypical items than participants in a control or other condition.

For the current research I predict that if regulatory fit enhances cognitive flexibility participants who experience a fit between their measured chronic focus and their situational focus will assign higher ratings to the low typicality exemplars than participants who experience a mismatch. This prediction is in line with past research by Memmert et al. (2010) and Markman and colleagues (Grimm et al., 2008; Maddox et al., 2006; 2010; Markman et al., 2007). There may also be a main effect of either chronic or situational regulatory focus (or both), as suggested by the work of Crowe and Higgins (1997), and research by Förster and Friedman (Förster & Higgins, 2005; Friedman & Förster, 2005), such that participants with either a strong chronic promotion focus, or a manipulation situational promotion focus, assign higher ratings to atypical exemplars than participants with a less strong chronic promotion focus (or a stronger chronic prevention focus), or a situational prevention focus.

No research to my knowledge has measured both approach and avoidance motivation with the Behavioral Inhibition System/Behavioral Activation System scales (BIS/BAS; Carver & White, 1994) as well as chronic regulatory focus with the RFQ in a study of regulatory focus/fit effects. This is important because promotion and prevention foci involve both approach (behavioral activation) and avoidance (behavioral inhibition) motivations, and are theoretically distinct from these systems. However some research that has measured approach and avoidance motivation have reported findings that are similar to those reported for regulatory focus. For instance De Dreu, Nijstad, and Baas (2011) reported that individuals high in trait approach motivation (as measured by the BAS scales) were more creative when they were primed with global processing manipulations. This can be considered akin to a regulatory fit effect, except that trait approach motivation is in the place of a promotion focus. Thus I wanted to know whether trait approach and avoidance motivation might interact with the situational focus manipulation in a similar manner to the results of Memmert et al. (2010).

1.6 Rationale for studying motivation and categorization

Chapter 4 investigates how two motivational states (promotion and prevention regulatory focus) influence performance on a categorization task. Additionally individual differences in motivation are measured prior to the manipulation, and mood is assessed following the regulatory focus manipulation. This chapter's original contribution to knowledge is that manipulated regulatory focus states influence negative mood such that participants in a prevention focus reported significantly higher negative mood than participants in a promotion focus. Negative mood ratings were significantly negatively related to poor and moderate exemplar typicality ratings. Prior work has found mood effects on poor exemplar typicality ratings, but this is the first study to report that negative mood also relates negatively to moderate exemplar typicality ratings.

1.6.1 Thesis question 4: the influence of motivation on cognitive processing

The question my thesis seeks to address from the above-reviewed context is: Does regulatory fit result in broadened attention/enhanced cognitive flexibility on a naturalistic categorization task?

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Chapter 2

2 Is there an upside to feeling down? The relationship between depressive symptoms, hypomanic symptoms, mood, and category learning performance

The influence of negative mood states on cognitive processing has been a popular topic of study, but questions remain as to the nature of the effects. Some studies have reported findings in line with the hypothesis that negative mood narrows attention; for instance Gasper and Clore (2002) reported that participants in a negative mood condition made more local triad classifications on a global-local classification task compared to positive and neutral mood condition participants. Baumann and Kuhl (2005) reported that people primed with negatively valenced words before each trial of a global-local response task were slower to respond to global trials than people primed with neutral words. Oaksford, Morris, Grainger, and Williams (1996) reported that negative mood participants performed less well on a variant of the Wason card selection task than neutral mood participants. Research by Tucker and colleagues (Derryberry & Tucker, 1994; Tucker & Williamson, 1984) reported that threatening situations constrict the scope of perceptual attention. In a series of studies Mikulincer, Kedem, and Paz (1990a), and Mikulincer, Paz, and Kedem (1990b) reported that state and trait anxiety was negatively related to low typicality exemplar ratings, indicative of narrowed conceptual attention.

In contrast to the idea that negative mood narrows attention, Gable and Harmon-Jones (2010c) manipulated sadness and found that it led to broadened attention relative to a neutral mood condition on a global-local reaction time task, with participants in the sad mood condition exhibiting longer response times to local response trials. The authors suggested that depression might also broaden attention and be related to enhanced creativity. In line with this hypothesis von Hecker and Meiser (2005) reported that university students who reported higher levels of current depressive symptoms performed the same as students with lower levels of self-reported depressive symptoms on a word recognition task, but students with high self-reported depressive symptom were more likely to correctly remember the color of the frames around the words, indicating that they noticed non-essential elements of the task better than students with lower levels of self-reported depressive symptoms. Although these results do not show that depression enhances creativity, it is possible that a less inhibited, defocused state of attention (which was displayed by the students with higher levels of self-reported depressive symptoms) could result in enhanced creativity. However two meta-analyses have failed to find a relationship between negative mood and creativity (Baas, De Dreu, & Nijstad, 2008; Davis, 2009). Impairment on tasks that benefit from cognitive flexibility have also been reported in depressed patients, for instance major depression has been linked with poor performance on the Wisconsin Card Sorting Task (Austin et al., 1992; Merriam, Thase, Haas, Keshavan, & Sweeney, 1999). In line with the idea that flexible processing is impaired in depression, Smith, Tracy, and Murray (1993) reported that university students and adult patients with higher than average self-reported depressive symptoms were impaired on a category learning task that benefited from a flexible, rule-based strategy, but unimpaired on a task that could be learned via similarity.

Although there is generally more support for the hypothesis that negative mood states narrow attention and reduce flexibility than there is evidence that negative/depressive mood states broaden attention or enhance flexibility, the issue continues to be debated. This paper addresses the question of whether self-reported depressive symptoms in university students are related to better or worse performance on complex tasks that utilize executive functioning abilities such as hypothesis testing and rule selection using a category learning paradigm.

The relationship between depressive symptoms and performance on learning tasks that benefit or do not benefit from cognitive flexibility is important because cognitive flexibility is beneficial for many commonly encountered everyday tasks as well as problem-solving tasks. If even moderate levels of depressive symptoms are related to lower performance on tasks benefiting from flexibility this has implications for understanding academic performance in undergraduate populations as well as employee performance in workplaces.

2.1 The category learning paradigm

Category learning provides a useful paradigm in which to study the effects of depressive symptoms on cognitive performance. In the past two decades a large amount of research has been conducted with two groups of well-defined category sets: rule-based (RB) and non-rule-based (NRB). Category learning also provides a theory of category learning that can help to motivate this research and make predictions about the findings. The COmpetition between Verbal and Implicit Systems theory of category learning (COVIS; Ashby, Alfonso-Reese, Turken, & Waldron, 1998) differentiates between verbal and nonverbal category learning systems and is based on neuropsychological research.

RB category sets can be learned using explicit, verbal reasoning processes. A key feature of RB category sets is that the optimal rule that distinguishes the categories is verbalizable. A related feature is that the dimensions of the stimuli are treated separately. RB category sets can differ in terms of how complex the verbal rule is, from simple unidimensional rules, to multi-dimensional rules that require conjunctive or disjunctive reasoning. Unidimensional verbal rules are the easiest to learn and the most salient, and learning difficulty increases as the complexity of the rule increases. For participants to achieve high or perfect accuracy on a RB category-learning task, participants must select and test rules held in working memory. When a rule is found not to lead to consistently correct feedback, the rule should be abandoned so that new rules can be tested. The use of a new rule requires one to turn attention away from the old rule so that a new rule can be selected (Ashby et al., 1998). The verbal system is mediated by a circuit that goes from the prefrontal cortex (PFC) and the anterior cingulate cortex (ACC) to the head of the caudate nucleus, and back to the PFC. This model implicates the PFC for working memory, and explicit reasoning, the ACC for rule selection, and the basal ganglia for rule switching. Working memory and executive attention are crucial cognitive components of the verbal system. RB category sets are learned best by the verbal system because they draw upon explicit reasoning, working memory, rule selection, and rule-switching processes.

NRB category sets are not learned well using explicit, verbal reasoning processes. Instead of involving attention to separate stimulus dimensions, the integration of relevant stimulus information prior to making a categorization decision is crucial for successful NRB learning to occur. This integration of information is extremely difficult to describe using a verbal rule. The nonverbal system is mediated by the basal ganglia, with a focus on the striatum due to its role in dopamine reward-based feedback and because most of the visual cortex extends directly onto the tail of the caudate nucleus (Ashby et al., 1998). Within the striatum the putamen is closely connected with motor output and the caudate nucleus is associated with cognitive behavior. Ashby et al. (1998) hypothesize that for every categorization decision made a unit in the prefrontal cortex is activated by the striatum and the strength of activation is indicative of the implicit system's confidence that the response was correct. With repeated trials and activations the category responses become associated with the stimuli. Feedback is immediate and the dopamine released into the striatum causes synapses that have been activated recently to be strengthened (Ashby & Maddox, 2005). NRB category sets are learned best by the nonverbal category learning system due to the lack of a perfect verbal rule that distinguishes between categories.

COVIS specifies that both the verbal and nonverbal systems are active and in competition with one another during learning. Eventually one system will dominate the response output in a particular category learning task/learning session. The system that comes to dominate responding is the one that receives the most correct feedback. The verbal system is hypothesized to dominate all early responding while the nonverbal system takes longer to learn categories and thus longer to dominate responding. COVIS predicts that early learning relies on the verbal system, but if the category structure is not verbalizable, responding eventually switches to the nonverbal system (Ashby et al., 1998).

If depressive symptoms are related to narrowed attention or reduced flexibility, then participants higher in self-reported depressive symptoms should perform less well on RB category learning tasks if those tasks benefit from cognitive flexibility. Performance on

NRB category learning may not be related to depressive symptoms but it is possible that early learning may be related to depressive symptoms if the verbal system is being used.

2.2 The role of dopamine in category learning

Category learning provides a useful paradigm for studying the relationship between depressive symptoms and cognitive processes for a further reason. The COVIS model makes specific predictions about the influence of dopamine on category learning. Dopamine is theorized to play a key role in both the verbal and nonverbal category learning systems (Ashby et al., 1998), and is also implicated in theories of positive mood (Ashby, Isen, & Turken, 1999), and depression (Nestler & Carlezon, 2006).

In the nonverbal category learning system, dopamine that originates in the substantia nigra pars compacta travels to the tail of the caudate nucleus and provides the crucial reward signal needed for successful NRB learning to occur. When corrective feedback is not given immediately after participants make a response, learning is impaired on NRB but not RB category sets (Maddox, Ashby, & Bohil, 2003). The learning of NRB category sets is reliant on closely-spaced corrective feedback because the cortico-striatal synapses that are crucial for feedback-based learning are only active for several seconds. If corrective feedback (and thus the dopamine-mediated reward signal) is not received in the same time period the nonverbal system cannot make the correct connection between the categorization response and the corrective feedback. As a result decreased dopamine in the tail of the caudate nucleus is hypothesized to impair non-rule-based category learning (Ashby et al., 1998). Support for this prediction comes from Parkinson's disease. In Parkinson's disease dopamine cells in the ventral tegmental area and the substantia nigra die in increasing numbers (Kolb & Whishaw, 1990). In a study by Knowlton, Mangels, and Squire (1996), Parkinson's disease patients were impaired on a NRB category learning task, and there was a negative relationship between disease severity and performance.

Dopamine also plays an important role in the verbal system. Ashby et al. (1998) make several predictions about interactions between dopamine levels and RB category learning. They predict that *increased* dopamine levels in frontal brain regions enhances rule selection and RB category learning (up to a point, beyond which too much dopamine would impair rule selection and subsequent performance), whereas *decreased* dopamine in frontal brain regions (beyond usual levels) should impair RB category learning when rule selection and working memory are required. Ashby et al. (1998) also predict that *decreased* dopamine levels in the ACC impair performance on RB category learning tasks, whereas *decreased* dopamine levels throughout the caudate nucleus should cause deficits in rule-based category learning when switching executive attention is required. These predictions are based on several separate lines of evidence, including research showing that administration of amphetamines (which increases dopamine levels in frontal brain regions) is associated with increased response changing on a 2-choice guessing paradigm (Ridley, Baker, Frith, Dowdy, & Crow, 1988; cited by Ashby et al., 1998). Patients with positive schizophrenia symptoms (which is also thought to be associated with increased dopamine levels in frontal brain regions) exhibit difficulty maintaining cognitive set (DSM-IV; APA, 1994). Patients with negative schizophrenia symptoms, as well as people prescribed dopamine agonist medications (both of which are related to reductions in frontal region dopamine levels) exhibit increased perseverative errors on the WCST (Berger et al., 1989; cited by Ashby et al., 1998; Malmo, 1974; cited by Ashby et al., 1998).

Ashby et al. (1998) hypothesized that depression should be related to impaired RB and possibly NRB category learning. This argument is based on research showing that depressed participants exhibit impairments on aspects of the WCST, which designed to assess frontal lobe impairments, and uses some of the same cognitive processes as rule-based learning tasks (Berman, Doran, Pickard, & Weinberger, 1993; Franke et al., 1993). The possibility of NRB impairment is due to the psychomotor agitation/disturbance reported in some depressed patients, however this symptom is not found in everyone with major depressive disorder (Calligiuri & Ellwanger, 2000). Motor disturbances are mediated by the basal ganglia and thus the nonverbal system may be affected in some cases (Sobin & Sakheim, 1997).

There is growing evidence that dopamine plays a key role in depression, specifically the mesolimbic dopamine pathway that projects from the ventral tegmental area (VTA) to the nucleus accumbens (Nestler & Carlezon, 2006). While it is not possible to directly manipulate dopamine levels in specific brain regions in humans, a technique called optogenetics allows dopamine transmitting neurons in the VTA to be isolated and turned on and off via fibre optic cables inserted into the brains of mice (Deisseroth, 2010). In a study using optogenetics, depression-like behaviors resulted (mice struggled less when suspended by their tails and showed a reduced preference for water containing sucrose) when VTA neurons were switched off. When the VTA neurons were turned on, the same mice significantly altered their behavior, behaving no differently than control mice that did not have their VTA neurons turned off. This is the first study to manipulate dopamine levels in the VTA and show a direct effect on depression-like behaviors (Tye et al., 2012). This is significant because the VTA is a part of the COVIS model's verbal category learning system.

As previously mentioned, the verbal system contains a circuit that includes the PFC, caudate nucleus, and ACC (Ashby et al., 1998). According to COVIS the ACC selects which new verbal rules to try out, and the head of the caudate nucleus controls the rule switching. Dopamine projections between the VTA and substantia nigra mediate this switching process. Although dopamine is theorized to play a role in the nonverbal system, the dopamine projections in this system are between the substantia nigra and the visual cortex (Maddox & Ashby, 2004). Therefore depressive symptoms should be related to RB category learning but not NRB category learning.

There are several links between RB category learning, dopamine, and depressive symptoms, but little research has specifically investigated depressive symptoms and category learning. Smith, Tracy, and Murray (1993) conducted two studies looking at the relationship between depressive symptoms and category learning. In the first study adults from a general university population completed the Beck Depression Inventory (BDI; Beck, 1967) and then performed two category learning tasks, one that was RB and one that was NRB. The stimuli consisted of 4-letter nonwords (e.g. BUNO, KYRA). Using the BDI, adults with self-reported depression levels higher than the mean score reported by all participants performed more poorly on the RB task than participants with scores lower than the mean. The second experiment studied a group of adult men who were patients at a medical centre for veterans. Subjects were classified as non-depressed, moderately depressed, and severely depressed using the BDI recommended cut-off scores. Subjects completed either a RB category set or a NRB category set, and this time the stimuli consisted of abstract faces with four features that varied along one of two dimensions. Subjects classified as severely depressed (but not those classified as moderately depressed) were impaired on RB but not NRB category learning. There were no other differences between the groups.

2.3 The current research

To provide a fuller test of the hypothesis that depressive symptoms are negatively related to RB category learning I used a complex RB category set in addition to an easy to learn RB category set. In the studies by Smith et al., (1993) the perfect verbal rule (for the RB category set) in both studies was a relatively easy to learn single-dimensional rule. Smith et al. (1993) demonstrated that current self-reported depressive symptoms were related to impaired RB category learning. Some research has reported cognitive impairments in subjects who are no longer depressed (Weiland-Fiedler et al. 2004). To address the possibility that past depressive symptoms might be related to reduced RB category learning performance I assessed subjects' history of depressive symptoms in addition to their current depressive symptoms.

While depression is a relatively well-specified psychological disorder that can be linked to the COVIS theory of category learning, it is possible that related constructs may also show similar patterns, a possibility that has not, to the best of my knowledge, been examined. Both depression and bipolar disorder have been connected with frontal brain region dysfunction and working memory and executive function impairments (Arts, Jabben, Krabbendam, & van Os, 2008; Bora, Yucel, & Pantelis, 2009; Kurtz & Gerraty, 2009; Robinson, Thompson, Gallagher, Goswami, Young, & Ferrier, 2006). Hypomanic symptoms are a predictor of bipolar disorder (Depue, Krauss, Spoont, & Arbisi, 1989). Therefore it is feasible that current hypomanic symptoms may be negatively related to

RB category learning performance. As in depression, I also assessed history of hypomanic symptoms.

Depression is related to proneness to worry (Fresco, Frankel, Mennin, Turk, & Heimberg, 2002; Starcevic, 1995). Further, worry has been found to impair verbal working memory (Rapee, 1993). Dual-task studies of category learning have reported that adding a verbal working memory task to a categorization task impairs RB learning to a greater extent than NRB learning (Waldron & Ashby, 2001; Zeithamova & Maddox, 2006). Thus proneness to worry could act similarly to a verbal dual ask, and it is possible that worry will be negatively related to RB but not NRB category learning.

Finally, depression is related to lower than usual approach motivation (Henriques & Davidson, 2000; Kasch, Rottenberg, Arnow, & Gotlib, 2002), or dysregulation of approach motivation, and higher than usual avoidance motivation (Depue & Iacono, 1989; Kasch et al., 2002). Similarly, bipolar disorder has also been connected with approach motivation dysregulation (Alloy & Abramson, 2010). Therefore it is possible that either approach or avoidance motivation (or both) could be related to RB category learning performance.

In the present research participants consisted of undergraduate students who reported a range of depressive symptoms but were not necessarily clinically depressed. The issue of whether even high levels of depressive symptoms reported by students is comparable to ratings of depression in clinically depressed patients is contentious, with some arguing that the two are qualitatively different (Gotlib, 1984), and others arguing that they are analogous (Vredenburg et al., 1993). Gotlib (1984) administered the BDI to 475 university students, along with other measures of depression, measures of dysfunctional attitudes, hostility, maladaptive attitudes, anxiety, distress, and assertiveness. There were moderate to high positive intercorrelations between the BDI and all of the other measures, with the exception of assertiveness (which was negatively correlated with BDI scores). Students who scored highly on one measure tended to score high on the others. Given these results Gotlib (1984) argued that the BDI might be measuring general psychological distress, and not depression specifically. Despite this issue it is of interest to understand how non-clinical depressive symptoms relate to category learning performance and to cognitive processing more generally.

In the first study I used two RB category learning tasks, one that is similar to the stimuli used by Smith et al. (1993) in that it is relatively easy to learn using a perfect verbal rule, and a second, more complex rule-based category learning task that requires the use of a disjunctive verbal rule. This allowed for a fuller test of the hypothesis that there is a negative relationship between depressive symptoms and rule-based category learning performance. I also used a NRB category set that is similar to the one used by Smith et al. (1993) to investigate whether there is any relationship between NRB learning and depressive symptoms.

In the second study I again tested the hypothesis that depressive symptoms are negatively related to RB category learning, but I also included a measure of positive and negative mood to assess whether current positive or negative mood is related to performance, and if so, what is the nature of the relationship for RB and NRB categories. The RB category set that I used has previously been reported to benefit from enhanced cognitive flexibility, while the NRB category set has been reported not to benefit from cognitive flexibility (Maddox, Baldwin, & Markman, 2006). In both studies I measured related constructs to explore possible relationships that have not previously been predicted or investigated in the COVIS theory of category learning.

2.4 Study 1

Study 1 was designed to investigate the relationship between self-reported depressive symptoms and RB and NRB category learning. Previous research suggests that performance on a RB category-learning task, but not a NRB task should be negatively related to depressive symptoms (Smith et al., 1993). In this research I compared learning on two RB category sets, one that can be learned via a single-dimensional verbal rule, and one that requires a complex disjunctive verbal rule for perfect performance. I also employed a NRB category set that is relatively complex but can be learned well without a verbal rule. In addition to current level of depressive symptoms, I also measured history of depressive symptoms, proneness to worry, current hypomanic symptoms, history of hypomanic symptoms, and approach and avoidance motivational strength. To the best of my knowledge these constructs have not been previously studied in the context of category learning. I included several distinct but related measures because I wanted to know whether depressive symptoms specifically related to category learning performance given that prior research has found strong and positive intercorrelations between depression measures and other mood measures (Gotlib, 1984).

I predicted that current depressive symptoms would be negatively related to complex RB category learning but not NRB learning, or simple RB category learning. This is in contrast to one of the findings of Smith et al. (1993), who in one study reported that performance on a simple RB category learning task was related to higher than average depressive symptoms, however it is in line with the results of a second study that found simple RB performance was related only to severe (and not moderate) levels of depressive symptoms. I predicted that simple RB category learning performance would *not* be related to depressive symptoms because the rule is so easy to find. There are three dimensions in this set (shape, colour, and size), meaning that participants have a 1 in 3 chance of identifying and using the optimal verbal rule on the first trial. Thus while this category set requires participants to find and apply a verbalizable rule, this rule is easy to find and does not tap cognitive flexibility to the extent that the complex RB category set does. In contrast because the optimal verbal rule for the complex RB set is disjunctive, this taps cognitive flexibility and thus depressive symptoms should be negatively related to complex RB performance.

I predicted that history of depressive symptoms, proneness to worry, hypomanic symptoms (past and present), and avoidance motivation might also be negatively related to complex RB category learning performance. My predictions about approach motivation were less clear, because it's possible that people who are sensitive to rewards will be more engaged during category learning than people lower in behavioral activation. However because an overactive reward system has been linked to hypomanic symptoms (and bipolar disorder), it is possible that this relationship could be negative

(Alloy & Abramson, 2010).

2.4.1 Method

2.4.1.1 Sample and design

Subjects included 90 university undergraduates (68 females, 22 males) from the University of Western Ontario who participated either for $10 pay or for one hour's worth of course credit. Subjects were randomly assigned to each of the three category learning tasks.

2.4.1.2 Materials

2.4.1.2.1 Questionnaires

The Beck Depression Inventory. The Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996) is designed to assess the severity of depressive symptoms in both psychiatric and normal populations. It consists of 21 groups of statements that assess the features of depression (e.g. sadness, loss of pleasure, changes in sleep, etc.). BDI-II statements are rated from 0-3, with higher scores indicating increasing severity of symptoms (Beck et al., 1996). Participants are asked to consider their symptoms in the past two weeks when responding. The BDI-II has a high level of internal consistency (Beck et al., 1996; Whisman, Perez, & Ramel, 2000), as well as good convergent and discriminant validity in college student populations (Dozois, Dobson, & Ahnberg, 1998; Steer & Clark, 1997; Whisman, Perez, & Ramel, 2000).

The General Behavior Inventory. The General Behaviour Inventory (GBI; Depue, 1987) is a 73-item measure of bipolar and unipolar mood symptoms that was originally developed to assess minor forms of mood disorders as well as major depressive disorder and major bipolar disorder. The GBI has been used to identify adolescents and adults at risk of developing major depression or bipolar disorder (Akiskal, Khani, & Scott-Strauss, 1979; Reichart et al., 2005). The GBI contains a 46-item depression scale (GBI-D) as well as a 28-item hypomania scale (GBI-H). Hypomania is associated with bipolar disorder and is characterized by persistent euphoric or irritable mood states (DSM-IV; American Psychiatric Association, 2000). Responses are made on a 4-point scale ranging from 1 ("Never or Hardly ever") to 4 ("Very often or Almost constantly"). Participants are asked to rate how frequently they have experienced a behavior since they first noticed it across their lifetime. Many of the questions specify a minimum time range such as "several days or more". An example question from the GBI-D scale is "Have there been times of several days or more when you were so sad that it was quite painful or you felt that you couldn't stand it?" An example question from the GBI-H scale is "Have you had periods of extreme happiness and intense energy (clearly more than your usual self) when, for several days or more, it took you over an hour to get to sleep at night?"

The Penn State Worry Questionnaire. The Penn State Worry Questionnaire (PSWQ) is a 16-item questionnaire that assesses the frequency and intensity of proneness to worry (Meyer, Miller, Metzger, & Borkovec, 1990). Example items are "I find it easy to dismiss worrisome thoughts." and ""I know I should not worry about things, but I just cannot help it". Responses are made on a 5-item scale from 1 ("Not at all typical of me") to 5 ("Very typical of me"). This measure has good construct validity and internal consistency (Meyer et al., 1990; Molina & Borkovec, 1994).

BIS/BAS scale. Carver and White's (1994) Behavioral Inhibition System/Behavioral Activation System (BIS/BAS) scales were designed to assess Gray's (1990) regulatory approach and avoidance systems in individuals. This is a 24-item measure and items are rated from 1 ("very true for me") to 4 ("very false for me"). There are four subscales in this questionnaire, three that are BAS-related, and one that is BIS-related.

The Behavioral Approach System (BAS) is sensitive to cues signaling reward and non-punishment. The BAS governs movement towards desired end states. This system has been argued to underlie positive affective states, including happiness and elation (Gray, 1990). Someone with a high BAS sensitivity should experience a strong pull to engage in goal-directed behavior and a strong reaction to impending incentives. Research has also connected an underactive BAS system with an increased risk of depression (Fowles, 1988). BAS sensitivity has also been found to relate to depression (Campbell-Sills, Liverant, & Brown, 2004; Kasch et al., 2002; McFarland, Shankman, Tenke, Bruder, &

Klein, 2006) as well as bipolar disorder (Meyer, Johnson, & Carver, 1999). The three BAS-related subscales focus on distinct aspects of sensitivity to rewards, they are: BAS Drive (4 items), BAS Fun Seeking (4 items), the BAS Reward Responsiveness (5 items). An example BAS Drive subscale item is “I go out of my way to get things I want”. An example BAS Fun Seeking item is “I crave excitement and new sensations”. An example BAS Reward Responsiveness item is “When I see an opportunity for something I like I get excited right away”. The BAS subscales are often summed and used as an overall indicator of BAS sensitivity (Hayden et al., 2008; McFarland et al., 2006).

The Behavioral Inhibition System (BIS) is activated in response to environmental cues signaling punishment, novelty, and non-reward, and inhibits behavior that could lead to aversive outcomes. This system has also been argued to underlie other negative affective feelings including fear, sadness, and anxiety (Gray, 1990). High levels of BIS have been connected to higher self-reports of depression symptoms (Hayden et al., 2008). The BIS subscale (7 items) includes items such as “If I think something unpleasant is going to happen, I usually get pretty ‘worked up.’” and “Criticism or scolding hurts me quite a bit.”

Hypomanic Personality Scale. The Hypomanic Personality Scale (HPS, Eckblad & Chapman, 1986) is a 48-item true/false measure that assesses features of hypomanic personality (e.g., elevated sociability, mood, energy, and perceived uniqueness). High scores on this measure are associated with increased rates of bipolar disorders and depressive episodes (Kwapil, Miller, Zinser, Chapman, Chapman & Eckblad, 2000). Example questions from the HPS are “Sometimes ideas and insights come to me so fast I cannot express them all” and “I frequently get into moods where I feel very speeded-up and irritable”.

2.4.1.2.2 Category learning tasks

Three category learning tasks were chosen from the original set of six created by Shepard, Hovland, and Jenkins (1961). In each category set there are three features (shape, size, and color) that can have one of two dimensions (square or triangle, large or small, orange or blue), as shown in Figure 2.1. In each category set there are eight stimuli, and four belong in each of two separate categories.

Easy rule-based. In the first category learning task, easy rule-based/Type I[4] (ERB), only one feature is used to indicate category membership, and subjects can achieve perfect performance using a single-dimensional verbal rule. The rule that would result in perfect performance in Figure 2.1 is "Orange shapes belong in Category A, blue shapes belong in Category B" because the feature used to indicate category membership is color. Out of the original six category sets, this first type is the easiest to learn and results in the highest performance (Nosofsky, Gluck, Palmeri, McKinley & Glauthier, 1994; Shepard et al., 1961).

Hard rule-based. In the second category learning task, hard rule-based/Type II (HRB), two features are used to indicate category membership, and subjects can achieve perfect performance using a disjunctive verbal rule. The verbal rule that would result in perfect performance in Figure 2.1 would be "Blue triangles and orange squares belong in Category A, orange triangles and blue squares belong in Category B". Thus neither color nor shape are individually helpful in assigning category membership, but the combination of color and shape is. This category set is the second easiest to learn out of the six category sets (Nosofsky et al., 1994; Shepard et al., 1961).

Non-rule-based. In the third category learning task, non-rule-based/Type IV (NRB), all three features are used to indicate category membership and this task is thought to be learned primarily via family resemblance. This means that the members of Category A have features in common with one another, for instance in Figure 2.1 they are mostly large, and mostly orange, and mostly triangles, whereas Category B members are mostly small, mostly blue, and mostly square. However the NRB task can also be thought of as a rule-plus-exception category learning task. For instance, in Figure 2.1 another possible method of achieving perfect performance is to memorize the exceptional outlying stimuli

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[4] Shepard et al. (1961) created six category sets and ordered them according to difficulty (e.g. Type I, Type II…Type VI), although some category structures were equivalent in difficulty (Type III, IV, and V).

(in Figure 2.1 this is the large blue triangle and the small orange square). The verbal rule would be “Large shapes (except the blue square), plus the small orange triangle belong in Category A, and small shapes (except the orange triangle), plus the large blue square, belong in Category B”. This category set is the third hardest to learn of the six sets, and is equivalent in difficulty to Types III and V (Nosofsky et al., 1994; Shepard et al., 1961).

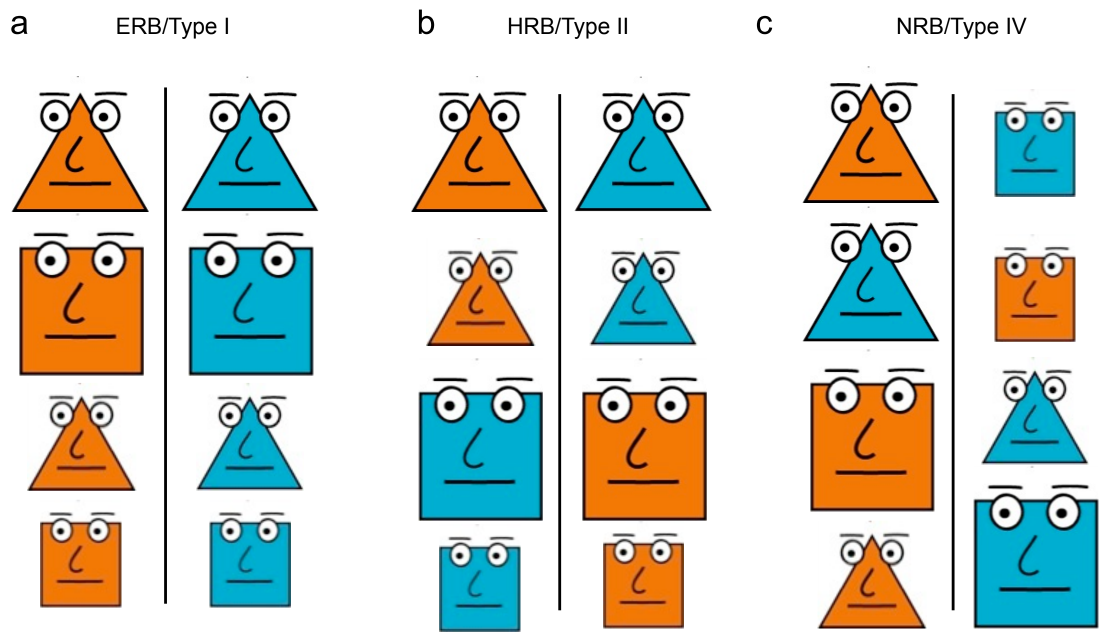

Figure 2.1. Category learning tasks from Shepard, Hovland, and Jenkins (1961): easy rule-based (Panel A), hard rule-based (Panel B), non-rule-based (Panel C).

2.4.1.3 Procedure

Subjects were tested in groups of up to four in the Categorization Lab at the University of Western Ontario. Upon agreeing to participate, subjects completed the mood questionnaires using paper and pencil. Subjects were then randomly assigned to one of the three category learning conditions (ERB, HRB, and NRB) and completed 80 trials (ten repeating blocks of eight stimuli) of the task on a computer.

Subjects were told that they would be presented with abstract shapes and asked to classify them as either belonging to the forest (category A) or the mountains (category B). Subjects saw each stimulus one-at-a-time on a computer screen and were instructed to press the “0” or the “1” key to indicate whether the shape belonged in the forest or the mountains respectively. After responding, subjects were given corrective feedback: the shape would smile and move towards the correct location on the screen to indicate a correct response, or the shape would frown and move towards the incorrect location and then smile and move to the correct location to indicate an incorrect response. Another trial began following this feedback. Stimuli were presented in a random order within each block of eight stimuli and blocks were presented in an unbroken fashion. Figure 2.2 shows an example instance of the order of events for a correct response and the order of events for an incorrect response.

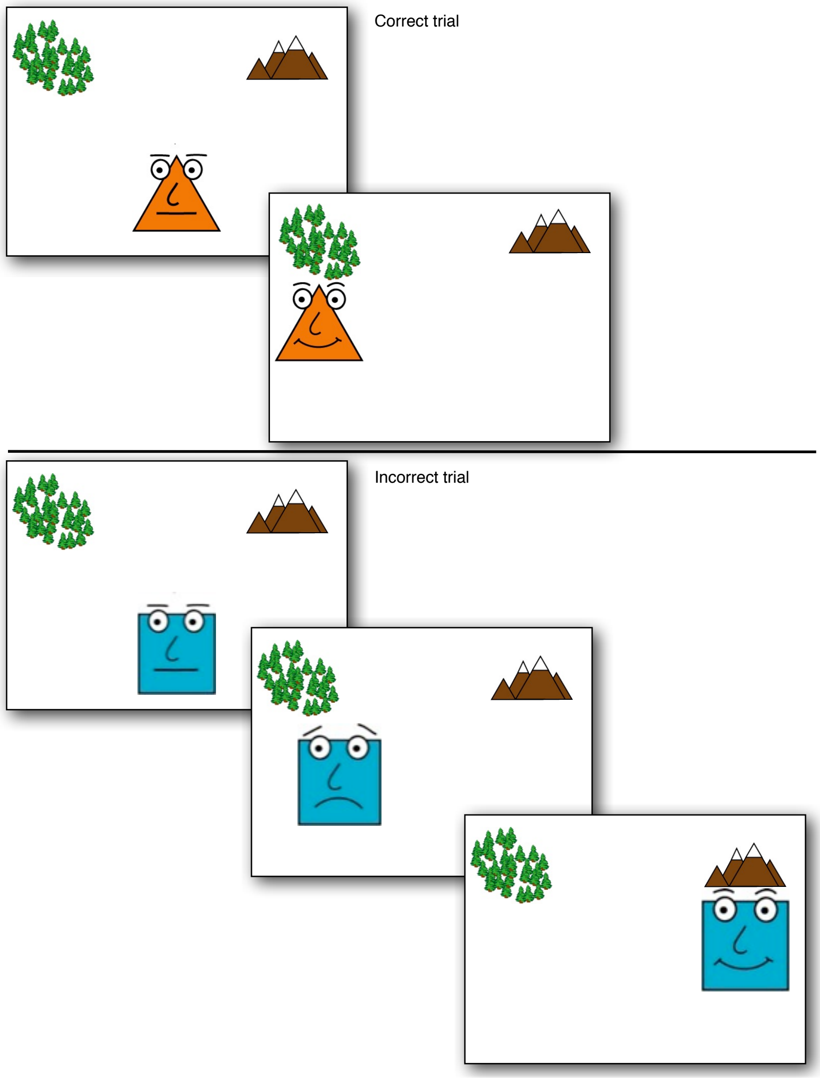

Figure 2.2. Sample screens of a correct trial and an incorrect trial on the categorization learning tasks. On correct trials the neutral face of the stimulus smiles and moves to the chosen (correct) location. On incorrect trials the neutral face is transformed into a frown, moves to the chosen (incorrect) location, then smiles and moves to the correct location to indicate the correct answer.

2.4.2 Results

2.4.2.1 Category learning performance

Subjects performed ten blocks (80 trials) of one of the three category sets. The averaged performance of subjects who learned the ERB category set was $M = .86$, $SD = .17$. The averaged performance of subjects who learned the HRB category set was $M = .68$, $SD = .16$. The averaged performance of subjects who learned the NRB category set was $M =$

.68, *SD* = .14. The learning curve of all three category types across all ten blocks of learning is shown in Figure 2.3. This learning curve is similar to the one originally reported by Shepard et al. (1961), and repeated more recently (Nosofsky et al., 1994), with the ERB category set having the highest performance, followed by the HRB category set, and the NRB category set. An analysis of variance revealed a statistically significant effect of condition, $F(2,90) = 17.02$, $p < .001$, $\eta^2 = .28$. Tukey HSD post hoc tests revealed that performance on the ERB category learning task was significantly higher than on the HRB or NRB tasks (*p*'s < .001). However performance between the HRB and NRB conditions did not differ, $p = .98$.[5]

[5] Final block performance was also analyzed, and again an analysis of variance between the three conditions was significant, $F(2,90) = 7.77$, $p < .01$, $\eta^2 = .15$ A Tukey post hoc test revealed that ERB final block performance was significantly higher than the HRB ($p = .04$) and NRB ($p = .001$) category sets.

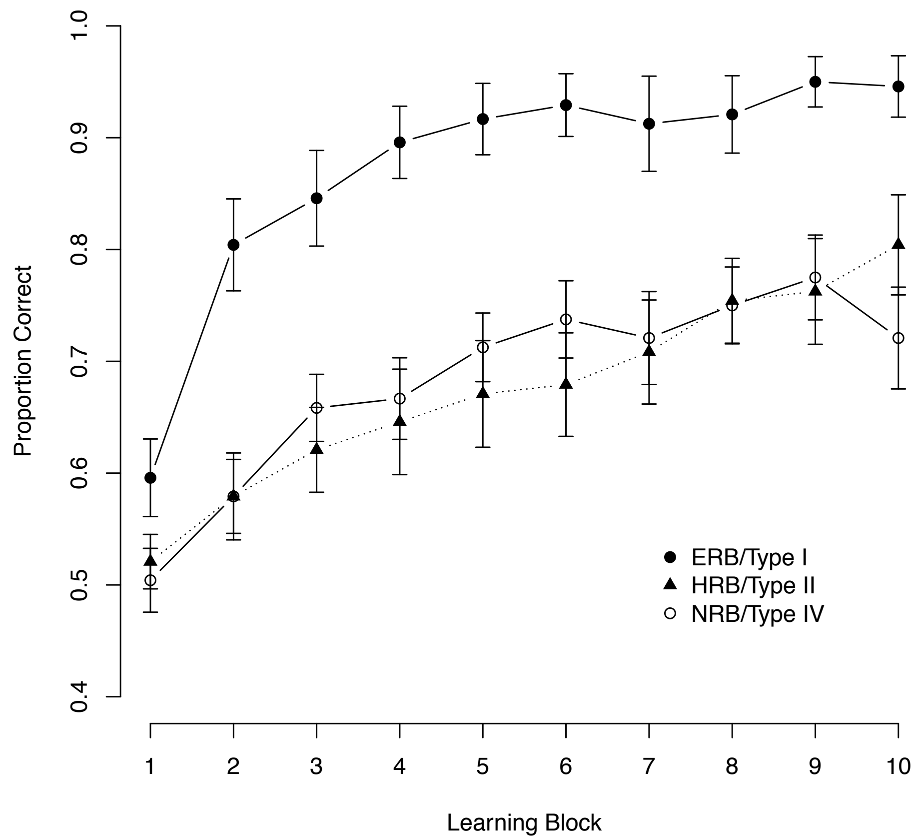

Figure 2.3. Proportion correct across all ten learning blocks for the easy rule-based (ERB), hard rule-based (HRB), and non-rule-based (NRB) category sets.

2.4.2.2 Questionnaire reliability and descriptives

The BDI-II, GBI-D, and GBI-H questionnaires all showed good levels of reliability, (α's = .89, .97, and .92) respectively. The PSWQ showed good reliability as well, (α = .75). Finally the BIS/BAS subscales and BAS total showed good reliability levels, (α's = .74 - .86), with the exception of BAS Fun Seeking, (α =.62). Table 2.1 shows the means and standard deviations of all of the questionnaires, by category learning condition as well as across conditions.

Table 2.1. Means (and standard deviations) of measures of self-reported mood questionnaires across and within groups.

Questionnaire/Measure	ERB	HRB	NRB	Overall
BDI - II	12.00 (8.43)	9.56 (6.13)	10.13 (8.18)	10.44 (7.57)
GBI- Depression	81.43 (22.15)	86.40 (26.52)	85.20 (26.80)	84.34 (25.05)
GBI- Hypomania	48.92 (11.09)	54.72 (13.56)	50.50 (15.61)	51.38 (13.62)
HPS	24.90 (4.76)	25.13 (6.07)	21.67 (4.78)	23.90 (5.42)
PSWQ	51.20 (13.25)	50.37 (14.47)	55.83 (11.95)	52.47 (13.33)
BIS	21.17 (3.51)	21.27 (4.88)	20.13 (5.06)	20.86 (4.52)
BAS Total	41.50 (3.18)	39.17 (7.72)	38.97 (7.16)	39.88 (6.38)

Notes: BDI-II = Beck Depression Inventory II, GBI = General Behavior Inventory, HPS = Hypomanic Personality Scale, PSWQ = Penn State Worry Questionnaire, BIS = Behavioral Inhibition Scale, BAS = Behavioral Activation Scale. ERB = easy rule-based, HRB = hard rule-based, NRB = non-rule-based.

2.4.2.3 Correlation and Regression Results

To determine whether there were significant relationships between performance on the category learning tasks and any of the questionnaires, Pearson product moment correlations (all two-tailed) were performed between subjects' averaged performance across all ten blocks of responding for each of the three category learning tasks and the BDI-II, GBI-D, GBI-H, HPS, PSWQ, BIS, and BAS Total scores. The BAS Total score is presented instead of the three BAS subscales because the subscales were moderately to highly intercorrelated (*r*s between .351 and .687) for all subscales and category learning tasks except one correlation in the ERB category learning task, and I was interested in general BAS sensitivity and not specific constructs measured by the BAS subscales. Due to experimenter error there was no BDI questionnaire data for nine subjects in the ERB condition and three subjects in the HRB condition. To correct the family-wise error rate, a stricter level of significance was adopted using a Bonferroni correction ($.05/7 = p < .007$). All correlations reported or flagged as significant meet this stricter criterion.

As predicted, the BDI-II correlated significantly and positively with several of the other questionnaires (all questionnaire intercorrelations can be seen in Appendix E). Given the pattern of intercorrelations between questionnaires, I wanted to know whether these variables contributed a significant proportion of variance to performance on the category learning tasks that was not shared with the other variables. I conducted a multiple linear regression on each of the category learning tasks with overall performance as the dependent variables and the questionnaire scores (BDI-II, GBI-D, HPS, GBI-H, PSWQ, BAS Total, BIS) as the predictor variables. All of the predictor variables were entered at the same time, and I centred all of the variables to insure against multicollinearity.

Zero-order correlation results are presented and discussed first, followed by the multiple regression results.

2.4.3 ERB Results

There were no significant correlations between any of the mood questionnaires and overall performance on the ERB category set (all *p*'s > .007), as can be seen in Table 2.2. Scatterplots of all ERB and questionnaire correlations can be found in Appendix F.

Table 2.2. Pearson product moment correlations between category learning task performance and all study 1 questionnaires.

Questionnaire/Measure	ERB
Beck Depression Inventory Total	.087
Penn State Worry Questionnaire Total	.045
General Behavior Inventory - Depression	-.126
General Behavior Inventory - Hypomania	-.120
Hypomanic Personality Scale	-.259
BIS	.108
BAS Total	.179

Notes: ERB = easy rule-based, BAS = Behavioral Approach Scale; BIS = Behavioral Inhibition Scale.

The multiple regression between the questionnaires and overall ERB performance did not reach significance, (R^2= .171, adjusted R^2 = - .275, $F(7, 20) = 0.38$, $p = .90$).

2.4.4 HRB Results

There were two significant zero-order correlations between the questionnaires and HRB performance, as shown in Table 2.3.

Table 2.3. Pearson product moment correlations between category learning task performance and all study 1 questionnaires.

Questionnaire/Measure	HRB
Beck Depression Inventory Total	-.541**
Penn State Worry Questionnaire Total	.036
General Behavior Inventory - Depression	-.188
General Behavior Inventory - Hypomania	-.488**
Hypomanic Personality Scale	-.168
BIS	-.103
BAS Total	-.401

Notes: HRB = hard rule-based, BAS = Behavioral Approach Scale, BIS = Behavioral Inhibition Scale.
** $p < .007$

There was a significant negative correlation between HRB performance and BDI-II score $r(27) = -.541$, $p < .007$. Figure 2.4 shows this relationship (Panel A), along with the ERB (Panel B) and NRB (Panel C) relationships.

There was no significant correlation between HRB performance and the GBI-D scale, $r(30) = -.188$, $p = .32$. There was a significant negative correlation between HRB performance and the GBI-H scale, $r(30) = -.488$, $p < .007$, as shown in Figure 2.5, a subject with a GBI-H score of 94 and overall proportion correct of .48 appears to be exceptional and possibly driving the association. When this subject was removed from the analysis the strength of the relationship was reduced beyond the corrected significance level, $r(29) = -.433$, $p = .02$. Therefore this relationship should be interpreted with caution. There was no significant relationship between HRB performance and the HPS, $r(30) = -.168$, $p = .38$.

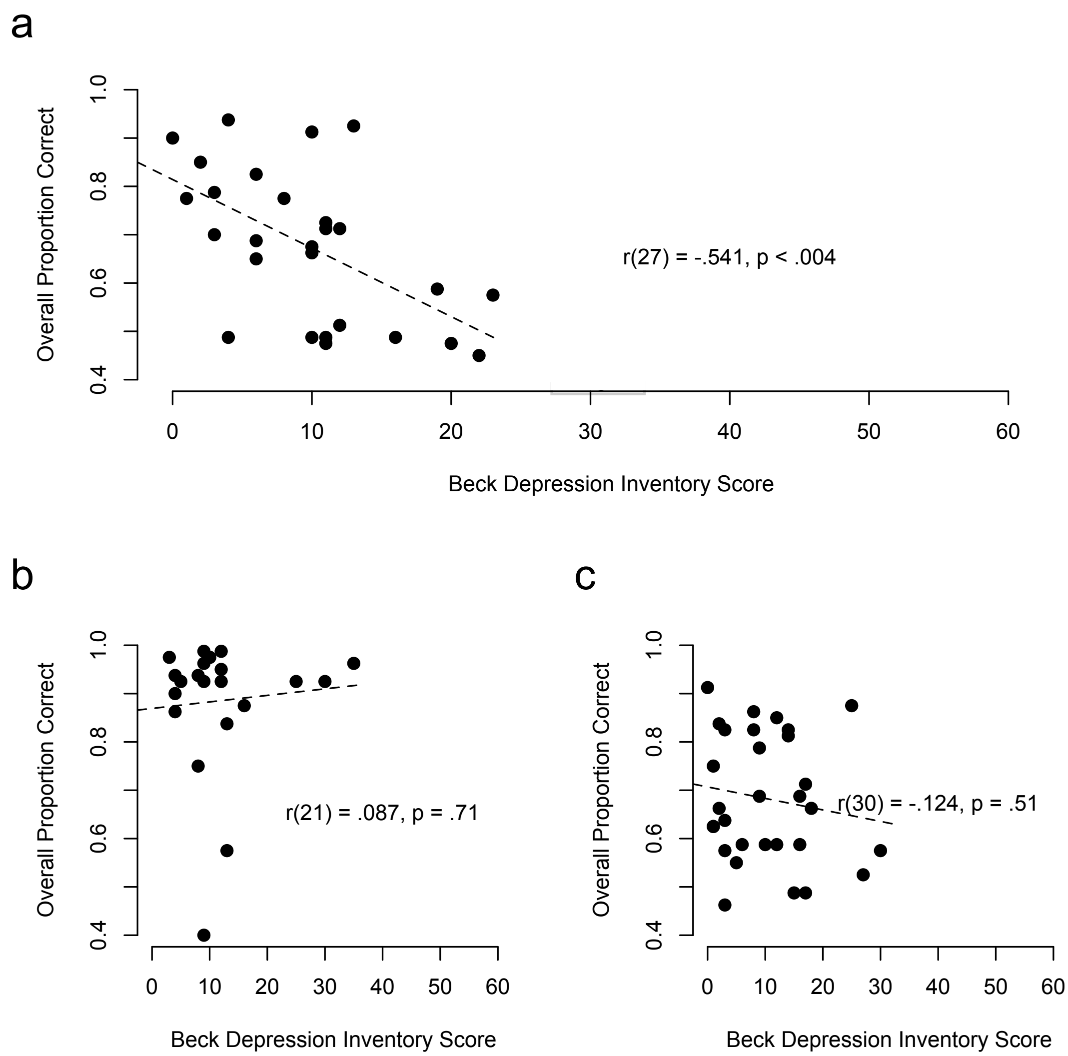

Figure 2.4. Correlations between overall performance and total Beck Depression Inventory Scores by category learning task: Hard rule-based (Panel A), Easy rule-based (Panel B), and Non-rule-based (Panel C).

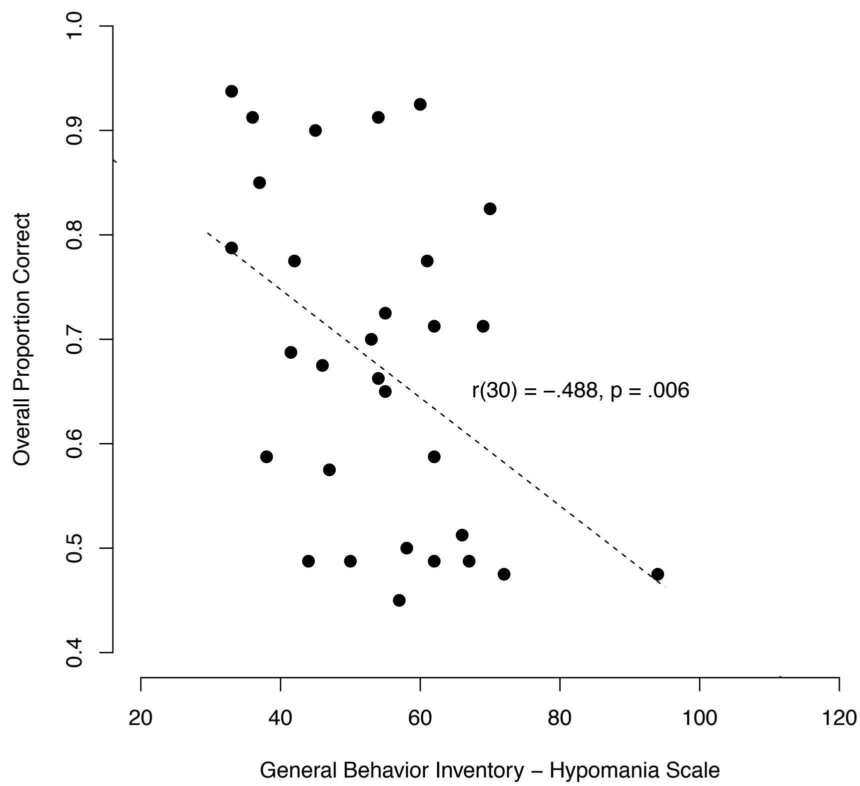

Figure 2.5. Correlations between overall category learning performance and General Behavior Inventory Hypomania Scale score for the hard rule-based category set.

There was no significant relationship between overall HRB performance and the PSWQ, $r(30) = .036$, $p = .85$.There was no significant relationship between overall HRB performance and the BAS Total score, $r(30) = -.401$, $p = .03$, or between HRB overall performance and the BIS scale, $r(30) = -.103$, $p = .59$.

Scatterplots of all HRB and questionnaire correlations can be found in Appendix G.

The multiple regression between the questionnaires and overall HRB performance reached significance, meaning that the linear combination of the seven questionnaires was significantly related to overall performance, ($R^2 = .701$, adjusted $R^2 = .591$, $F(7, 26) = 6.38$, $p = .001$).

The BDI-II (β = -.02, t = -4.689, $p < .001$) the PSWQ (β = .01, t = 3.04, $p < .01$), and the GBI-H (β = -.005, t = - 2.11, $p < .05$) questionnaires significantly predicted HRB overall performance.

Table 2.4 shows the zero-order, part, and partial correlations of overall HRB performance with the questionnaires included in the regression. The partial correlations reflect the correlation between the predictor and criterion variables when the variation that can be attributed to any other predictor variable is removed (controlled for) from both the predictor and criterion. The part correlations reflect the degree of relationship between the predictor and criterion variables when the variation that can be attributed to another predictor is removed from the predictor variable but not the criterion variable. Here I interpret the part correlations because they can be compared to one another (because the criterion variable is not residualized), and because their squared value represents the proportion of variance from the criterion variable that is uniquely associated with the predictor variable (Cohen & Cohen, 1975).

Table 2.4. Zero-order, partial, and part correlations between HRB performance and study 1 questionnaires.

Questionnaire/Measure	Zero-order	Partial	Part
Beck Depression Inventory Total	-.541**	-.732	-.588*
Penn State Worry Questionnaire Total	.036	.572	.381*
General Behavior Inventory - Depression	-.188	.339	.197
General Behavior Inventory - Hypomania	-.488**	-.436	-.265*
Hypomanic Personality Scale	-.168	.012	.006
BIS	-.103	.085	.047
BAS Total	-.401	-.303	-.174

Notes: ** $p < .007$, * $p < .05$ in regression analysis. BAS = Behavioral Activation Scale; BIS = Behavioral Inhibition Scale.

The correlation between overall performance and the BDI-II remained significant when the variability from the other questionnaires was removed, $r(27) = -.588$, as did the correlation between GBI-H and overall performance, $r(30) = -.265$. An unexpected result is that the correlation the PSWQ and overall performance reached significance, $r(30) = .381$, and this relationship is positive. When the squared partial correlations were computed it was revealed that the BDI-II accounted for 35%, the PSWQ accounted for 15%, and the GBI-H accounted for 7% of the variance in overall HRB performance.

2.4.5 NRB Results

NRB/Type IV. There were no significant correlations between overall NRB performance and any of the questionnaires, as shown in Table 2.4. Scatterplots of all NRB and questionnaire correlations can be found in Appendix H.

Table 2.5. Pearson correlations between non-rule-based category learning performance and all study 1 questionnaires.

Questionnaire/Measure	NRB
Beck Depression Inventory Total	-.124
Penn State Worry Questionnaire Total	-.294
General Behavior Inventory - Depression	-.418
General Behavior Inventory - Hypomania	-.315
Hypomanic Personality Scale	.166
BIS	-.027
BAS Total	.141

Notes: NRB = Non-rule-based; BAS = Behavioral Activation Scale; BIS = Behavioral Inhibition Scale.

The multiple regression for overall NRB category learning performance did not reach significance, (R^2= .282, adjusted R^2 = .054, $F(7, 29) = 1.24$, $p = .33$).

2.4.6 Comparing correlations between learning tasks

In order to determine whether the Pearson's correlations between overall performance and each of the questionnaires/measured differed significantly from one another, tests of difference between independent correlation coefficients were conducted between all three conditions using freely available software (Preacher, 2002). Complete sets of comparisons can be seen in Appendix I.

When the ERB and HRB conditions were compared, the BDI-II, and BAS Total correlations were significantly different ($z = -2.22$, $p < .05$, $z = -2.23$, $p < .05$; both two-tailed) respectively. When the HRB and NRB conditions were compared only the BAS Total correlations differed significantly ($z = -2.08$, $p < .05$, two-tailed). The difference on the BDI-II was significant in the expected direction ($z = -1.71$, $p < .05$, one-tailed). There were no significant differences between the ERB and NRB conditions.

2.4.7 Discussion

The current study examined the relationship between several different depression and mood-related questionnaires, and performance on three different types of category learning tasks: an easy rule-based task (ERB), a complex rule-based task (HRB), and a non-rule-based task (NRB).

The primary relationship of interest was between self-reported current depressive symptoms (as assessed by the BDI-II), and performance on the category learning tasks. I predicted that there would be a significant negative relationship between BDI-II score and HRB performance, but no significant relationships between BDI-II score and ERB or NRB performance, and this hypothesis was confirmed when zero-order correlations were computed as well as when a multiple regression was conducted. I also collected participants' ratings of their history of depressive symptoms, and found that this was not significantly related to ERB, HRB, or NRB category learning. When the BDI-II correlations were compared between the conditions, there was a significant difference between the ERB and HRB category learning tasks, but the difference between per the HRB and NRB tasks was only significant with a one-tailed test.

Previous work by Smith et al. (1993) showed that subjects with higher ratings of depressive symptoms were impaired on RB category learning but unimpaired on NRB category learning. The present work replicates and extends those experiments with an updated measure of depressive symptoms (the BDI-II; Beck et al., 1996), and with a wider variety of category learning tasks. The RB tasks used by Smith et al. (1993) were equivalent in complexity to the ERB category set, and yet I did not find a significant negative relationship between task performance and depression score, while Smith et al.'s (1993) sample of university students with higher than average depressive symptom scores were impaired on this easy task relative to students with lower than average depressive symptom scores. One possibility is that the verbal nature of the stimuli used by Smith et al. (e.g. nonwords) increased the complexity of the task for participants. In a second study Smith et al. (1993) reported that only subjects classified as severely depressed were impaired on the criterial attribute (rule-based) category set, subjects classified as low and moderately depressed using BDI cut-offs were not. The HRB set used in the current experiment resulted in a negative relationship between performance and current depressive symptoms, and this is in line with the Smith et al. (1993) results, and extends the results with a more complex category set.

In addition to current depressive symptoms, I administered several related questionnaires. I predicted that current hypomanic symptoms might also be negatively related to performance on the HRB category set. I did not find this, or any other relationship between current hypomanic symptoms and category learning performance. This could be due to the fact that subjects in the current sample did not have a wide range of scores on this scale. However lifetime history of hypomanic symptoms was negatively related to overall HRB performance. This result was found in the zero-order correlations as well as the multiple regression analysis, and is in line with the hypothesis that hypomania could be related to executive function impairments (Malhi, Ivanovski, Hadzi-Pavlovic, Mitchell, Vieta, & Sachdev, 2007). However the differences between the correlation coefficients did not reach significance.

I hypothesized that if worry takes up space in working memory (as argued by Rapee, 1993) then higher levels of worry should impair complex rule-based (e.g. HRB) category learning. However proneness to worry was not related significantly to any of the category learning tasks when the zero-order correlation was inspected, however the results of the multiple regression indicated that proneness to worry was significantly and positively related to HRB performance. This unexpected result is difficult to interpret. It is possible that a harder to learn, rule-based category set would result in a significant negative relationship, and that on the current HRB set proneness to worry served to motivate participants to perform as well as possible.

The current study and choice of the BDI-II was motivated by prior work (e.g. Smith et al., 1993). It is possible that current self-reported depressive symptoms may be related to cognitive resources used in RB category learning in a way that other related constructs are not, a possibility that is strengthened by the results of the multiple regression analysis.

I predicted that there would be no relationship between performance on the NRB task and self-reported current depressive symptoms because the cognitive processes involved in

NRB learning are not mediated by the frontal brain regions affected by depression. In line with this hypothesis, no significant relationships between NRB category learning and any of the questionnaires were found in both zero-order correlations and regression analyses.

Limitations of this study are that the NRB task could also be learned with a complex verbal rule as described earlier, and the relatively small number of learning trials (80) might not have been sufficient to allow participants to develop a nonverbal learning strategy. Thus in Experiment 2 I use a NRB category set that can only be learned well via nonverbal processes, and I utilize a greater number of learning trials than in Study 1.

2.5 Study 2

Study 1 demonstrated that current level of self-reported depression, and self-reported history of hypomanic symptoms were negatively related to performance on a complex RB task, but not performance on a simple RB task. In contrast on a difficult category learning task that could be learned via verbal or nonverbal processes none of the questionnaire scores were significantly related to or significantly predicted overall performance. Study 2 was designed to extend and generalize these results with a different complex RB category set and a second category set that can only be learned well via nonverbal processes. A longer learning period was used to look at potential differences between early and late learning stages in addition to overall performance.

A measure of positive and negative mood was added to look at the relationship between current mood state and category learning performance. The use of the BDI in non-clinical student populations has been criticized and argued to not reflect major depression, but to reflect general distress or negative affectivity (Gotlib, 1984). In line with this argument, I found a pattern of strong positive intercorrelations between the majority of measures used in Study 1. However, the BDI-II accounted for the most variance in HRB performance. Adding a measure of current mood allows me to see the proportion of variance that is unique to BDI-II scores, in light of the current mood of participants. Watson et al. (1988) suggest that because depressive symptoms are affectively complex, it is helpful to include a measure of current mood that distinguishes between positive and negative mood states, as the BDI-II’s questions contain both positively and negatively valenced items. Further, given the relationship between positive mood and cognitive flexibility (e.g. Isen, Daubman, & Nowicki, 1987), it is possible that positive affect will be positively related to RB category learning performance. Positive affect is related to increased dopamine in frontal brain regions (Ashby et al., 1999; Depue & Collins, 1999). In contrast depression is associated with a pattern of left frontal hypoactivation (Henriques & Davidson, 1991), and possibly with reduced dopamine in frontal brain regions (Tye et al., 2012). Thus in Study 2 I again predicted that current depression symptoms would be negatively related to RB category learning performance, however it is unclear whether this relationship will remain significant in a regression with current mood included.

The BDI-II and the mood measure, the Positive Affect Negative Affect Schedule (PANAS: Watson, Clark, & Tellegen, 1988), are both straightforward measures of one's current state. Given the strong relationship found in Study 1 between the BDI-II and complex RB category learning, I predict that I will find a similarly strong relationship for current positive mood state and complex RB performance. Prior research on negative mood is less straightforward, with some studies demonstrating that negative mood narrows attention (Gasper & Clore, 2002), and other studies reporting null effects (Isen et al., 1987). Therefore it is possible that current negative mood will be negatively related to rule-based task performance, but it is also possible that no significant relationship will be found.

2.5.1 Method

2.5.1.1 Sample and design

Subjects included 82 adults (39 males, and 43 females) from the University of Western Ontario who participated for course credit. Average age was 18.89 years (*SD* = 1.10). Subjects were randomly assigned to one of the two category sets (described below).

2.5.1.2 Materials

2.5.1.2.1 Questionnaires

The majority of the questionnaires used in Study 1 were again used in Study 2: the Beck Depression Inventory II (BDI-II; Beck et al., 1996), the General Behavior Inventory

(GBI; Depue, 1987), the Penn State Worry Questionnaire (PSWQ; Meyer et al., 1990), and the Behavioral Inhibition System/Behavioral Approach System scale (BIS/BAS; Carver & White, 1994). The Hypomanic Personality Scale (HPS; Eckblad & Chapman, 1986), was not included in Study 2 due to the lack of significant relationships between HPS scores and category learning performance in Study 1, and to allow participants more time to complete the category learning tasks.

Additionally, current mood was assessed using the Positive Affect Negative Affect Schedule (PANAS; Watson et al., 1988), a well-established measure of positive and negative mood consisting of ten positive and ten negative descriptors which are rated from 1 ("not at all") to 5 ("extremely"). Participants are asked to rate how they feel "right now" in the "present moment" when responding. Responses to the positive (negative) descriptors are summed and averaged to create a positive (negative) affect scale.

2.5.1.2.2 Category learning tasks

Two category learning tasks were chosen: a) a complex, rule-based (RB) category learning task that could only be learned via a single-dimensional verbal rule, and b) a non-rule-based (NRB) category learning task that could only be learned well via a nonverbal rule.

The category learning task stimuli consisted of sine-wave gratings that varied in spatial frequency and orientation. A total of 80 stimuli were generated for each category set (RB and NRB), with 40 stimuli in each category (Ashby & Gott, 1988; Zeithamova & Maddox, 2006). Stimuli were generated by randomly sampling 40 values from a multivariate normal distribution described by each category's parameters. The PsychoPy package (Pierce, 2007) was used to generate sine wave gratings corresponding to each coordinate sampled from the distributions above. For both category learning tasks sine wave grating frequency was calculated as $f = .25 + (xf/50)$ cycles per stimulus and orientation was calculated as $o = xo \times (\pi/20)$ degrees. The resulting category structures for the RB and NRB category sets are illustrated in Figure 2.6.

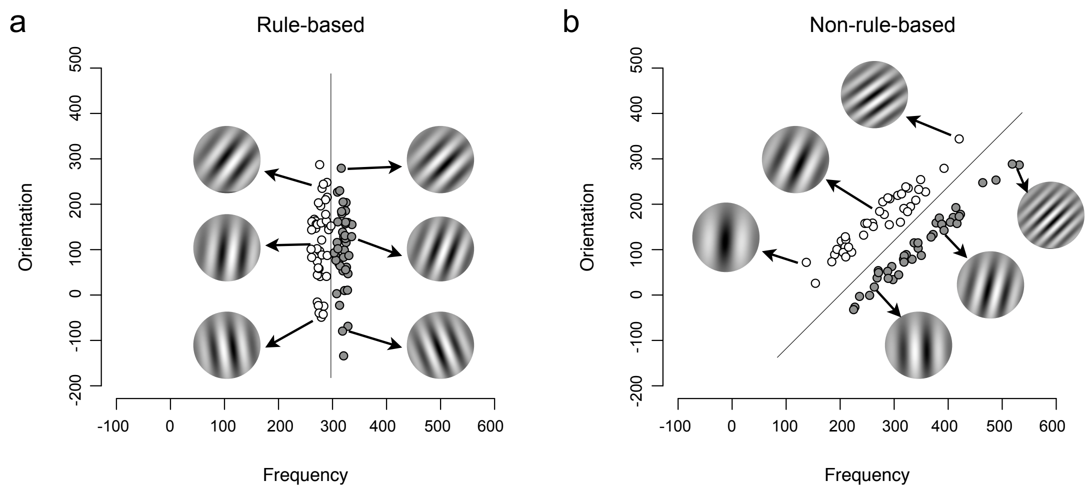

Figure 2.6. Rule-based (Panel A) and non-rule-based category (Panel B) category sets used in Study 2.

The RB category learning task required learners to find a single-dimensional rule and to simultaneously inhibit responding to the other dimension. In order to correctly classify the stimuli in Figure 2.6, Panel A, the learner needed to base responding on the frequency dimension while ignoring the more salient orientation dimension. An example optimal verbal rule could be phrased as: "Respond A if the stimulus has three or more stripes, otherwise respond B". The NRB category set in Figure 2.6, Panel B required learners to utilize both orientation and frequency, and there was no easily verbalizable rule that allowed for optimal performance.

2.5.1.3 Procedure

Subjects were tested in groups of up to 4 at a time, and each subject was seated at a carrel with a 15-inch iMac computer. Subjects completed the questionnaires on the computer and questionnaires were presented using SurveyMonkey. Following completion of the questionnaires subjects were randomly assigned to one of two category learning tasks (RB, NRB). Corrective feedback was given after each response on the category learning task. When responses were correct, participants saw the word "CORRECT" in green font before the next trial advanced. When a response was incorrect participants saw the word "INCORRECT" in red font. Participants had unlimited time in which to make responses.

All subjects completed four blocks of 80 trials (320 in total). The presentation order of the 80 stimuli was randomly generated on each block for each subject. After the 320 trials of the categorization task were completed participants were asked to complete a final survey unrelated to the present experiment and were then thanked for their participation and debriefed.

2.5.2 Results

2.5.2.1 Category learning task performance

The averaged proportion correct across all 320 trials of subjects who learned the RB category set was $M = .70$, $SD = .15$. The averaged performance of subjects who learned the NRB category set was $M = .60$, $SD = .10$. Performance on the category learning tasks was significantly different, $t(80) = 4.27$, $p < .001$. The learning curve of the two category learning tasks across all four blocks of performance is shown in Figure 2.7.

A repeated-measures analysis of variance (ANOVA) showed a significant effect of block for the RB category learning task, $F(3, 39) = 20.20$, $p < .001$, $\eta^2 = .608$, indicating that performance differed significantly across at least some learning blocks. Pair-wise comparisons showed that Block 1 ($M = .62$, $SD = .13$) performance was significantly lower than performance in Blocks 2 ($M = .73$, $SD = .15$), Block 3 ($M = .73$, $SD = .15$), and Block 4 ($M = .71$, $SD = .19$), $p < .001$. No other differences between blocks were significant (all p's > .05).

For the NRB category set, a repeated-measures ANOVA also found a significant effect of block, $F(3, 37) = 2.96$, $p < .05$, $\eta^2 = .193$. Pair-wise comparisons showed that Block 1 ($M = .57$, $SD = .07$) differed significantly from Block 2 ($M = .61$, $SD = .10$), $p < .05$, and 3 ($M = .62$, $SD = .11$), $p < .01$. However the difference between Block 1 and Block 4 ($M = .61$, $SD = .12$), did not reach significance, $p = .058$. No other differences between blocks reached significance (all p's > .05).

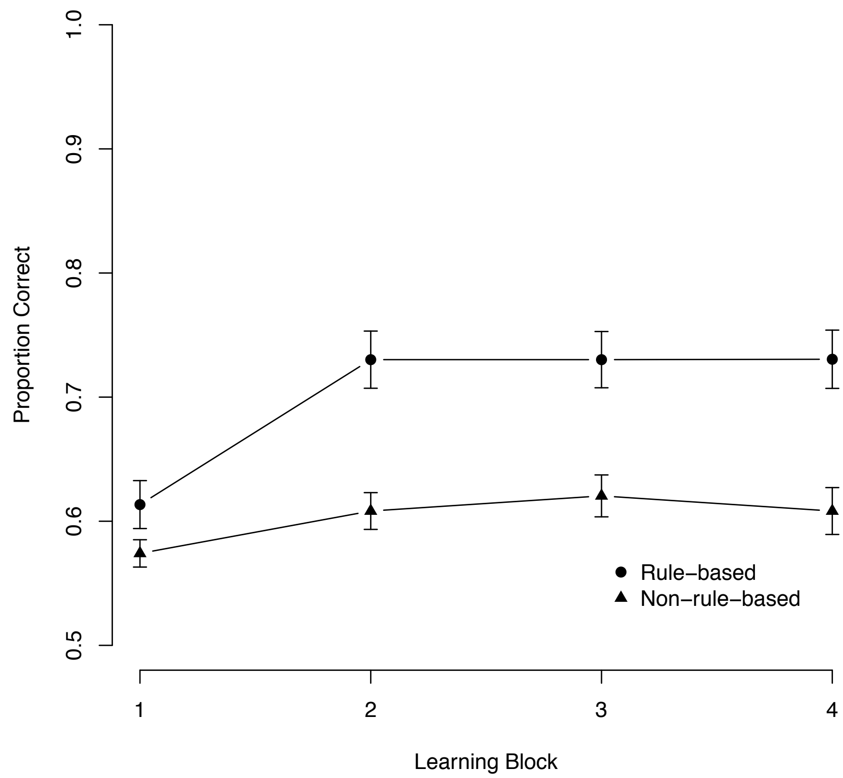

Figure 2.7. Category learning proportion correct of rule-based and non-rule-based conditions by block.

2.5.2.2 Questionnaire reliabilities and descriptives

The means and standard deviations of the questionnaires are presented in Table 2.3. The reliability of the majority of questionnaires was good: Cronbach's values between .73 and .95 for the BDI-II (α = .90), the GBI-D (α = .95), the GBI-H (α = .91), BAS Drive (α = .74), BAS Reward Responsiveness (α = .73), BAS Fun Seeking (α = .80), and BAS Total (α = .83), the PANAS Positive Scale (α = .91), and the PANAS Negative Scale (α = .92). The BIS scale however did not demonstrate good reliability (α = .64).

Table 2.6. Means (and standard deviations) of all questionnaires total scores between and across conditions.

Questionnaire	Rule-based	Non-rule-based	Overall
BDI-II	9.83 (6.56)	10.75 (9.52)	10.28 (8.10)
PSWQ	47.41 (11.70)	46.72 (11.79)	47.08 (11.68)
GBI-Depression	75.82 (16.96)	77.03 (21.90)	76.42 (19.47)
GBI-Hypomania	48.13 (10.30)	47.23 (11.86)	47.68 (11.05)
BAS Total	41.33 (4.86)	42.56 (4.78)	41.95 (4.83)
BIS	20.67 (2.83)	20.53 (3.05)	20.60 (2.92)
PANAS - Positive	2.52 (0.85)	2.73 (0.81)	2.62 (0.83)
PANAS - Negative	1.63 (0.72)	1.68 (0.75)	1.65 (0.73)

Notes: BDI-II = Beck Depression Inventory II, PSWQ = Penn State Worry Questionnaire, GBI = General Behavior Inventory, BIS = Behavioral Inhibition Scale, BAS = Behavioral Activation Scale, PANAS = Positive Affect Negative Affect Schedule.

2.5.2.3 Correlational and Regression Results

BAS subscales (BAS Fun Seeking, BAS Drive, and BAS Reward Responsiveness) were combined into a BAS Total score for both category learning conditions due to significant moderate and positive intercorrelations between the subscales (r's > .33), and because I was interested in overall BAS sensitivity, not specific BAS subscales. To correct the family-wise error rate, a more conservative p-value was used to determine significance using a Bonferroni correction (.05/8= $p < .0063$). All correlations reported or flagged as significant meet this stricter criterion.

Although the BDI-II, PSWQ, and PANAS Positive scale questionnaires correlated significantly with overall performance on the RB category learning task, these questionnaires correlated significantly with several of the other questionnaires (all questionnaire intercorrelations can be seen in Appendix E). Given the pattern of intercorrelations between questionnaires, I wanted to know whether these variables contributed a significant proportion of variance to performance on the category learning task that was not shared with the other variables. Although I only found significant correlations between performance on the category learning task and the questionnaires on the RB category learning task, I conducted a multiple linear regression on both of the category learning tasks with Block 1 and overall performance as the dependent variables (in two separate regressions) and the questionnaire scores (BDI-II, GBI-D, GBI-H, PSWQ, BAS Total, BIS, PANAS Positive, PANAS Negative) as the predictor variables.

All of the predictor variables were entered at the same time, and I centred all of the variables to insure against multicollinearity.

2.5.2.3.1 Rule-based correlations and regressions

Table 2.7 shows the correlations between all measures and the RB category set.

Depressive symptoms. As predicted, there was a significant correlation between subject scores on the BDI-II and overall RB category learning performance, $r(42) = -.462$, $p < .002$, shown in Figure 2.8, Panel B. This negative relationship between BDI total score and RB performance was present throughout performance, however it was strongest at the beginning of the learning task, $r(42) = -.539$, $p < .001$ (shown in Figure 2.8, Panel A), and not significant at any other learning block (r's = .280 - .381). The correlation between performance on the RB category set and the GBI-D did not reach significance overall, $r(39) = -.312$, $p = .053$, or at any single learning block, although there was a trend in Block 1, $r(39) = -.382$, $p < .02$.

Table 2.7. Correlations between performance on the rule-based category learning task and mood questionnaires.

	Rule-based learning performance				
	Block 1	Block 2	Block 3	Block 4	Overall
BDI-II	-.539*	-.353	-.381	-.280	-.462*
PSWQ	-.424*	-.312	-.200	.034	-.304
GBI - Depression	-.382	-.268	-.249	-.098	-.312
GBI - Hypomania	-.357	-.328	-.371	-.109	-.383
BIS	-.280	-.129	-.057	-.068	-.171
BAS Total	.055	-.044	-.013	-.053	-.007
PANAS Positive Affect	.454*	.365	.310	.375	.397
PANAS Negative Affect	-.076	.007	-.009	.047	-.040

Notes: * $p < .0063$. BDI-II = Beck Depression Inventory II, PSWQ = Penn State Worry Questionnaire, GBI = General Behavior Inventory, BIS = Behavioral Inhibition Scale, BAS = Behavioral Activation Scale, PANAS = Positive Affect Negative Affect Schedule.

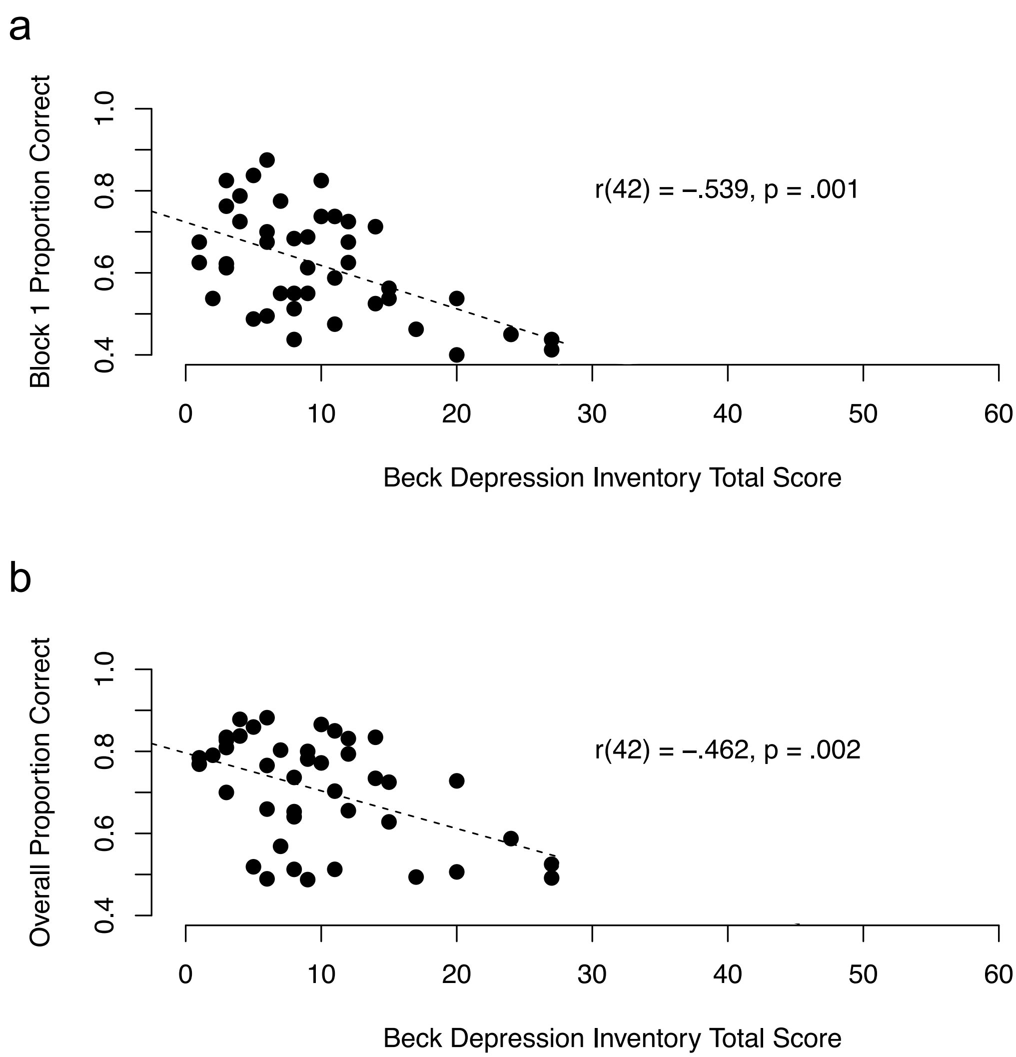

Figure 2.8. The relationships between: Block 1 rule-based category learning performance and current depressive symptoms (Panel A), and overall rule-based learning performance and current depressive symptoms (Panel B).

Hypomania. There was no significant relationship between overall RB performance and the GBI-H, $r(39) = -.383$, $p < .02$. This relationship did not reach significance at any stage of learning (all *r*'s between -.109 and -.371).

Worry. The correlation between RB overall performance and the PSWQ did not reach significance, $r(41) = -.304$, $p = .05$. However there was a significant relationship between the PSWQ and RB performance in Block 1, $r(41) = -.424$, $p = .006$, as shown in Figure

2.9. This relationship did not reach significance in any subsequent blocks (*r*'s = .034 - -.312).

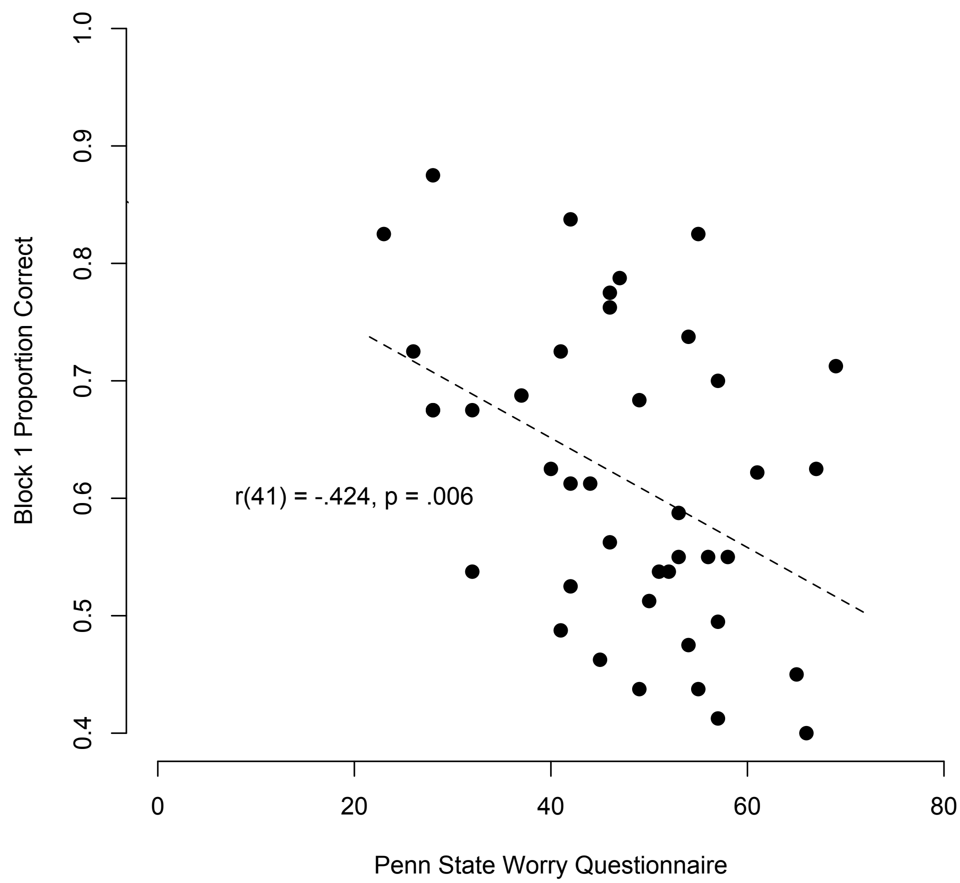

Figure 2.9. Relationship between Block 1 rule-based category learning and proneness to worry.

Mood. Current positive mood as measured by the PANAS Positive Scale correlated significantly and positively with performance on the RB category set in Block 1, $r(39) = .454$, $p = .004$, as shown in Figure 2.10, but not with overall performance, $r(39) = .397$, $p = .01$, or in Blocks 2-4 (*r*'s = .310 - .375). In contrast negative mood did not correlate significantly with overall RB performance, $r(39) = -.040$, $p = .81$, or performance at any individual block (*r*'s = .007 - .076).

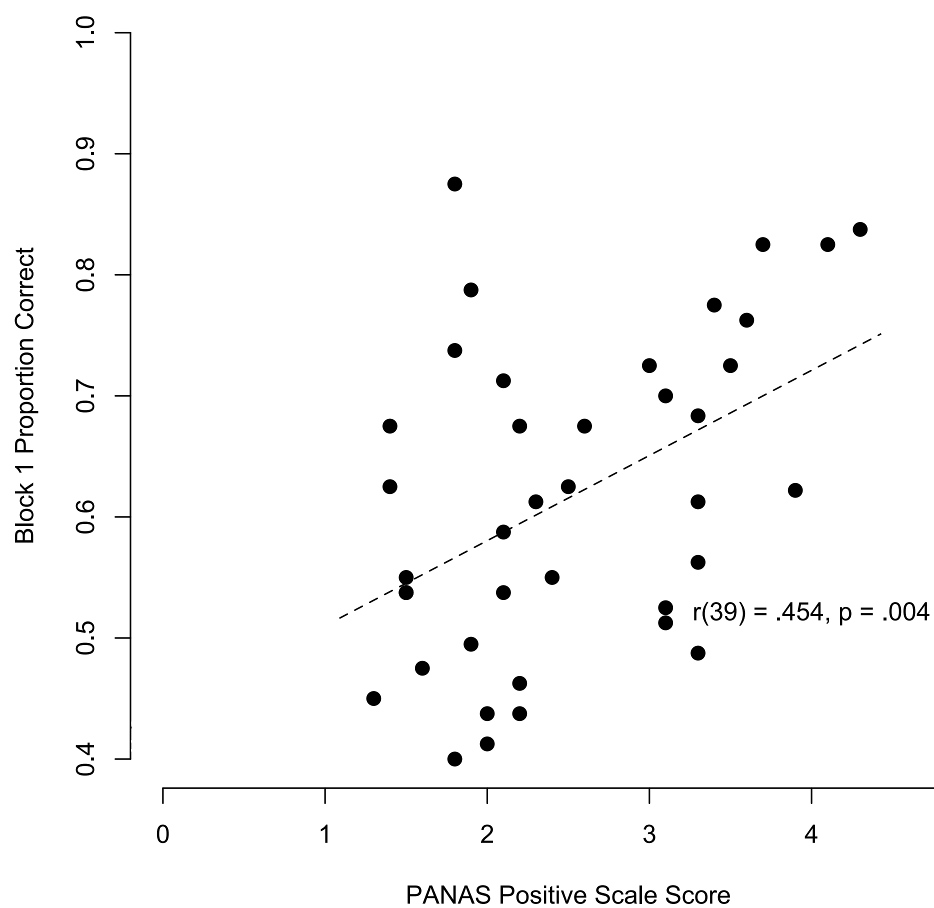

Figure 2.10. Relationship between Block 1 rule-based category learning and positive mood.

Approach/avoidance motivation. There was no significant relationship between BIS and overall performance, $r(39) = -.040$, $p = .81$, or BAS Total and overall performance, $r(39) = -.040$, $p = .81$, or any significant relationships at any point in learning (all *p*'s > .006).

All Block 1 and overall performance scatterplots for the RB category set can be found in Appendix J.

Regression Results

Block 1. The multiple regression between the questionnaires and Block 1 RB performance reached significance, meaning that the linear combination of the eight questionnaires was significantly related to performance, (R^2= .501, adjusted R^2 = .368, $F(8, 38) = 3.76$, $p = .004$). Only the PANAS positive mood subscale significantly predicted Block 1 RB performance, ($\beta = -.01$, $t = 2.50$, $p < .05$).

Table 2.8 shows the zero-order, partial, and part correlations of Block 1 RB performance with the questionnaires included in the regression. When the variability from the other questionnaires was removed from performance only positive mood remained significant, $r(39) = .322$, $p < .05$, accounting for 10% of the variance in Block 1 RB performance. Notably, when the variability that could be attributed to other variables was removed from the BDI-II the relationship between the BDI-II and Block 1 RB performance was no longer significant, $r(39) = -.143$, $p = .28$. Similarly, when the variability that could be attributed to other variables was removed from the relationship between the PSWQ and Block 1 RB performance the relationship was no longer significant, $r(39) = -.038$, $p =$ .77.

Table 2.8. Zero-order, partial, and part correlations between rule-based Block 1 performance and all questionnaires.

	Rule-based block 1 performance		
	Zero-order	**Partial**	**Part**
BDI-II	-.539**	-.199	-.143
PSWQ	-.424**	-.054	-.038
GBI - Depression	-.382	.159	.114
GBI- Hypomania	-.357	-.320	-.238
BIS	-.280	-.158	-.113
BAS Total	.055	-.046	-.032
PANAS Positive Affect	.454**	.415	.322*
PANAS Negative Affect	-.076	-.051	-.036

Notes: ** $p < .0063$, * $p < .05$ in the regression equation. BDI-II = Beck Depression Inventory II, PSWQ = Penn State Worry Questionnaire, GBI = General Behavior Inventory, BIS = Behavioral Inhibition Scale, BAS = Behavioral Activation Scale, PANAS = Positive Affect Negative Affect Schedule.

When the regression analysis was repeated *without* the PANAS questionnaire subscales (positive and negative), the regression remained significant (R^2= .382, adjusted R^2= .266, $F(6, 38) = 3.29$, $p = .012$). The BDI-II ($\beta = -.01$, $t = -2.36$, $p < .05$), significantly predicted RB Block 1 performance, accounting for 11% of the variance in performance. This result is in line with the main result from Study 1.

Overall performance. The multiple regression between the questionnaires and overall RB performance also reached significance, meaning that the linear combination of the eight questionnaires was significantly related to overall performance, (R^2= .471, adjusted R^2 = .330, $F(8, 38) = 3.34$, $p = .007$).

The GBI-H ($\beta = -.01$, $t = -2.94$, $p < .01$), and the PANAS positive subscale ($\beta = .09$, $t = 2.71$, $p < .05$) questionnaires significantly predicted RB overall performance, accounting for 15% and 13% of the variance respectively.

Table 2.9 shows the zero-order, part, and partial correlations of overall RB performance with the questionnaires included in the regression. Notably the correlation between overall RB performance and the BDI-II did not remain significant when the variability from the other questionnaires was removed, $r(39) = -.121$, $p > .05$.

Table 2.9. Zero-order, partial, and part correlations between overall rule-based performance and all questionnaires.

	Rule-based overall performance		
	Zero-order	**Partial**	**Part**
BDI-II	-.462**	-.165	-.121
PSWQ	-.304	.026	-.019
GBI – Depression	-.312	.282	.214
GBI- Hypomania	-.383	-.473	-.390*
BIS	-.171	-.048	-.035
BAS Total	-.007	-.061	-.044
PANAS Positive Affect	.397	.444	.360*
PANAS Negative Affect	-.040	.039	.028

Notes: ** $p < .0063$, * $p < .05$ in the regression equation. BDI-II = Beck Depression Inventory II, PSWQ = Penn State Worry Questionnaire, GBI = General Behavior Inventory, BIS = Behavioral Inhibition System, BAS = Behavioral Activation System, PANAS = Positive Affect Negative Affect Schedule.

When the regression analysis was repeated *without* the PANAS questionnaire subscales (positive and negative), the regression did not reach significance, (R^2= .295, adjusted R^2= .162, $F(6, 38) = 2.23$, $p = .07$).

2.5.2.3.2 Non-rule-based correlations and regression

As shown in Table 2.10, there were no significant correlations between overall NRB performance and any of the questionnaires (all *p*'s > .0063). Additionally when the four learning blocks were examined individually there were no significant correlations between NRB performance at any block and any of the questionnaires (all *p*'s > .0063). All Block 1 and overall performance scatterplots for the NRB category set can be found in Appendix K.

Table 2.10. Correlations between performance on the non-rule-based category learning task and questionnaires.

	Non-rule-based learning performance				
	Block 1	Block 2	Block 3	Block 4	Overall
BDI-II	.025	-.186	.129	.014	-.001
PSWQ	-.096	-.284	-.020	-.081	-.142
GBI – Depression	-.024	-.255	-.066	-.093	-.138
GBI- Hypomania	.153	-.289	.007	-.090	-.083
BIS	.096	-.008	-.131	-.072	-.052
BAS Total	.184	-.122	.071	.012	.034
PANAS Positive Affect	.163	.209	.217	.185	.241
PANAS Negative Affect	-.060	-.088	.138	.150	.066

Notes: BDI-II = Beck Depression Inventory II, PSWQ = Penn State Worry Questionnaire, GBI = General Behavior Inventory, BIS = Behavioral Inhibition Scale, BAS = Behavioral Activation Scale, PANAS = Positive Affect Negative Affect Schedule.

Although NRB performance was fairly low across the 320 trials (M = .60, SD = .10), the results do not indicate that the lack of significant correlations was due to an overall absence of learning. When participants were split into two groups based on overall performance (both N's = 20) and the correlations between performance and the questionnaires were computed for these groups separately the pattern of results did not change. There were no significant correlations between NRB category learning and any of the questionnaires for either the high performance (M = .67, SD = .05) or low performance (M = .54, SD = .04) groups. Further, when the mean BDI score of high performing subjects (M = 11.10, SD =11.94) and low performing subjects (M = 10.75, SD

= 7.51) was compared, there was no significant difference between the groups, $F(1, 39) = 0.012$, $p = .91$.

NRB. The multiple regression between the questionnaires and NRB performance did not reach significance for either Block 1, ($R^2 = .208$, adjusted $R^2 = -.011$, $F(8, 37) = 0.01$, $p = .95$), or overall performance, ($R^2 = .168$, adjusted $R^2 = -.062$, $F(8, 37) = 0.01$, $p = .73$).

2.5.3 Comparing correlations between conditions

In order to determine whether the Pearson's correlations between Block 1 and overall performance and each of the questionnaires/measured differed significantly from one another, tests of difference between independent correlation coefficients were conducted between the RB and NRB conditions using freely available software (Preacher, 2002). Complete sets of comparisons can be seen in Appendix L.

When the Block 1 correlations between the RB and NRB conditions were compared, the BDI-II ($z = -2.74$, $p = .006$), GBI-H ($z = -2.24$, $p < .05$), and PANAS Positive ($z = -2.62$, $p = .009$) correlations were significantly different (all two-tailed). When overall performance correlations between the RB and NRB conditions were compared, only the BDI-II differed significantly ($z = -2.17$, $p < .05$, two-tailed).

2.5.4 Discussion

Study 2 extended the results of Study 1 by using a RB category learning task that has previously been found to benefit from cognitive flexibility, as well as a category set that can only be learned well via nonverbal processes, and has not been found to benefit from cognitive flexibility (Maddox et al., 2006). Due to the increased complexity of these category sets, and to allow for the examination of early versus late periods of learning, participants completed more trials than in Study 1. In addition to measuring current level of depressive symptoms and depressive symptom history and related constructs, I added a measure of current positive and negative mood.

As in Study 1, there was a significant negative relationship between current level of self-reported depressive symptoms and complex RB performance. This relationship was present in overall performance, and was strongest in the first block of learning (which is equivalent to the overall performance of Study 1). As in Study 1 there were no significant relationships between history of depressive symptoms and RB category learning performance.

Unlike Study 1 I found a significant negative relationship between proneness to worry and RB performance. Students who reported higher levels of worrying performed less well in the first block of learning. This difference in results could be due to the increased complexity of the current rule-based category set. Although the rule was single-dimensional the current stimuli were more visually complex and may have placed increased demands on working memory.

I found a strong and significant relationship between self-reported positive affect and RB category learning performance in early learning. There was no relationship between self-reported negative affect and category learning.

In addition to zero-order correlations, I also conducted a multiple linear regression in order to examine the influence of each of the questionnaires when the variability that was shared with other questionnaires was removed due to the strong and positive correlations between many of the questionnaires. The results revealed that although the BDI-II correlated strongly and negatively with RB performance, this correlation was reduced below significance in regressions examining the Block 1 and overall RB performance. Only positive mood significantly predicted Block 1 performance, and only positive mood and history of hypomanic symptoms significantly predicted overall performance.

As in Study 1 there were no significant relationships between NRB performance and any of the questionnaire scores. This is in line with the idea that RB and NRB category learning are governed by distinct category learning systems (Ashby et al., 1998).

2.6 General Discussion

The key findings from this series of studies are that a) self-reported depressive symptoms are negatively related to complex rule-based category learning performance, b) this relationship does not remain significant when the variance that can be attributed to positive mood is removed, and c) current self-reported positive mood is positively related to complex rule-based category learning performance, and this relationship persists when the variance that can be attributed to other questionnaires/constructs is removed.

Study 1 extends the results of Smith et al. (1993), showing that depressive symptoms (as assessed with a self report inventory) are negatively related to RB category learning. However Study 1 also assessed several related constructs, and found that history of hypomanic symptoms was also negatively related to RB performance, a finding that did not change when the variance that could be attributed to other measures was taken into consideration.

In light of this pattern of results and the work of Smith et al. (1993), it would be tempting to conclude that depressive symptoms are negatively related to RB category learning performance, and that these results are in line with the idea that major depression is related to impaired executive functioning. However the pattern of intercorrelations between questionnaires and the results of Study 2 call this conclusion into question.

Across both studies current depressive symptoms correlated positively with history of depressive symptoms, history of hypomanic symptoms, and proneness to worry. Interestingly, when a multiple linear regression was performed with positive mood included, the effects of depressive symptoms were reduced below significance, and only positive mood significantly predicted early RB learning. When positive mood was excluded from the regression, the results mirrored the results from Study 1, in that depressive symptoms significantly predicted RB performance. In light of the intercorrelations between these variables and the predictive power of current positive mood ratings it is hard to argue that the self-reports of depressive symptoms are measuring depression and not general psychological distress, as argued by Gotlib (1984).

However Clark and Watson (1991) reported that the BDI seems to measure three components: a general distress component, a low positive mood component, and a general somatic complaints component. The finding that positive mood contributes more unique variance to RB category learning than depressive symptoms (that include a low positive mood component) suggests that in a general university population the BDI might be assessing (the lack of) positive mood. This is in line with the DSM-IV definition of depression, which requires either elevated sad mood or a loss of pleasure/interest (e.g. anhedonia).

Study 2 is the first study (to the best of my knowledge) to look at the potential relationship between mood and category learning performance. I found a significant positive relationship between positive mood and complex RB category learning in early learning. This finding is in line with prior research showing that positive mood increases cognitive flexibility (Ashby et al., 1999; Isen et al., 1987). The existence of a positive relationship between positive mood and RB learning, as well as the lack of any significant relationship between positive mood and NRB learning is in line with the hypothesis that positive affect is related to increased dopamine in frontal brain regions (e.g. Ashby et al., 1999). In contrast negative mood was not significantly related to either RB or NRB category learning performance.

History of hypomanic symptoms significantly predicted complex RB performance in Study 1 and Study 2. Further research is needed to examine this potential relationship. As in depression, the mesolimbic dopamine circuit has been implicated in theories of bipolar disorder (Cousins, Butts, & Young, 2009), thus it might not be surprising that hypomania symptom history/future risk of bipolar disorder is negatively related to complex rule-based category learning performance.

Proneness to worry was assessed in both Study 1 and Study 2, with conflicting results. Study 1 found that proneness to worry was positively related to HRB category learning performance, while Study 2 found that proneness to worry was negatively related to early rule-based category learning performance. Further work is needed to clarify the nature of this relationship.

Approach and avoidance motivation were assessed in both studies, and no significant results were found between category learning performance and either variable. The lack of relationship between avoidance motivation and category learning performance could be due to the fact that the category learning tasks were not particularly threatening. The relationship between approach motivation and HRB category learning performance approached significance in Study 1 but not Study 2. One speculation is that there was a subtle activation of the approach system in Study 1 due to the use of smiling faces to inform subjects of correct responses.

A key limitation to the generality of this work is the correlational nature of the studies. Although the correlations were theoretically motivated, and the results were compelling, strong conclusions cannot be drawn. Future research should examine the influence of manipulated mood on category learning. In order to address whether clinical depression is related to impaired RB category learning it will be necessary to use patients who have been identified as clinically depressed, something that my work nor the work of Smith et al. (1993) has done.

So, is there an upside to feeling down? Based on the pattern of findings across the two studies, the short answer is “no”. Depressive symptoms were negatively related to complex, rule-based category learning performance, and negative mood ratings were unrelated to learning. Rather it seems that positive mood is related to improved complex learning. Current positive mood was positively related to complex rule-based category learning and when positive mood was included in a multiple regression with depressive symptoms, only positive mood significantly predicted performance.

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Chapter 3

3 Better mood and better performance: learning rule-based categories is enhanced by a positive mood[6]

3.1 Experiment

A well-established finding is that mood interacts with cognitive processing (for a review, see Isen, 1999), with executive functioning implicated as a possible source of the effects of this interaction (Mitchell & Phillips, 2007). Positive mood leads to enhanced cognitive flexibility, whereas negative mood may reduce (or may not affect) cognitive flexibility (for a review, see Ashby, Isen, & Turken, 1999). Category learning has also been associated with cognitive flexibility[7] (Ashby et al., 1999; Maddox, Baldwin, & Markman, 2006), making category learning well suited to the study of the effects of mood on cognition. For example, Ashby, Alfonso-Reese, Turken, and Waldron (1998) predicted that depressed subjects should be impaired in learning rule-based (RB) category sets. Smith, Tracy, and Murray (1993) supported this prediction and also found that depressed subjects were not impaired when learning non-RB categories. However, the more general question of how induced positive and negative mood states influence category learning remains unanswered. We addressed this question by using two kinds of categories, one in which learning is thought to be enhanced by cognitive flexibility and one in which learning is not thought to be enhanced by cognitive flexibility (Maddox et al., 2006).

Our starting point was the COmpetition between Verbal and Implicit Systems (COVIS) theory, which posits the existence of separate explicit/verbal and implicit/nonverbal category-learning systems (Ashby et al., 1998). The explicit/verbal system enables people to learn RB categories and is associated with the prefrontal cortex (PFC) and the anterior

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[7] We define cognitive flexibility as the ability to seek out and apply alternate strategies to problems (Maddox, Baldwin, & Markman, 2006) and to find unusual relationships between items (Isen, Johnson, Mertz, & Robinson, 1985).

cingulate cortex (ACC). RB category learning uses hypothesis testing, rule selection, and inhibition to find and apply rules that can be verbalized, and it is influenced by cognitive flexibility. The implicit system enables people to learn non-RB categories, relies on connections between visual cortical areas and the basal ganglia, and is not affected by cognitive flexibility. This system is likely procedural in nature and dependent on a dopamine-mediated reward signal (Maddox, Ashby, Ing, & Pickering, 2004). RB and non-RB category sets have been dissociated behaviorally (for a review, see Maddox & Ashby, 2004) and neurobiologically (Nomura et al., 2007), making them appropriate for the study of mood effects.

We argue that positive mood increases cognitive flexibility, and this effect enhances the explicit category-learning system mediated by the PFC (Ashby et al., 1999; Ashby & Ell, 2001; Minda & Miles, 2010). We base our predictions on two lines of research. First, Ashby et al. (1999) hypothesized that positive affect is associated with enhanced cognitive flexibility as a result of increased dopamine in the frontal cortical areas of the brain. Second, the COVIS theory predicts that increased dopamine in the PFC and ACC should enhance learning on RB tasks, and reduced dopamine should impair learning on RB tasks (Ashby et al., 1998). Thus, positive mood should be associated with enhanced RB category learning, an important prediction that has not to our knowledge been tested directly.

We induced a positive, neutral, or negative mood in subjects and presented them with one of two kinds of category sets that have been widely used in the category-learning literature (Ashby & Maddox, 2005). These sets consisted of sine-wave gratings (Gabor patches) that varied in spatial frequency and orientation. The RB set of Gabor patches required learners to find a single-dimensional rule in order to correctly classify the stimuli on the basis of frequency but not orientation, and the NRB set of Gabor patches required learners to assess both orientation and frequency. Subjects in the RB condition were able to formulate a verbal rule to ensure optimal performance, but subjects in the NRB condition were not able to form a rule that could be easily verbalized.

We predicted that subjects in a positive mood, compared with those in a neutral or negative mood, would perform better when learning RB categories. It was unclear whether a negative mood would impair RB learning relative to a neutral mood, as the effects of negative mood on cognitive processing are variable and difficult to predict (for a review, see Isen, 1990). Because the PFC and the ACC do not mediate the nonverbal system, we did not expect mood to affect NRB category learning.

3.2 Method

3.2.1 Subjects

Subjects were 87 university students (61 females and 26 males), who received $10.00 or 1 hour of course credit for participation. Subjects were randomly assigned to one of the three mood-induction conditions and one of the two category sets. Six subjects who scored below 50% on the categorization task were excluded from data analysis.

3.2.2 Materials

We used a series of music clips and video clips from YouTube[8] to establish affective states. We verified that these clips evoked the intended emotions by conducting a pilot study. After each viewing or listening, subjects in the pilot study (7 graduate students, who did not participate in the main experiment) rated how the clip made them feel on a 7-point scale, which ranged from 1 (*very sad*) to 4 (*neutral*) to 7 (*very happy*). Table 3.1 shows the complete list of clip selections and the average ratings by pilot subjects; it also denotes the clips selected for the main experiment. As a manipulation check during the main experiment, we queried subjects with the Positive and Negative Affect Schedule (PANAS) after using the selected clips to induce moods. The PANAS assesses positive and negative affective dimensions (Watson, Clark, & Tellegen, 1988).

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[8] The clips can be found by searching for their titles on YouTube (http://www.youtube.com/), or URLs can be obtained from the first author.

Table 3.1. Music and video clips used in the pilot study.

Selection		**Average subject rating**
Positive Music	Mozart – "Eine Kleine Nachtmusik Allegro"*	6.57
	Handel - "The Arrival of the Queen of Sheba"	5.00
	Vivaldi - "Spring"	6.14
Neutral Music	Mark Salona - "One Angel's Hands"*	3.86
	Linkin Park - "In the End (Instrumental)"	4.14
	Stephen Rhodes - "Voice of Compassion"	3.29
Negative Music	"*Schindler's List* Soundtrack - Main Theme"*	2.00
	"I Am Legend Movie Theme Song"	2.71
	"Distant Everyday Memories"	2.57
Positive Video	"Laughing Baby"*	6.57
	"*Whose Line is it Anyway*: Sound Effects"	6.43
	"Where the Hell is Matt?"	6.00
Neutral Video	"*Antiques Roadshow* television show"*	4.14
	"Facebook on 60 Minutes"	3.71
	"Report on the importance of Sleep"	4.29
Negative Video	"Chinese Earthquake news report"*	1.43
	"Madison's story -- about child with cancer"	1.71
	"Death scene from the film "The Champ""	1.86

Notes: Clips were taken from the Youtube Web site. Asterisks denote clips that were used in Experiment 1.

The Gabor patches used in the main experiment were generated according to established methodologies (see Ashby & Gott, 1988; Zeithamova & Maddox, 2006). For each category set (RB and NRB), we randomly sampled 80 values from a multivariate normal distribution described by that category's parameters (shown in Table 3.2). The resulting structures for the RB and NRB category sets are illustrated in Figure 3.1.[3] We used the PsychoPy software package (Pierce, 2007) to generate a Gabor patch corresponding to each coordinate sampled from the multivariate distributions.

[3] Stimulus parameters and generation were the same as those used by Zeithamova and Maddox (2006).

Table 3.2. Distribution parameters for rule-based and non-rule-based category sets.

Category Structure	μ_f	μ_o	σ^2_f	σ^2_o	$cov_{f,o}$
Rule-based					
Category A	280	125	75	9000	0
Category B	320	125	75	9000	0
Non-rule-based					
Category A	268	157	4538	4538	435
Category B	332	93	4538	4538	4351

Notes: Dimensions are in arbitrary units; see Figure 3.1 for scaling factors. The subscripted letters *o* and *f* refer to orientation and frequency, respectively.

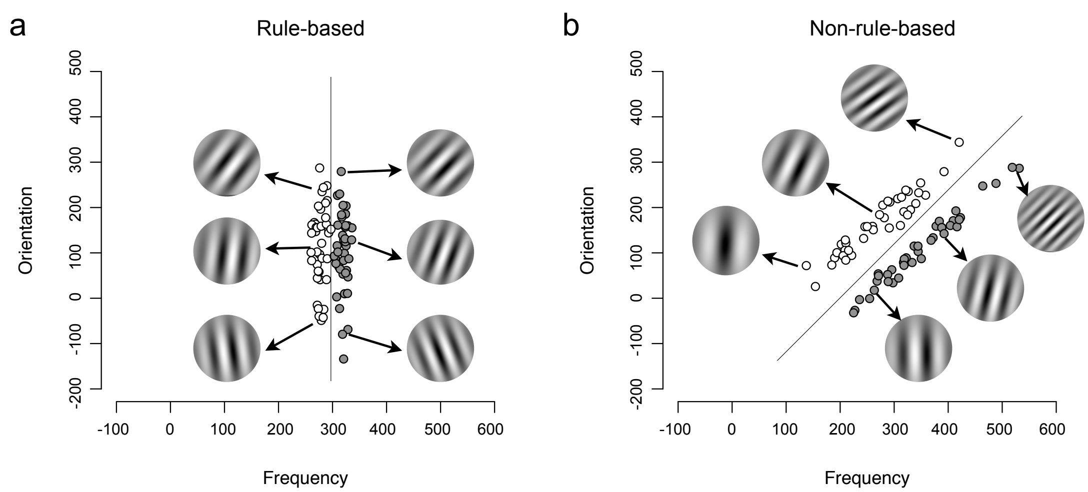

Figure 3.1. Structures used in the rule-based category set (Panel A) and non-rule-based, category set (Panel B). Category A stimuli are represented by light circles, and Category B stimuli are represented by dark circles. The solid lines show the optimal decision boundaries between the stimuli. The values of the stimulus dimensions are arbitrary units. Each stimulus was created by converting the value of these arbitrary units into a frequency value (cycles per stimulus) and an orientation value (degree of tilt). For both category sets, the grating frequency (f) was calculated as $0.25 + (x_f/50)$ cycles per stimulus, and the grating orientation (o) was calculated as $x_o \times (\pi/20)°$. The Gabor patches are examples of the actual stimuli seen by subjects.

3.2.3 Procedure

In the main experiment, subjects were assigned randomly to one of three mood-induction conditions (positive, neutral, or negative), as well as to one of two category sets (RB or NRB). Subjects were presented with the clips (music first, then video) from their assigned mood condition and then completed the PANAS so we could ensure that the mood induction was successful.

After receiving instructions, subjects performed a category-learning task on a computer. On each trial, a Gabor patch appeared in the center of the screen, and subjects pressed the "A" or the "B" key to classify the stimulus. Subjects who viewed the RB category set (Figure 3.1, Panel A) had to find a single-dimensional rule to correctly classify the stimuli on the basis of the frequency of the grating, while ignoring the more salient dimension of orientation. The optimal verbal rule for such classification could be phrased as follows: "Press 'A' if the stimulus has three or more stripes; otherwise, press 'B.'" The NRB category set (Figure 3.1 Panel B) required learners to assess both orientation and frequency. There was no rule for this set that could be easily verbalized to allow for optimal performance. In both conditions, feedback ("CORRECT" or "INCORRECT") was presented after each response. Subjects completed four unbroken blocks of 80 trials each (320 total). The presentation order of the 80 stimuli was randomly generated within each block for each subject.

3.3 Results

3.3.1 PANAS

Scores on the Positive Affect scale were as follows—positive-mood condition: 2.89; neutral-mood condition: 2.45; and negative-mood condition: 2.42. A significant effect of mood on positive affect was found, $F(2, 78) = 3.98$, $p < .05$, $\eta^2 = .093$. Positive-mood subjects showed only marginally more positive affect than neutral-mood subjects did ($p < .06$), but they showed significantly more positive affect than negative-mood subjects did ($p < .05$). These scores indicate that the mood-induction procedures were effective. Scores on the Negative Affect scale were as follows—positive-mood condition: 1.15; neutral-mood condition: 1.18; and negative-mood condition: 2.13. A significant effect of mood on negative affect was found, $F(2, 78) = 30.36$, $p < .001$, $\eta^2 = .438$, with negative-mood subjects showing significantly more negative affect than positive- and neutral-mood subjects did ($p < .0001$ in both cases). These results again indicate that the mood-induction procedures were effective.

3.3.2 Category learning

Figure 3.2 shows the learning curve (average proportion of correct responses in Blocks 1–4) for each condition and each category set. A mixed analysis of variance revealed main effects of category set, $F(1, 75) = 31.94$, $p < .001$, $\eta^2 = .257$; mood, $F(2, 75) = 4.40$, $p < .05$, $\eta^2 = .071$; and block, $F(3, 225) = 41.33$, $p < .001$, $\eta^2 = .322$. It also revealed a significant interaction between mood and category set, $F(2, 75) = 4.17$, $p < .05$, $\eta^2 = .067$. We conducted two separate analyses of variance (one for the RB category and one for the NRB category) to examine this interaction.

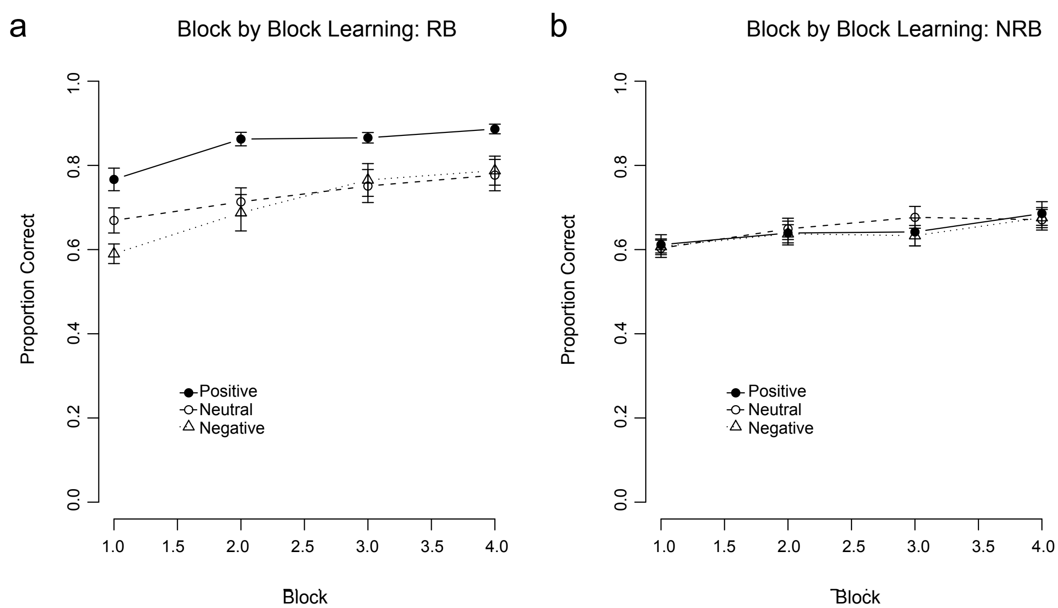

Figure 3.2. Average proportion of correct responses to stimuli in three mood conditions as a function of trial block. Subjects were tested on either the rule-based (RB) category set (Panel A) or the NRB category set (Panel B). Error bars denote standard errors of the mean.

A main effect of mood on overall performance was found for the RB category set, $F(2, 35) = 6.28$, $p < .001$, $\eta^2 = .264$. A Tukey's honestly significant difference test showed that overall performance by subjects in the positive-mood condition ($M = .85$) was higher than performance by subjects in the negative-mood condition ($M = .73$, $p < .0001$) and subjects in the neutral-mood condition ($M = .73$, $p < .0001$). Performance did not differ between subjects in the neutral- and negative-mood conditions ($p = .69$). No effect of mood on overall performance was found for the II category set ($p = .71$). Overall proportions correct were as follows—positive-mood condition: .64; negative-mood condition: .66; and neutral-mood condition: .64.

3.3.3 Computational modeling

For insight into the response strategies used by our subjects, we fit decision-bound models to the first block of each subject's data[9] (see Ashby, 1992a; Maddox & Ashby, 1993). We analyzed the first block of trials because that is when mood-induction effects are likely to be strongest, and it is also when cognitive flexibility is most needed. One class of models assumed that each subject's performance was based on a single-dimensional rule (we used an optimal version with a fixed intercept and a version with the intercept as a free parameter). Another class of models assumed that each subject's performance was based on the two-dimensional NRB boundary (we used an optimal version with a fixed intercept and slope, a version with a fixed slope, and a version with a freely varying slope and intercept). We fit these models to each subject's data by maximizing the log likelihood. Model comparisons were carried out using Akaike's information criterion, which penalizes a model for the number of free parameters (Ashby, 1992b). The proportion of subjects whose responses were best fit by their respective optimal model is shown in Figure 3.3. For the RB categories, .83 of positive-mood subjects, .62 of neutral-mood subjects, and .54 of negative-mood subjects were fit best by a model that assumed a single-dimensional rule. For the NRB categories, .71 of positive-

[9] See Appendix N for further computational modeling details.

mood subjects, .40 of neutral-mood subjects, and .43 of negative-mood subjects were fit best by one of the NRB models.

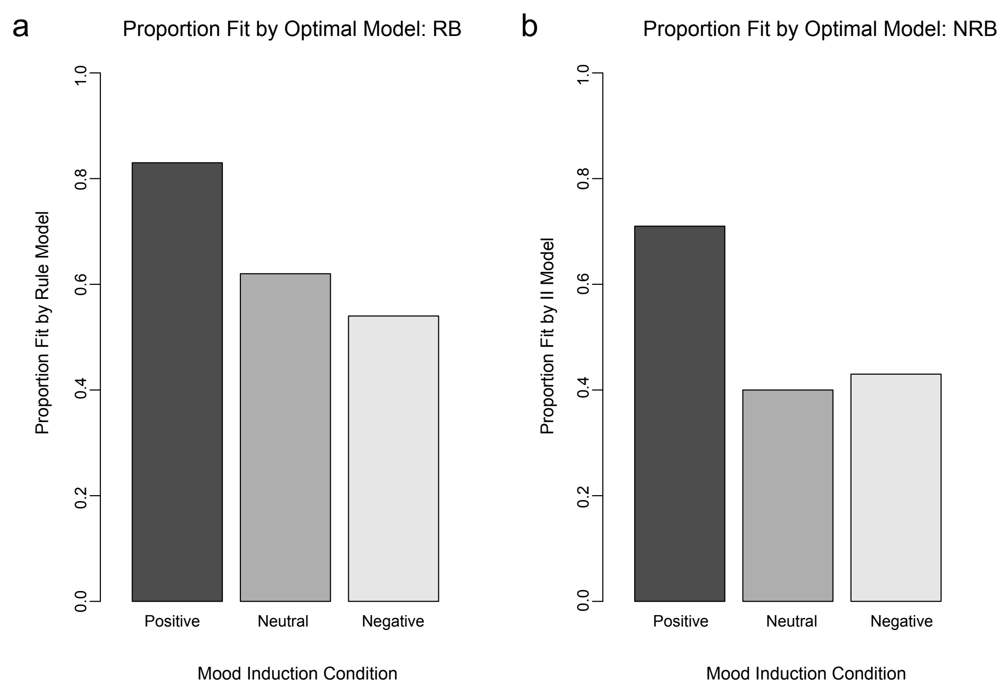

Figure 3.3. Proportion of subjects in each mood-induction condition whose responses best fit the optimal model for the category set to which they were assigned. Subjects learned either the a) rule-based (RB) category set or the b) non-rule-based (NRB) category set.

3.4 Discussion

In this experiment, positive, neutral, and negative moods were induced before subjects learned either an RB or a NRB category set. The RB set required subjects to use hypothesis testing, rule selection, and response inhibition to achieve optimal performance, and the NRB set was best learned by associating regions of perceptual space with responses (Ashby & Gott, 1988). We found that positive mood enhanced RB learning compared with neutral and negative moods. Mood did not seem to affect NRB learning. However, a comparison of decision-bound models suggested that positive-mood subjects displayed a greater degree of cognitive flexibility compared with neutral- and negative-mood subjects by adopting an optimal strategy early in both RB and NRB learning.

The COVIS theory suggests that people learn categories using an explicit, rule-based system or an implicit, similarity-based system (Ashby et al., 1998; Ashby & Maddox, 2005; Minda & Miles, 2010). The brain areas that mediate these systems have been well studied, linking the PFC, ACC, and medial temporal lobes to the explicit system but not to the implicit system. Our experiment highlights a variable that facilitates the learning of RB categories using the explicit system.

The finding that positive mood enhances performance of the explicit system posited by the COVIS theory corresponds with the dopamine hypothesis of positive affect (Ashby et al., 1999). Our results connect this research with existing work on category learning, and we view this connection as a substantial step forward in the study of cognition and mood. We suspect that our positive-mood subjects experienced increased cognitive flexibility, which allowed them to find the optimal verbal rule faster than negative-mood subjects and neutral-mood subjects did. Performance on the NRB category set did not differ strongly across the different mood conditions. This result is also in line with the dopamine hypothesis, as positive mood is not theorized to affect the same brain regions hypothesized by the COVIS theory to be involved with the learning of NRB category sets. However, our modeling results suggest that the cognitive flexibility associated with positive mood may affect the strategies used in NRB category learning. This cognitive flexibility could allow the explicit system to exhaust rule searches more effectively, even though performance levels may remain unchanged between the conditions.

We failed to find an effect of negative mood in RB learning. This is in line with previous research that reported no differences between negative- and neutral-mood subjects on measures of cognitive flexibility (Isen, Daubman, & Nowicki, 1987). It may be that negative mood does not affect RB category learning, although we think it could, given the right circumstances. One possible explanation of why we did not find such an effect is that the induced negative mood may not have been sustained long enough to interfere with performance. We suspect that subjects in certain negative states will be impaired in

RB category learning. Future work should examine ways of sustaining mood states and should explore a wider range of negative mood states.

An intriguing possibility that was not observed is that negative mood could enhance NRB category learning. Recent research suggests that affective states low in motivational intensity (e.g., amusement, sadness) are associated with broadened attention, and affective states high in motivational intensity (e.g., desire, disgust) are associated with narrowed attention (Gable & Harmon-Jones, 2008, 2010). Thus, for example, sadness may facilitate performance when broadened attention is beneficial for category learning. We did not find this effect, either because learning of the NRB category set used did not benefit from broadened attention or because the induced negative mood was high in motivational intensity. These interesting ideas require further research.

Smith et al. (1993) showed that clinically depressed subjects were impaired in RB category learning and unimpaired in NRB category learning, but our research is the first to investigate how experimentally induced mood states influence category learning. We have shown that positive mood enhanced the learning of an RB category set, an advantage that was strong and sustained throughout the task. Positive mood did not improve the learning of NRB categories, though there was evidence that positive mood enhanced selection of the optimal strategy. By connecting theories of multiple-system category learning and positive affect, our research suggests that positive affect enhances performance when category learning benefits from cognitive flexibility. Future work should examine the interaction between mood states (motivationally weak compared with intense), valence (positive compared with negative), and category type (explicit compared with implicit) in category learning.

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Chapter 4

4 The influence of regulatory focus and regulatory fit on categorization

The ability to connect concepts that are usually unrelated to one another, take on multiple perspectives, and come up with new ways of doing things are highly valued skills in our society. These skills are examples of *cognitive flexibility*. Flexibility exists orthogonally to perseveration, where one cannot move beyond their current way of performing or thinking. A classic example that demonstrates both of these concepts is the Duncker Candle task (Duncker, 1945). In this paradigm participants are presented with three items: a box of tacks, a candle, and a matchbook. The participant is asked to find a way to attach the candle to the (corkboard) wall so that when the candle is lit the wax won't drip onto the table below, using only the materials provided. The solution entails removing the tacks from the box, tacking the box to the wall, and using it as a holder for the candle. Then a match from the matchbook can be used to light the candle, and the box should block any melting wax from the table. Finding this solution is thought to require cognitive flexibility, because it requires participants to think of the box as a platform that can be tacked to the wall, and not simply as a holder of tacks. Perseverance/effort does not help people to solve this problem. When one has successfully shifted their thinking or strategy they have overcome *functional fixedness*. When participants are in a good mood they are more likely to solve the Duncker Candle problem (Isen, Daubman & Nowicki, 1987), and several other studies have connected positive mood to enhanced cognitive flexibility (Estrada, Isen, & Young, 1997; Greene & Noice, 1988; Fredrickson, 2001; Kazen & Kuhl, 2005; Kuhl & Kazen, 1999).

More recently motivational states been connected to conceptual breadth and cognitive flexibility. In regulatory focus theory (Higgins, 1997) people are theorized to have distinct motivational orientations that are derived from the approach and avoidance systems and exist orthogonally to them, meaning that each system involves both approach and avoidance. The promotion system prepares an individual to maximize positive outcomes (gains) and minimize the absence of positive outcomes (non-gains) in the environment. The prevention system prepares an individual to maximize potential positive outcomes (non-losses) in the environment and minimize potential negative outcomes (losses). Promotion goals are centered around and driven by nurturance needs, while prevention goals are centered around security needs (Higgins, 1996). These distinct needs engender different strategies of goal pursuit: promotion-focused individuals prefer to use eager, risky strategies to approach gains and avoid non-gains, while prevention-focused individuals prefer to use vigilant, conservative strategies to approach non-losses and avoid losses (Crowe & Higgins, 1997).

Due to the fundamental nature of these self-regulatory systems, all people have a promotion system and a prevention system. However one system or the other can come to dominate people's self-regulation goals. This is thought to be due to the emphasis placed on ideals (hopes and aspirations) or oughts (duties and responsibilities) by an individual's caregivers, role models, and peers across time (Higgins, 1996). This long-term, sustained focus is referred to as *chronic* regulatory focus. These chronic systems can interact with the constraints and affordances of various situations and tasks, which can also be construed as promotion or prevention-focused. In addition to chronic regulatory states, it is possible to manipulate people's dominant regulatory focus momentarily, and this temporary focus is referred to as *situational* regulatory focus.

Regulatory focus has been found to influence conceptual breadth. In an experiment by Crowe & Higgins (1997) participants were asked to do a sorting task using lists of exemplars taken from Rosch (1975). Participants first sorted a list of 12 high and moderate typicality fruits into subgroups according to any one dimension that was plausible to the participant, and this task was repeated using a list of 12 vegetables that were also high and moderately typical category exemplars. Following this participants were asked to record as many other dimensions that could be used to sort the vegetables, excluding the one they had already chosen. Regulatory focus was manipulated by informing participants that they would get to do a liked or disliked activity based on their performance on the sorting task. Participants with a promotion focus sorted along dimensions that created more subgroups than participants with a prevention focus.

Prevention-focused participants were also more likely choose the same dimension across the two sorting tasks (e.g. they were more likely to perseverate). When participants were asked to list other dimensions that could be used to sort the categories, there was a trend for participants in the promotion condition to list more dimensions. The authors interpreted the results in a strategic decision making framework. In this framework a promotion focus is concerned with ensuring “hits” and avoiding errors of omission, whereas a prevention focus is concerned with insuring correct rejections and avoiding errors of commission. However this study can also be interpreted to suggest that participants with a promotion focus have a broader conceptual focus than participants with a prevention focus.

The theory that a promotion focus is related to broadened attention compared to a prevention focus has been bolstered and expanded in subsequent research by Förster and colleagues (Förster & Higgins, 2005; Friedman & Förster, 2005). Förster and Higgins (2005) measured the chronic regulatory focus of participants and had them complete a global/local processing task. In this task participants are shown one of eight composite letters that is composed of smaller letters on each trial. Participants were asked to make a key press on a blue response key when they saw the letter “L” and a key press on a red response key when they saw the letter “H”. The location of the target letters were varied such that they appeared on the local or global level of the stimuli. The small (local) and composite (global) letters always mismatched so that the target was always only on either the local or global level. Participants with a chronic promotion focus responded faster to global targets whereas participants with a chronic prevention focus responded faster to local targets. Friedman and Förster (2005) induced approach (promotion) and avoidance (prevention) motivational states and then had participants perform a measure of attentional flexibility (a Stroop task in Experiment 1 and a working memory 2-back task in Experiment 2). Participants in promotion conditions performed better than participants in prevention conditions. These results indicate that a promotion focus is associated with broadened attention and cognitive flexibility while a prevention focus is associated with narrowed attention and reduced flexibility.

Regardless of whether the focus is chronic or situational in nature, regulatory states interact with the environment. For instance a regulatory state can either can fit or not fit with the reward structure of a task (Maddox, Baldwin, & Markman, 2006). In both cases, if one has a promotion focus (chronic or situational) and is in an environment that highlights gains, the subject is said to be in a state of *regulatory fit*, because looking for possible gains in the environment matches with an environment where gains are possible. If one has a promotion focus but the environment highlights losses, then the subjects is said to be in a state of *regulatory mismatch* because looking for possible gains in the environment does not match with an environment where only losses are possible. Likewise if one has a prevention focus and the environment highlights losses this creates a state of regulatory fit because looking for possible losses in an environment matches an environment where losses are possible. Finally if one has a prevention focus and the environment highlights gains, this creates a state of regulatory mismatch because looking for possible losses in the environment does not match with an environment where only gains are possible (Maddox et al., 2006).

While the above mentioned studies are informative regarding the influence of regulatory focus states on attentional and conceptual breadth and flexibility, more recent research argues that regulatory fit, and not simply focus, influences these factors. Markman and colleagues (Maddox et al., 2006; Grimm, Markman, Maddox, & Baldwin, 2008) have put forward the hypothesis that regulatory fit enhances cognitive flexibility. Maddox et al. (2006) define cognitive flexibility as “an increase in an individual’s ability or willingness to try different strategies across trials to achieve some stated goal, as opposed to utilizing gradual incremental changes in strategy” (p. 1378). Across several studies they reported that regulatory fit improved performance on category learning tasks that benefitted from broad shifts in strategy and suffered on tasks that did not benefit from trying new strategies and abandoning old ones, relative to a regulatory mismatch condition. Grimm et al. (2008) also reported that participants experiencing a match between their situational focus and the reward structure of the task performed better on a category learning task that benefitted from cognitive flexibility and worse on a task that did not benefit from flexibility. Additionally they have used well-known measures of cognitive flexibility, including the Wisconisn Card Sorting Task (WCST; Maddox, Filoteo, Glass & Markman, 2010), and the Remote Associates Task (RAT; Markman, Maddox, Worthy & Baldwin, 2007), and have again showed that a match between the situational focus and the task reward structure results in enhanced performance relative to a mismatch.

While the body of work outlined above provides support for the idea that regulatory fit enhances cognitive flexibility, the paradigm consistently used to support these results relies on setting up a situation in which explicit gains/non-gains (promotion) and non-losses/losses (prevention) are set up on two levels: situational regulatory focus and the reward structure of the task. The tasks participants complete always have correct and incorrect responses and participants receive feedback after they make each response. The feedback participants receive after each trial is critical to creating conditions of regulatory fit and non-fit. Prior research on regulatory focus effects also commonly uses tasks in which there is a correct or incorrect response, and where feedback occurs. This poses two issues: 1) given that success and failure feedback influence emotions, and that emotions are known to influence cognitive processing, it is difficult to disentangle effects deriving from feedback from effects deriving from motivational state 2) it is unclear whether these effects will be found in more naturalistic situations in which there are many possible correct responses, or in which one's response is not necessarily correct or incorrect. One study has used a different paradigm to study regulatory fit effects on cognitive processes. Memmert, Unklebach, & Ganns (2010) measured chronic regulatory focus using the General Regulatory Focus Questionnaire (GRFM; Lockwood, Jordan, & Kunda, 2002), and manipulated situational focus using approach and avoidance-priming mazes (Friedman & Förster, 2001). They reported that participants who experienced a fit between their chronic focus and their situational focus were more likely to notice an unexpected character in an inattentional blindness task. They hypothesized that regulatory fit led to broadened attention relative to regulatory mismatch (Memmert et al., 2010).

It is not yet known whether regulatory fit will influence cognitive flexibility using a task with no corrective feedback, and previous research studying the influence of regulatory fit on cognitive flexibility has used a paradigm with gains and losses and clear correct and incorrect responses. I wanted to see whether regulatory fit effects would be found on a task where there were no correct or incorrect response and no explicit trial by trial feedback, as this is a more frequently occurring situation in everyday life, where there are multiple possible good choices and no clear feedback about whether one made a good decision or not. The paradigm I used to manipulate regulatory fit versus mismatch is derived from Memmert et al. (2010). Unlike Memmert et al. (2010) I use different measures of chronic focus, and a different situational focus manipulation. The GRFM has been used in several studies looking at regulatory focus and fit (Keller & Bless, 2006; Memmert, Unkelbach & Ganns, 2010, Plessner, Unkelbach, Memmert, Baltes, & Kolb, 2009), however it has been reported to correlate more strongly with positive and negative mood, and approach and avoidance motivation than another commonly used measure of chronic regulatory focus (Summerville & Roese, 2008). For these reasons I will be using the Regulatory Focus Questionnaire (Harlow, Friedman, & Higgins, 1997), which was not found to correlate with positive and negative mood, or approach and avoidance motivation (Summerville & Roese, 2008).

The task I used is based on the work of Rosch (1975). In the original study participants were asked to rate the goodness of fit of a number of category exemplars to ten different categories. Some category exemplars were considered a better fit to a given category than others. For instance, participants endorsed the exemplars “apple” and “orange” as extremely good members of the fruit category, whereas “prunes”, “coconut” and “olive” were considered less good members of the category. This work showed that people seem to have ideas of what makes a given exemplar a better or worse member of a category, and challenged the view that people use necessary and sufficient features in making categorization decisions.

The exemplars and categories from Rosch (1975) have been used as a measure of conceptual breadth or cognitive flexibility in prior research (Isen & Daubman, 1984; Mikulincer, Kedem & Paz, 1990a; Price & Harmon-Jones, 2010), by comparing people’s ratings of low typicality items. Atypical/low typicality items are thought to tap cognitive flexibility because assigning a higher than average rating to a low typicality item means one is able to see features of the exemplars that connect them to the category and find different relationships between the exemplar and category that are less obvious, despite being plausible. In contrast high typicality items do not require as much flexibility because the aspects or features of the exemplar that relate to the category easily come to mind. For instance in the category "vehicle", it is easy to agree that a "car" is a good example. However the exemplar "camel" requires a greater degree of flexibility, more flexibility than "car". Past research has found that participants with higher state or trait anxiety are less inclusive in their ratings of atypical category exemplars (Mikulincer et al., 1990a), whereas participants in a positive mood (Isen & Daubman, 1984), or a mild state of arousal (Price & Harmon-Jones, 2010), assign higher ratings to atypical items than participants in a control or other condition.

For the current research I predicted that if regulatory fit enhances cognitive flexibility participants who experience a fit between their measured chronic focus and their situational focus will assign higher ratings to the low typicality exemplars than participants who experience a mismatch. This prediction is in line with past research by Memmert et al. (2010) and the work of Markman and colleagues (Grimm et al., 2008; Maddox et al., 2006; 2010; Markman et al., 2007). There may also be a main effect of either chronic or situational regulatory focus (or both), as suggested by the work of Crowe and Higgins (1997), and research by Förster and Friedman (Förster & Higgins, 2005; Friedman & Förster, 2005), such that participants with either a strong chronic promotion focus, or a manipulated situational promotion focus, assign higher ratings to atypical exemplars than participants with a less strong chronic promotion focus (or a stronger chronic prevention focus), or a situational prevention focus.

No research to my knowledge has measured both approach and avoidance motivation with the BIS/BAS scales as well as chronic regulatory focus with the RFQ in a study of regulatory focus/fit effects. This is important because promotion and prevention foci involve both approach and avoidance motivations, and are theoretically distinct from these systems. However some research that has measured approach and avoidance motivation have reported findings that are similar to those reported for regulatory focus. For instance De Dreu, Nijstad, and Baas (2011) reported that individuals high in trait approach motivation (as measured by the BAS scales) were more creative when they were primed with global processing manipulations. This can be considered akin to a regulatory fit effect, except that trait approach motivation is in the place of a promotion focus. Thus I wanted to know whether trait approach and avoidance motivation might interact with the situational focus manipulation in a similar manner to the results of Memmert et al. (2010).

Beyond the possibility of regulatory fit and focus effects, another issue I wanted to address was the possible interaction between approach and avoidance motivational states, regulatory focus, and mood. Summerville and Roese (2008) administered several motivation questionnaires to 504 undergraduate students, including the GRFM (Lockwood et al., 2002), the RFQ (Harlow et al., 1997), the Behavioral Inhibition Scale/Behavioural Approach Scales (BIS/BAS; Carver & White, 1994). Although promotion and prevention states are supposed to exist orthogonally to approach and avoidance, the GRFM promotion subscale correlated strongly with the approach items on the BIS/BAS, and the GRFM prevention subscale correlated strongly with the avoidance items on the BIS/BAS. In another experiment, the authors reported that the GRFM promotion and prevention subscales correlated significantly with the positive and negative affect scales from the PANAS. This is problematic because regulatory focus is supposed to be independent of valence (Higgins, 1996). The authors conclude that the Lockwood et al. (2002) questionnaire functions more like a measure of approach/avoidance than like a measure of regulatory focus, and that affect seems to play a significant role in this measure. However the RFQ did not correlate with the BIS/BAS or the PANAS, indicating that it is measuring something other than mood and approach and avoidance motivation. Prior work examining regulatory fit effects has often used the GRFM (including Memmert et al., 2010). Thus I wanted to know whether I would extend their effects using the RFQ instead of the GRFM.

4.1 Experiment

4.1.1 Methods

4.1.1.1 Sample and design

Participants were 86 undergraduates (66 females, 20 males) who participated for course credit, 43 in the Promotion condition and 43 in the Prevention condition. One participant was not included in the analyses for failing to follow instructions (they completed the categorization task prior to completing the essay manipulation), leaving 43 in the Promotion condition and 42 in the Prevention condition.

4.1.1.2 Materials and Procedure

Participants were informed that they were completing two separate experiments, one on "student life" and one on "categorization" to reduce expectancy effects. Participants were randomly assigned to either the promotion or the prevention regulatory focus condition. In both conditions participants were told that they would be completing several questionnaires (the chronic regulatory focus measure, the approach/avoidance motivation measure) and an essay-writing task concerned with student life (the regulatory focus manipulation) and then a simple cognitive task (the Rosch categorization task). Up to five participants completed the experiment in each session, and participants were seated in individual carrels within a single room. Figure 4.1 shows the order in which participants completed the different measures and tasks.

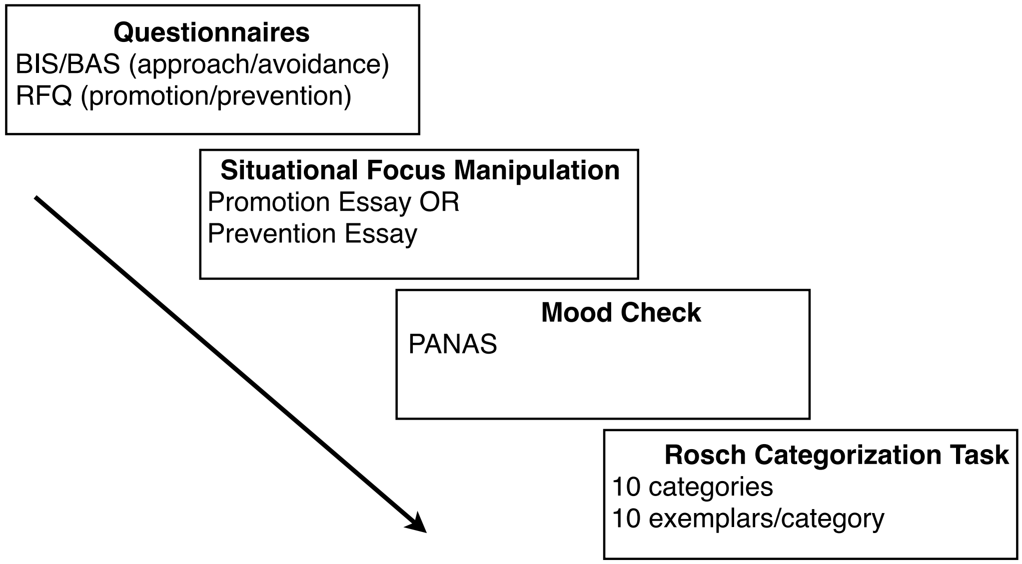

Figure 4.1. Visual representation of experimental methods.

Participants first completed a questionnaire measuring their chronic regulatory state, the Regulatory Focus Questionnaire (RFQ; Harlow, Friedman, & Higgins, 1997, The Regulatory Focus Questionnaire, Columbia University, unpublished manuscript). It was designed to assess one's history of promotion and prevention-related successes, and the frequency of those successes, with higher scores indicating more success than lower scores. In this measure participants assign a numeric value ranging from 1 "never or seldom" to 5 "very often" (with 3 "sometimes" as the midpoint) alongside 11 questions concerned with promotion or prevention goals. An example promotion subscale question is "Do you often do well at different things that you try"? An example prevention subscale question is "How often did you obey rules and regulations that were established by your parents"? Six of the items comprise a promotion subscale and five comprise a prevention subscale. Each of these scales are reported to share a low correlation with one another, indicative of their mutual independence (Harlow et al., 1997; Higgins et al., 2001). A measure of chronic regulatory strength/ promotion focus strength can be computed by subtracting the prevention subscale total from the promotion subscale total.

Following completion of the regulatory focus measure participants completed a measure of approach/avoidance motivation, the Behavioral Inhibition System/Behavioral Activation System scales (BIS/BAS; Carver & White, 1994). The BIS/BAS scales were designed to assess Gray's (1990) regulatory approach and avoidance systems in individuals. This is a 24-item measure and items are rated from 1 (very true for me) to 4 (very false for me). There are four subscales in this questionnaire, 3 which are BAS-related, and 1 that is BIS-related. The Behavioral Activation System (BAS) is sensitive to cues signaling reward and non-punishment and governs movement towards desired end states. This system has been argued to underlie positive affective states, including happiness and elation (Gray, 1990). An example BAS Drive item is "When I want something I usually go all-out to get it". An example BAS Reward Responsiveness item is "When I see an opportunity for something I like I get excited right away." An example BAS Fun Seeking item is "I crave excitement and new sensations." The BAS subscales are often summed and used as an overall indicator of BAS sensitivity (Hayden et al., 2008; McFarland et al., 2006). Someone with a high BAS sensitivity should experience a strong pull to engage in goal-directed behavior and a strong reaction to impending incentives. The Behavioral Inhibition System (BIS) is sensitive to cues signaling punishment, non-reward, and novelty. This system is argued to underlie negative affective states, including anxiety, and sadness (Gray, 1990). Example behavioral inhibition/avoidance items are "Criticism or scolding hurts me quite a bit" and "I feel worried when I think I have done poorly at something important". Someone with a high BIS sensitivity should be concerned with avoiding negative outcomes and be sensitive to negative feedback.

Upon completion of the motivation questionnaires *situational* regulatory focus was manipulated by asking participants to spend between five and seven minutes writing a short essay about their "hopes and aspirations" (promotion condition) or their "duties and obligations" (prevention condition) in "the next few years" on a lined sheet of paper with the instructions at the top of the page.

Following the situational regulatory focus manipulation the current mood state of participants was assessed using the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). In this 20-item mood measure participants are asked to rate the extent to which they are currently feeling 20 emotions, 10 positive and 10 negative on a 5-point Likert scale ranging from 1 ("Not at all") to 5 ("Extremely"). The positive and negative items are averaged to create a positive mood score and a negative mood score.

After indicating their current mood state, participants completed the 100-item categorization task based on Rosch's Cognitive Representions of Semantic Categories (1975). Participants were presented with a list of 10 categories (furniture, fruit, vehicle, weapon, vegetable, carpenter's tool, bird, sport, toy, clothing) and 10 respective exemplars from each category that varied in prototypicality, from extremely typical (e.g. car), to moderately typical (e.g. scooter), to atypical (e.g. camel). Participants were asked to rate the extent to which each exemplar fit a given category label, for instance they were asked "How good of a Vehicle [category label] is a Scooter [category exemplar]"? Participants filled in their responses using paper and pencil on a 7-point Likert scale, from 1 ("not at all a good fit) to 7 ("extremely good fit"). For each category label, each set of category exemplars included 2 extremely typical (high typicality) exemplars, 3 moderately typical (medium typicality) exemplars, and 5 atypical (low typicality) exemplars. The first exemplar participants rated was always a typical one, and the following 9 exemplars were randomly presented. The high and medium typicality items were used as filler and control items, and the ratings of low typicality items were of primary interest. The category labels, the subset of exemplars I chose for each, and the original ratings presented by Rosch (1975) can be seen in Appendix Q.

Upon completion of the ratings task participants completed a short questionnaire asking them demographic information and information about their day (unrelated to current experiment) and were then thanked for their participation and debriefed.

4.1.2 Results

4.1.2.1 Questionnaire reliability and descriptives

The means and standard deviations of the questionnaires are presented in Table 4.1. The reliability for the RFQ was questionable for the Promotion subscale (6 items; α = .63), good for the Prevention subscale (5 items; α = .80), acceptable for the BAS Total score (13 items; α = .77), and BIS Total score (7 items; α = .71), and good for the PANAS positive affect and negative affect scales, (10 items for each; α = .88 for both positive and negative scales).

Table 4.1. Means (standard deviations), and alphas of mood and motivation measures.

Questionnaire	Promotion	Prevention	Overall	α
RFQ Promotion	22.23 (3.10)	21.33 (3.47)	21.79 (3.30)	0.63
RFQ Prevention	16.26 (4.15)	15.14 (3.55)	15.71 (3.88)	0.80
BAS Total	40.95 (5.19)	40.87 (4.58)	40.91 (4.87)	0.77
BIS	20.95 (3.80)	21.19 (3.65)	21.07 (3.71)	0.71
PANAS Positive	3.06 (0.85)	3.26 (0.74)	3.16 (0.80)	0.88
PANAS Negative	1.59 (0.57)	1.91 (0.70)	1.75 (0.65)	0.88

Notes: RFQ = Regulatory Focus Questionnaire; BAS = Behavioral Approach Scale; BIS = Behavioral Inhibition Scale; PANAS = Positive Affect Negative Affect Scale.

Across conditions the RFQ promotion subscale mean (M = 21.79, SD = 3.30) was significantly higher than the prevention subscale mean (M = 15.71, SD = 3.88), $t(84)$ = 13.34, $p < .001$. Similarly the PANAS positive mood scale score (M = 3.16, SD = 0.80) was significantly higher than the PANAS negative mood scale score (M = 1.75, SD = 0.65), $t(84)$ = 16.76, $p < .001$. These differences are in line with the original results reported by the authors of the questionnaires (Higgins et al., 2001; Watson et al., 1988). While the BAS Total score (M = 40.91, SD = 4.87) is higher than the BIS Total score (M = 21.07, SD = 3.71) this difference is not meaningful and is due to the fact that the BAS Total score is the sum of three BAS subscales. Because I am interested in general approach motivation, and because the three BAS subscales were significantly and positively intercorrelated (all r's = .27 - .51), I use the BAS Total score in subsequent analyses as opposed to analyzing the three BAS subscales separately.

Between situational regulatory focus conditions (promotion essay versus prevention essay) there were no significant differences on the RFQ, $F(1, 84) = 1.59$, $p = .21$ for Promotion, $F(1, 84) = 1.78$ $p = .19$ for Prevention, or BIS/BAS Total scores, $F(1, 84) = 0.01$, $p = .94$ for BAS, $F(1, 84) = 0.09$, $p = .77$ for BIS, which was expected given that these questionnaires were completed prior to the situational focus manipulation. Participants completed the PANAS after the situational focus manipulation, and while the positive affect scale of the PANAS did not differ between the promotion ($M = 3.06$, $SD = .85$) and prevention ($M = 3.26$, $SD = .74$) regulatory focus conditions, $F(1, 84) = 1.43$, $p = .24$, there was a significant difference between conditions on the negative mood scale of the PANAS, with participants in the prevention condition ($M = 1.91$, $SD = .70$) reporting significantly higher levels of negative mood than participants in the promotion condition ($M = 1.59$, $SD = .57$), $F(1, 84) = 5.60$, $p = .02$, $\eta^2 = 0.06$.

4.1.2.2 Rosch ratings

To confirm that participants rated typicality according to the Rosch norms, a repeated measures analysis of variance was conducted with typicality rating (good, moderate, and low exemplars) as a within-subjects variable and regulatory focus condition (promotion, prevention) as a between-subjects variable. There was a significant effect of typicality rating $F(2, 82) = 723.73$, $p < .001$, $\eta^2 = 0.95$. Pairwise comparisons revealed that the good exemplar ($M = 6.80$, $SD = .30$) ratings were significantly higher than the moderate ($M = 5.57$, $SD = .54$), and low ($M = 4.03$, $SD = .72$) exemplar ratings (all p's < .001). Moderate exemplar ratings were significantly higher than poor exemplar ratings ($p < .001$). This demonstrates that participants rated good exemplars as more typical than moderate and poor exemplars, and moderate exemplars more highly than poor exemplars. Table 4.2 shows the averaged typicality ratings by level (good, moderate, and poor) by each of the ten categories, across all participants.

Table 4.2. Typicality ratings for poor, moderate, and good exemplars across all subjects.

Category	Poor	Moderate	Good
Furniture	3.33 (1.34)	4.71 (1.02)	6.84 (0.38)
Fruit	3.36 (1.29)	6.25 (0.90)	6.89 (0.38)
Vehicle	3.49 (1.43)	4.72 (1.23)	6.93 (0.27)
Weapon	4.00 (1.27)	5.89 (0.82)	6.79 (0.42)
Vegetable	4.92 (1.21)	5.91 (1.26)	6.57 (0.82)
Carpenter Tools	4.76 (1.18)	5.05 (1.41)	6.79 (0.56)
Birds	4.85 (1.18)	6.37 (0.77)	6.85 (0.52)
Sports	3.74 (1.23)	6.20 (0.89)	6.91 (0.37)
Toys	4.19 (1.46)	4.86 (1.33)	6.57 (0.98)
Clothing	3.62 (1.08)	5.73 (1.04)	6.88 (0.30)
	4.03 (0.72)	5.57 (0.54)	6.80 (0.30)

4.1.2.3 Regulatory focus and trait motivation effects

4.1.2.3.1 Chronic focus and trait motivation effects

In order to examine whether chronic regulatory focus was related to typicality ratings of poor exemplars, I conducted a series of regressions with chronic promotion focus, chronic prevention focus, and chronic regulatory strength (chronic promotion – chronic prevention) as criterion variables and poor exemplar typicality ratings as the dependent variable. It was not possible to conduct an analysis of variance with the RFQ chronic focus scores because the majority of participants had a promotion scale score greater than their prevention scale score. None of these chronic regulatory focus variables significantly predicted poor exemplar typicality ratings (all p's > .05).

To examine a possible influence of trait motivation on poor exemplar typicality ratings, I conducted regressions with the BAS and BIS total scores as the independent variables and poor exemplar typicality ratings as the dependent variable, and again the regression models did not reach significance (all p's > .05)

4.1.2.3.2 Situational focus effects

Although I predicted that I would find a fit between chronic and situational focus, it is also possible that situational focus alone influenced the poor exemplar typicality ratings. I wanted to test whether participants with a manipulated promotion versus a prevention focus showed differences on their typicality ratings of poor exemplars. Based on prior research showing that a promotion focus is associated with broadened attention and attentional flexibility, and a prevention focus with narrowed attention and reduced attentional flexibility (Förster & Higgins, 2005; Friedman & Förster, 2005), I predicted that the promotion and prevention conditions would differ in their poor exemplar typicality ratings, with the promotion condition displaying higher typicality ratings than the prevention condition. I also predicted that there would be no differences between the two groups on their ratings of good and moderate exemplar typicality ratings because these exemplars did not tap conceptual breadth or flexibility to the same extent.

I averaged each type of typicality rating for each category across participants and averaged these ratings by condition. I conducted a repeated measures analysis of variance with typicality rating (good, moderate, and poor) as a within-subjects variable and regulatory focus condition (promotion, prevention) as a between-subjects variable. There was a significant effect of typicality rating $F(2, 82) = 723.73$, $p < .001$, $\eta^2 = 0.95$, reflecting the differences in ratings between good, moderate, and poor exemplars, but the interaction between typicality rating and condition was not significant, $F(2, 82) = 1.64$, $p = .20$. However because I made the a priori prediction that the promotion and prevention conditions would differ significantly on their poor exemplar typicality ratings only, I conducted a one-way between-subjects analysis of variance and found that the promotion condition ($M = 4.18$, $SD = .75$) assigned higher typicality ratings to poor exemplars than participants in the prevention condition ($M = 3.87$, $SD = .67$), and this difference was significant, $F(1, 84) = 4.30$, $p = .049$, $\eta^2 = .041$.

Figure 4.2 shows the averaged typicality ratings by type (good, moderate, and poor). Table 4.3 shows these ratings by individual category, between situational regulatory focus conditions.

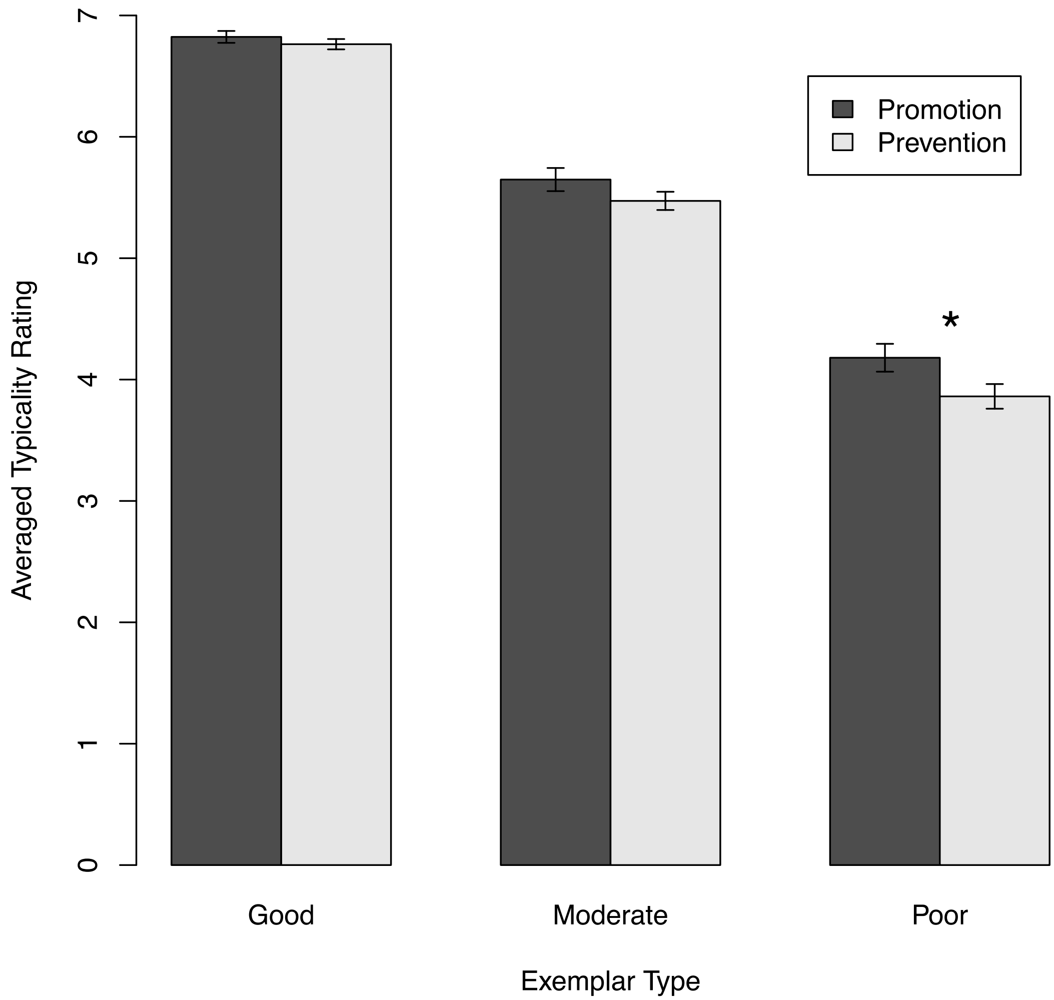

Figure 4.2. Typicality ratings ordered by exemplar type (good, moderate, and poor).
Note: * $p < .05$.

Table 4.3. Means (and standard deviations) of typicality ratings by category and between situational regulatory focus conditions.

	Promotion			**Prevention**		
Category	Poor	Moderate	Good	Poor	Moderate	Good
Furniture	3.26 (1.34)	4.68 (1.08)	6.76 (0.48)	3.41 (1.35)	4.74 (0.97)	6.93 (0.21)
Fruit	3.41 (1.34)	6.54 (0.66)	6.87 (0.40)	3.30 (1.26)	5.96 (1.00)	6.90 (0.35)
Vehicle	3.80 (1.37)	4.74 (1.40)	6.90 (0.36)	3.17 (1.43)	4.69 (1.06)	6.96 (0.13)
Weapon	4.30 (1.34)	6.09 (0.86)	6.80 (0.44)	3.71 (1.15)	5.69 (0.73)	6.79 (0.40)
Vegetable	5.17 (1.07)	6.28 (0.96)	6.73 (0.65)	4.66 (1.30)	5.52 (1.42)	6.40 (0.94)
Carpenter Tools	4.76 (1.32)	4.93 (1.53)	6.84 (0.42)	4.76 (1.04)	5.18 (1.27)	6.74 (0.68)
Birds	5.02 (1.06)	6.35 (0.74)	6.92 (0.34)	4.68 (1.27)	6.40 (0.81)	6.79 (0.66)
Sports	3.82 (1.28)	6.18 (0.97)	6.85 (0.49)	3.66 (1.19)	6.23 (0.81)	6.96 (0.17)
Toys	4.44 (1.39)	4.94 (1.21)	6.70 (0.63)	3.94 (1.50)	4.79 (1.46)	6.44 (1.23)
Clothing	3.82 (1.01)	5.78 (1.02)	6.87 (0.31)	3.40 (1.13)	5.67 (1.07)	6.88 (0.29)
	4.18 (0.75)	5.65 (0.61)	6.82 (0.32)	3.87 (0.67)	5.49 (0.46)	6.78 (0.27)

Considered in isolation these results suggest that the situational focus manipulation resulted in a significant difference in participants' poor exemplar typicality ratings. However due to the significant difference in negative mood reported by participants between the two situational regulatory focus conditions I conducted a final series of analyses to examine the interaction between regulatory focus condition, self reported negative affect, and poor exemplar typicality ratings further.

I conducted a multiple regression with regulatory focus condition (promotion essay, prevention essay) and negative affect ratings as predictor variables and poor exemplar typicality ratings as the criterion variable. The model was significant, $F(2,84) = 4.70$, $p = .01$, $\eta^2 = .10$. An examination of the coefficients revealed that regulatory focus condition did not reach significance, ($\beta = .152$, $t = 1.40$, $p = .16$), but negative affect ratings did, ($\beta = -.247$, $t = -2.28$, $p = .03$). This shows that as negative mood ratings decreased, poor exemplar typicality ratings increased.

Although I had not predicted that there would be differences in moderate exemplar typicality ratings, due to the significant correlation between negative affect ratings and moderate exemplar typicality ratings I wanted to see whether the same pattern held. I again entered regulatory focus condition (promotion essay, prevention essay) and negative affect ratings into a regression with moderate exemplar typicality ratings as the dependent variable. The model significantly predicted the data, $F(2,84) = 3.60$, $p = .03$, $\eta^2 = .08$. An examination of the coefficients revealed that regulatory focus condition did not significantly account for the variability in moderate exemplar typicality ratings, ($\beta = .088$, $t = 0.80$, $p = .42$), but negative affect ratings did, ($\beta = -.249$, $t = -2.28$, $p = .03$). Thus for both poor and moderate exemplars, as negative mood decreased, typicality ratings increased.

4.1.2.4 Regulatory fit effects

I wanted to know whether participants experiencing a fit between their chronic and situational regulatory foci were more likely to give higher ratings to the poor exemplar items than participants experiencing a mismatch, and followed the regression technique used by Memmert et al. (2010). I conducted a multiple regression with situational regulatory focus condition (promotion condition coded as “1”, prevention as “-1”), chronic regulatory focus strength (the RFQ prevention subscale score of each participant subtracted from the RFQ promotion subscale score of each participant), and the interaction between situational regulatory focus condition and chronic regulatory strength as predictor variables and the proportion of poor exemplar typicality ratings averaged across the 10 categories as the criterion variable. The continuous variable (chronic regulatory focus strength) was centered to reduce the risk of multicollinearity in the interaction term. The analysis of variance for the regression did not reach significance, $F(3,84) = 1.45$, $p = .23$, indicating the model did not significantly predict the data. I also conducted two regressions using each of the RFQ subscales, promotion and prevention, but neither analysis of variance reached significance (both p’s > .10).

4.1.2.4.1 Approach/avoidance fit effects

A final possibility related to regulatory fit that I wanted to explore was whether the BAS or BIS total scores interacted with the regulatory focus manipulation to predict poor exemplar typicality ratings. This was a valid possibility because prior work has reported strong correlations between another regulatory focus measure (the General Regulatory Focus Measure; Lockwood et al., 2002) and the BIS/BAS scales (Summerville & Roese, 2008). I repeated the multiple regression steps as described above, first with the BAS total and again with the BIS total, but neither analysis reached significance (both p’s > .19).

4.1.2.5 Correlations between questionnaires and typicality ratings

I wanted to know whether the poor exemplar typicality ratings were related to any of the motivation (RFQ, BIS/BAS) and mood (PANAS) questionnaires. Based on prior research I predicted that positive affect would be positively correlated with poor exemplar typicality ratings, and that negative affect would be negatively correlated with poor exemplar typicality ratings (Isen & Daubman, 1984; Mikulincer et al., 1990). Given the relationships previously described between positive mood and approach motivation, and negative mood and avoidance motivation, I anticipated that there could also be significant positive relationships between the BAS Total score and poor exemplar typicality ratings, and significant negative relationships between the BIS and poor exemplar typicality ratings. Finally although prior research has reported that the RFQ is not related to approach and avoidance motivation or mood, because these variables are related in my current sample it is also possible that the RFQ promotion subscale will be positively related to the poor exemplar typicality ratings, and that the RFQ prevention subscale will be negatively related to poor exemplar typicality ratings.

Table 4.4 shows the correlations between typicality ratings (poor, moderate, and good) and the motivation and mood measures. The poor exemplar typicality ratings were significantly negatively correlated with scores on the PANAS negative affect subscale, $r(85) = -.29$, $p = .008$, and that was the only significant correlation between the poor exemplar typicality ratings and any of the motivation and mood subscales.[10]

Figure 4.3 shows the relationship between the negative mood ratings and poor exemplar typicality ratings.

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[10] This relationship remained significant when I controlled for the PANAS positive affect scale, $r(82) = -.28$, $p = .009$.

Table 4.4. Correlations between typicality ratings and mood and motivation measures.

	Typicality Ratings		
	Poor Exemplars	**Moderate Exemplars**	**Good Exemplars**
Poor Exemplars	------		
Moderate Exemplars	.72***	------	
Good Exemplars	.35**	.59***	------
RFQ Promotion Scale	.14	.19	.10
RFQ Prevention Scale	.05	.08	.07
Behavioral Approach Scale Total	-.04	.07	.12
Behavioral Inhibition Scale Total	.02	.101	.25*
PANAS Positive Scale Total	-.07	-.14	.01
PANAS Negative Scale Total	-.29**	-.27*	-.17

Notes: *** $p < .001$, ** $p < .01$, * $p < .05$; RFQ = Regulatory Focus Questionnaire; PANAS = Positive Affect Negative Affect Scale.

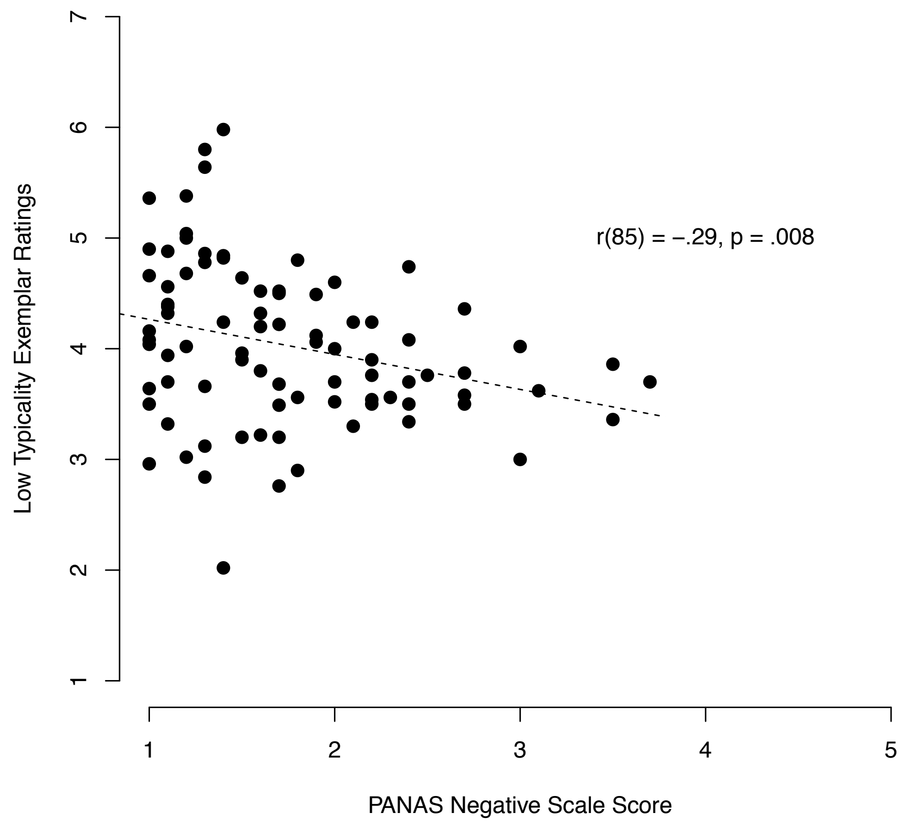

Figure 4.3. Relationship between poor exemplar typicality ratings and negative mood.

Although I did not predict any significant correlations would be found between moderate exemplar typicality ratings and motivation and mood measures, the PANAS negative affect scale correlated significantly and negatively with moderate exemplar typicality ratings, $r(85) = -.27$, $p = .01$.[11] Figure 4.4 shows this relationship.

[11] This relationship remained significant when I controlled for positive affect, $r(82) = -.24$, $p = .03$.

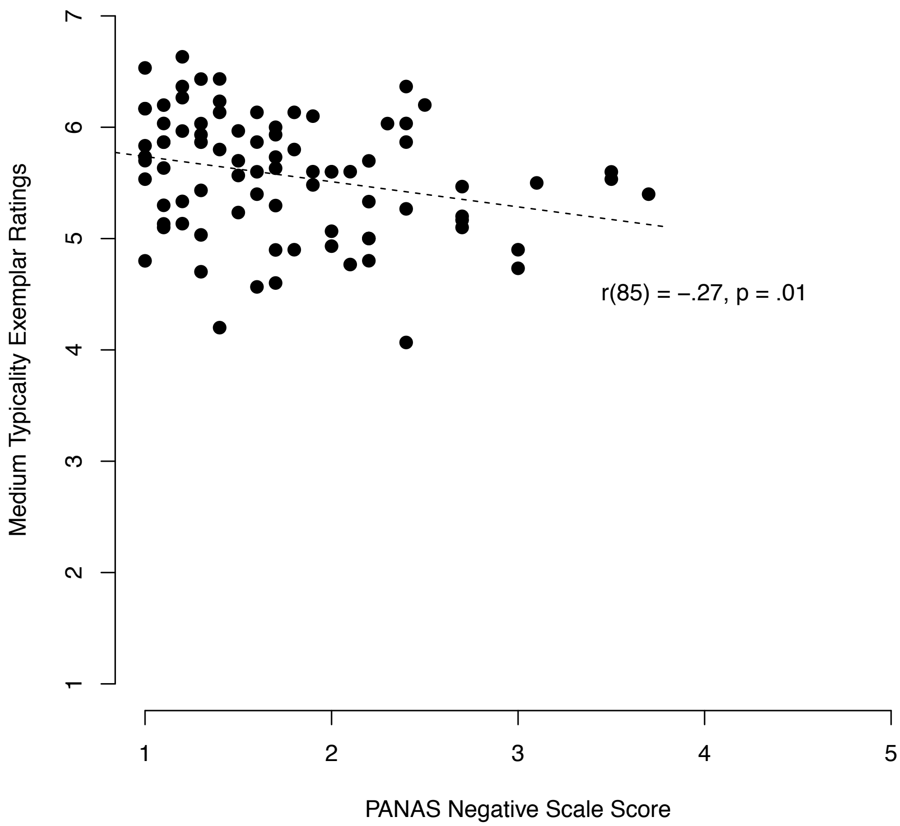

Figure 4.4. Relationship between moderate exemplar typicality ratings and negative mood.

A final unexpected significant correlation is that the BIS scale correlated positively with good exemplar typicality ratings, $r(85) = .25$, $p = .02$. However when the scatterplot of this relationship was inspected it was apparent that this small-sized positive relationship was being driven by a single participant (BIS = 13, high typicality rating = 5.05). When this participant's data was removed the relationship was no longer significant, $r(84) = .12$, $p = .27$, thus this relationship should be interpreted with caution.

4.1.2.6 Negative mood effects

A key question given the significant difference in negative mood between conditions, as well as the significant negative correlations between poor and moderate exemplar typicality ratings and negative mood, is what caused the variability in negative mood ratings across participants? I did not predict that there would be differences in negative mood between situational regulatory focus conditions, and prior research has not reported similar differences following regulatory focus manipulations. It is plausible that individual differences in regulatory focus, approach motivation, avoidance motivation, and the essay manipulation could all influence or be related to differences in negative mood. Thus I entered each centred continuous variable (BAS, BIS, RFQ Promotion, RFQ Prevention) as well as Regulatory Focus Condition (Promotion = 1, Prevention = -1) into a multiple linear regression, with PANAS negative mood rating as the dependent variable. Following guidelines by Yzerbyt, Muller, and Judd (2004), interactions between each continuous variable (BAS, BIS, RFQ Promotion, RFQ Prevention) and Regulatory Focus condition were entered as predictors to ensure that the interaction between negative mood and regulatory focus condition was not biased.

The regression model was significant and the variables accounted for a significant amount of the variance in negative mood ratings ($R^2 = .291$, adjusted $R^2 = .195$, $F(10, 84) = 3.04$, $p < .01$). An examination of the coefficients revealed that BAS Total ($\beta = .042$, $t(74) = 2.72$, $p < .01$), RFQ Promotion ($\beta = -.079$, $t(74) = -3.21$, $p < .01$), and Regulatory Focus Condition ($\beta = -.133$, $t(74) = -2.06$, $p < .05$) were significantly related to negative mood. The relationship between BAS and negative mood was positive, indicating that the higher the BAS rating the higher the negative mood rating, and the relationship between RFQ Promotion and negative mood was negative, indicating that the higher the RFQ Promotion score the lower the negative mood rating. Finally the relationship between regulatory focus condition and negative mood rating was also negative. Regulatory focus condition was coded as (1 = promotion, -1 = prevention), reflecting that negative mood ratings were higher in the prevention condition.

4.1.3 Discussion

This experiment was concerned with the influence of motivation and mood on cognitive flexibility. I found that participants who wrote about their hopes and aspirations gave higher typicality ratings to poor exemplars than participants who wrote about their duties and responsibilities. This is in line with prior research indicating that regulatory focus influences attentional breadth and flexibility (Förster & Higgins, 2005; Friedman & Förster, 2005). However the current results use a different manipulation of regulatory focus, as well as a task in which there are no correct or incorrect responses, and extends the results to conceptual breadth/flexibility. The present results also diverge from prior work in one key way: prior work has not reported significant mood differences between regulatory focus conditions (Crowe & Higgins, 1997; Förster & Higgins, 2005; Friedman & Förster, 2005). When negative mood was taken into account it became clear that negative mood, and not the essay manipulation, was accounting for the poor exemplar typicality ratings.

The finding that poor and moderate exemplar typicality ratings were negatively related to negative mood is in line with the hypothesis that negative mood is related to narrowed attentional and conceptual breadth and reduced flexibility (e.g. Gasper & Clore, 2002; Mikulincer et al., 1990a; Mikulincer et al., 1990b). Mikulincer et al. (1990a) measured participants' trait anxiety and reported that participants with lower levels of self-reported anxiety gave higher ratings to poor exemplar items. The PANAS negative affect scale has been found to tap state and trait anxiety (Watson & Clark, 1984). My research extends the results of Mikulincer et al. (1990a) by showing that an evaluative framework need not necessarily be explicit in the task paradigm to have an influence on poor exemplar typicality ratings.

There are several possibilities to explain why my results differ from prior reported results, in that the regulatory focus manipulation influenced negative mood ratings. The first is simply that the essay manipulation of regulatory focus engendered more negative mood in the prevention condition. I asked participants to write about their "hopes and aspirations" or their "duties and responsibilities in the next few years". It is possible that for undergraduate students just beginning their studies that thinking about their "duties and responsibilities" over the course of their studies increased their negative mood relative to students writing about their "hopes and aspirations". This possibility is in line with Higgin's self discrepancy theory (1987), which theorizes that when one is promotion-focused and does not achieve their goal, they feel sad/dejected, but when one is prevention-focused and does not achieve their goal they feel anxious. It is possible that in writing about their upcoming duties and responsibilities this evoked a sense of failing at one's duties and responsibilities in first year undergraduate students. A related possibility is simply that thinking about their duties and responsibilities was overwhelming and unpleasant. There is also research showing that prevention-focused failure produces anxiety (Higgins, 1997). This suggests that the prevention manipulation created an anxious state in participants. However the results of a regression analysis showed that BAS and RFQ Promotion scores also contributed to ratings of negative mood, showing that individual differences in approach motivation and chronic regulatory focus were related to negative mood.

A second possibility as to why my mood results differed from prior research is that the mood measure I used was more sensitive than that used previously. The PANAS conceptualizes mood as involving independent positive and negative valences, whereas the one-item question used by Friedman and Forster (2005) asked participants "How do you feel right now"? This conceptualizes mood as a single dimension ranging from negative ("very bad") to positive ("very good"). Participants answered this question after completing a maze manipulation of approach and avoidance motivation. The authors reported that there were no significant mood differences between conditions, and that mood did not change the pattern of results when it was included in regression analyses. This difference could account for the lack of correspondence between my results and previous work.[12]

Likewise participants in a study by Förster and Higgins (2005) answered the same mood question after having their chronic regulatory focus measured and after completing the main task. The authors reported that mood did not influence the pattern of results. Crowe and Higgins (1997) measured mood at the beginning of the experiment, after completing

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[12] Some studies subtract the PANAS Negative scale score from the Positive scale score to compute an overall mood score. When I did this and used the subtracted total as the dependent variable in an analysis of variance, there was no significant mood difference between the promotion and prevention situational focus conditions.

several of the tasks, and at the end of the experiment, and the summed scores (across the three time points) did not differ between conditions or influence the results. In contrast I measured people's positive and negative affect levels using a 20-item questionnaire that distinguished between positive mood states and negative mood states, and the questionnaire was administered immediately after participants completed the regulatory focus manipulation. Future research should employ a diversity of mood measures and regulatory focus manipulations to find out whether the difference in mood reported between the regulatory focus conditions is due to study design or is a real effect.

I also explored whether regulatory fit influenced people's poor exemplar typicality ratings. I did not find any significant regulatory fit effects. This is in contrast with the results of Memmert et al. (2010), who reported a significant effect of regulatory fit using the same paradigm (with a different task). However I used a different, and more theoretically valid measure of regulatory focus. Grimm, Markman, Maddox, and Baldwin (2009) argue that a situational focus manipulation can override a participant's chronic focus, and they also used the RFQ to measure chronic focus. My results are consistent with this explanation. Future research should examine whether there is further evidence whether the RFQ always over-rides one's chronic focus or whether there are cases in which fit effects between situational focus and chronic focus are present.

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Chapter 5

5 General Discussion

The results in this thesis demonstrate that positive mood enhances rule-based category learning that benefits from cognitive flexibility (Chapter 3). Additionally, self-reports of positive mood are positively related to this same kind of category learning performance (Chapter 2). Manipulated and measured negative mood did not have any strong influence or relationship to rule-based category learning (Chapters 2 and 3). Self-reported depressive symptoms, history of hypomanic symptoms, and proneness to worry were negatively related to rule-based category learning performance, but positive mood and history of hypomanic symptoms accounted for the most variance in rule-based category learning performance (Chapter 2). In contrast to the rule-based category learning findings, none of the factors measured or manipulated in Chapters 2 and 3 significantly influenced or related to non-rule-based category learning. This is the first series of studies to examine the influence of mood on category learning.

Although negative mood did not influence or relate to category learning performance, the findings of Chapter 4 demonstrate that self-reported negative mood is negatively related to typicality ratings of poor and moderate exemplar typicality ratings. The results in Chapter 4 also showed that a promotion focus resulted in higher poor exemplar typicality ratings than a prevention focus, however this effect did not remain significant when negative mood was taken into account.

5.1 Positive mood implications

Across the first three studies (Chapters 2 and 3) this research demonstrates that positive mood influences rule-based category learning that benefits from cognitive flexibility. These results are in line with the dopaminergic hypothesis of positive affect (Ashby, Isen, & Turken, 1999). Ashby et al. (1999) posit that mild increases in positive mood are associated with increased dopamine levels in frontal brain regions, specifically the prefrontal cortex (PFC), and anterior cingulated cortex (ACC). This increase in dopamine is associated with enhanced cognitive flexibility. In the COmpetition between Verbal and

Implicit Systems theory of category learning (COVIS; Ashby, Alfonso-Reese, Turken, & Waldron, 1998) the authors predicted that "Slight increases in dopamine, such as might occur during periods of mild transient happiness, could improve performance in verbal conditions" (p. 452). My results confirm the tentative prediction that positive mood could improve performance on a rule-based category learning task.

The rule-based task used in Study 2, Chapter 2, and in Chapter 3 has previously been found to benefit from cognitive flexibility (Maddox, Baldwin, & Markman, 2006). Maddox et al. (2006) define cognitive flexibility as the ability to seek out and apply alternate strategies to problems, and used the same rule-based category set that I used in Chapter 2 (Study 2) and Chapter 3 to test whether regulatory fit enhances performance on this category set. This category set requires participants to ignore the more salient stimulus dimension (orientation of the lines) and focus on the less salient dimension (frequency of the lines) to learn the perfect rule and achieve very high or perfect performance. Learning the correct rule, and that orientation does not result in perfect performance requires hypothesis-testing, rule selection, and response inhibition. It is likely that learning to ignore a salient dimension, and discovering that frequency is important requires flexibility that is comparable to overcoming functional fixedness. Further, once the correct rule has been learned, continuing to apply this rule accurately requires the kind of processing that Isen (1999) argues is enhanced by positive mood, namely processing that is careful and thorough.

These results also provide evidence against the capacity limitation hypothesis of positive mood (e.g. Mackie & Worth, 1989). If positive mood acts as a cognitive load that detracts from explicit reasoning processes, performance in the rule-based condition would have been worse, not better, than performance in the neutral and negative mood conditions. Prior research using the same category set has found that the addition of a secondary task during category learning that requires working memory impairs rule-based performance relative to a condition that does not (Zeithamova & Maddox, 2006). Therefore if positive mood acts as a cognitive load performance should have been impaired as opposed to enhanced on the rule-based category learning task.

It is also hard to argue that the present results demonstrate that positive mood participants responded more heuristically or carelessly than neutral mood participants, as is suggested by some research and theories (e.g. Bless, Bohner, Schwarz, & Strack, 1990). A heuristic or superficial response style would not have resulted in accurate performance on the rule-based category learning task used in Chapters 2 and 3. As mentioned, the most salient stimulus dimension in the rule-based task is orientation of the lines. If a participant responded carelessly or superficially they would likely focus on this salient but non-criterial dimension and demonstrate lower performance than a participant who paid closer attention to the two dimensions and learned that frequency was perfectly predictive of category membership. Further, learning the verbal rule required participants to pay close attention to the number of lines in each stimulus. The modeling results showed that participants in the positive mood condition were in fact more likely than participants in the neutral and negative mood conditions to be basing their responding on the frequency of the lines and not the orientation.

There is recent evidence that positive mood results in slower reaction times on tasks that require a narrowing of attention (e.g. Phillips, Bull, Adams, & Fraser, 2002; Rowe, Hirsch, & Anderson, 2007). The current tasks used were not time limited, and it is possible that if participants had been required to make responses more quickly that positive mood advantages may not have been found. What seems evident is that when response time is not limited, rule-based categorization performance is enhanced by positive mood. However, it is unclear whether all rule-based categorization performance would be improved by positive mood. For instance, Maddox et al. (2006) created a rule-based category set that did not benefit from cognitive flexibility. The optimal strategy was verbalizable but for the rule to be found small, incremental changes in strategy were required. Participants in a regulatory fit condition performed less well than participants in a regulatory mismatch condition, presumably due to the fact that cognitive flexibility was disadvantageous for performance (Maddox et al., 2006). Future research should investigate whether positive mood results in homologous findings.

Ashby et al. (1999) note it is possible that positive mood will enhance non-rule-based category learning due to a dopamine projection extending from the substantia nigra to the striatum, an area implicated in non-rule-based category learning. I did not find evidence for this in the behavioral data, however the computational modeling results suggested that participants in the positive mood condition were better able to find the correct strategy than neutral mood participants in both the rule-based and non-rule-based category learning tasks in early learning. It is possible that the modeling results are evidence of a positive mood enhancement. Because the computational modeling took the individual responses of participants into account this offers a finer-grained look at the learning abilities of participants relative to performance.

5.2 Negative mood implications

Chapter 3 successfully manipulated negative mood, but failed to find any significant difference in rule-based or non-rule-based category learning performance. Chapter 2 measured negative mood as well as depressive symptoms, but negative mood did not correlate significantly with performance. Current depressive symptoms *did* correlate negatively with complex rule-based performance, but when positive mood was taken into account this correlation was no longer significant.

Prior research on the influence of negative mood on cognitive processing has been mixed, with some research demonstrating that negative mood narrows attention (Baumann & Kuhl, 2005; Gasper & Clore, 2002; Mikulincer, Kedem, & Paz, 1990a; Mikulincer, Paz, & Kedem, 1990b), some research demonstrating it broadens attention (Gable & Harmon-Jones, 2010), and other research reporting null findings (Isen, Daubman, & Nowicki, 1987; Murray, Sujan, Hirt, & Sujan, 1990). Overall the literature suggests it is more common for manipulated negative mood to result in null effects. Several possibilities might explain my results as well as previous results.

Isen (1985) suggests that people are motivated to maintain positive mood states, and motivated to resist negative states. The resistance of negative mood is called mood repair. A related explanation is that even successful negative mood manipulations do not last long enough to have an influence on performance in many tasks. This could be due to mood repair strategies or it could be due to a lack of rehearsal of the negative information (which could be construed as part of the mood repair process). For instance Baumann and

Kuhl (2005) reported that negative mood resulted in slower responses on trials that required a global response. What is noteworthy about their manipulation is that participants in the negative mood condition were primed with a negatively valenced word before each trial, unlike most experiments where the mood manipulation precedes and does not continue into the experimental task. Similarly, Gable and Harmon-Jones (2010) primed participants before each response trial with a neutral or negatively valenced picture. In both cases the mood manipulations were maintained on a trial-by-trial basis, and resulted in significant results.

A third related possibility to explain why manipulated negative mood did not negatively influence rule-based category learning performance is that for most participants it is unusual to focus on negative events/feelings evoked by mood manipulations to the extent that it takes up space in working memory for a prolonged period of time, in other words, most people are able to regulate their emotions such that they do not experience negative mood for very long in an experimental situation. The hallmark of anxiety is worry, which can be defined as persistent, relatively uncontrollable negative thoughts (Borkovec, Robinson, Pruzinsky, & Depree, 1983), and a symptom of depression is rumination, which can be defined as repetitive, negative, and self-focused thoughts about the future impact of current depressive feelings (Nolen-Hoeksema, 1991). It can be argued that anxiety and depression each represent an impaired ability to regulate one’s emotions, particularly negative ones, although paradoxically both worry and rumination are considered to represent attempts to regulate one’s negative emotions (Borkovec et al., 1983; Gross, 1999). Rumination is linked to increased negative mood and depressive symptoms (Nolen-Hoeksema & Morrow, 1991), and people high in trait rumination are more likely to become depressed (Just & Alloy, 1997). Likewise worry is related to increased anxiety (Borkovec et al., 1983). Worry and rumination both involve a significant verbal component (Fresco, Frankel, Mennin, Turk, & Heimberg, 2002; Stober, Tepperwien, & Staak, 2000). It is possible that for most individuals, an experimental manipulation of negative mood does not result in the persistent negative thoughts associated with anxiety and depressive disorders that are related to impaired executive functions (see Austin, Mitchell, & Goodwin, 2001; and Castaneda, Tuulio-Henriksson, Marttunen, Suvisaari, & Lönnqvist, 2008 for reviews). Again, it is noteworthy that two successful negative mood inductions that resulted in significantly altered performance used trial-by-trial exposure to negatively valenced stimuli (Baumann & Kuhl, 2005; Gable & Harmon-Jones, 2010). However Gasper and Clore (2002) did not use trial-by-trial maintenance of negative mood, and reported significant results. Participants in the experiment wrote about a “sad experience” and then completed a brief global-local processing task. It is possible that because writing about a sad experience resulted in a negative mood state that persisted throughout the brief task.

Thus it is possible that a trial-by-trial negative mood induction might result in a significant reduction in rule-based category learning performance. In contrast positive mood inductions are posited to result in a release of dopamine in frontal brain regions and the effects of this release have been found to last about 30 minutes (Ashby et al., 1999). Thus successful positive mood inductions should not require maintenance in the way that negative mood inductions appear to. Evidence in support of the idea that negative mood inductions do not last as long as positive mood inductions argument comes from Kliegel et al. (2005), who reported significant performance differences between negative and neutral mood conditions in the first five minutes of the experimental task following the mood induction procedures.

5.3 Depressive symptom implications

Chapter 2 demonstrated that although depressive symptoms correlated strongly and negatively with complex rule-based category learning performance, their association with performance was not unique. In fact positive mood and history of hypomanic symptoms were the only two significant predictors of rule-based performance. However even though depressive symptoms did not contribute significant amounts of unique variance to rule-based performance, the negative correlations found support the hypothesis that depressive symptoms would be negatively related to rule-based category learning. These results are in line with the work of Smith et al. (1993), but go further to demonstrate that current positive mood contributes more unique variance to rule-based category learning performance than depressive symptoms.

A key limitation of this research is that participants were not clinically depressed. If self-reported depressive symptoms are comparable to major depression, then these results are in line with predictions made by COVIS, namely that depression should impair performance on rule-based category learning tasks. However whether one argues that current depressive symptoms exist on a continuum from non-depressed to major depression, or that participants who self report high levels of depressive symptoms are undergoing psychological distress that is more general, it is clear that this construct is negatively related to performance on rule-based category learning tasks. It has been proposed that self-reported depressive symptoms represent general negative affectivity (Watson & Clark, 1984). If this is true, then general negative affectivity is negatively related to performance, a finding in line with the idea that negative mood narrows attention (e.g. Gasper and Clore, 2002). What is interesting is that positive mood accounted for more unique variance than depressive symptoms, suggesting that the degree of positive mood (or the absence or presence of positive mood) is more important for performance on rule-based category learning tasks than general psychological distress or negative affectivity. Further, participants' current negative mood ratings were not significantly related to rule-based performance and did not contribute significant unique variance to performance.

The finding that positive mood might be more important for performance on rule-based category learning tasks than negative affectivity/depressive symptoms is interesting. Several researchers have suggested that depression may represent a lack of a positive mood more so than a presence of negative mood (Davidson, 1993; Heller, 1990; as cited by Fredrickson, 2001). Watson, Clark, and Carey (1984) have shown that depression presents a condition in which there is both high negative mood and low positive mood, and that it is positive mood that distinguishes depression from other psychological disorders (such as anxiety). However it is possible that the reason only positive mood contributes unique variance in the present research is because the sample consisted of university students who were not necessarily depressed. It is possible that in a clinically depressed sample that depressive symptoms and positive mood would show a different pattern of results, however recent research by Heller et al. (2009) provides evidence that depressive symptoms are related to a decreased ability to maintain positive mood states.

Participants with clinical depression showed decreased sustained activation of the nucleus accumbens during an emotion regulation task relative to non-depressed controls. The nucleus accumbens is implicated in positive mood. Participants' ratings of positive mood were related to this decreased activity, providing support for the hypothesis that a reduced capacity to experience positive mood is related to depressive symptoms.

5.4 Mood or motivation?

The Latin root of the word "emotion" is *emovere*, which means "to move or to push". Reflecting this definition, different groups of researchers argue that motivation and emotion are intertwined. One viewpoint argues that emotion in animals and humans have evolved from basic motivational systems concerned with approach and avoidance (Gray, 1981; Gray, 1990). Positive mood is argued to stem from the approach system, and negative mood is argued to stem from the avoidance system. A distinct but related line of research argues that feeling states arise from people's judgments of how effective their efforts are to approach goals and avoid anti-goals (Carver & Scheier, 1998). In this theory the purpose of positive emotions/moods is to motivate one to seek out new experiences (Carver, 2003). Positive moods encourage exploration because they signal that one is performing better than necessary, whereas negative moods signal that one is performing worse than necessary (Carver, 2003). In this framework positive and negative emotions can arise from either the approach or the avoidance systems, and this will influence the kind of emotion. For instance approach-motivated positive emotions include joy, and eagerness, whereas avoidance-motivated positive emotions include relief, and calmness (Carver, 2003). In all cases, emotion is the result of a feedback signaling process that monitors one's progress towards goals, and motivation is an integral part of emotional experience (Carver & Scheier, 1998).

Other theories argue that motivational systems exist independent of emotion, but that emotion is influenced by these systems (Higgins, 2001). For instance self-discrepancy theory is similar to control systems theory (Carver & Scheier, 1998) in that the perceived distance from ideal or ought motivational states influences emotion in predictable ways. When one perceives they are failing/succeeding at attaining a desired end state (promotion), depression/happiness results. When one perceives they are succeeding/failing at avoiding an undesired end state (prevention), relief/anxiety results. So although the motivational states preceding these emotions are supposed to be independent of emotion, emotion is tied to these states once the cognitive evaluative processes involved in assessing the progress being made towards reaching goals are active.

Higgins (2001) argues that:

> When studies manipulate emotional experiences with music, movies, gifts, or recollections of past events, it is possible that they manipulate nonemotional motivational states as well, such as promotion and prevention motivational states, and these motivational states might influence memory independent of emotions. (p. 209)

This implies that positive mood manipulations might be confounded with promotion focus motivation. This is an interesting and plausible proposition. A promotion regulatory focus state has been argued to broaden attention (Förster & Higgins, 2005; Friedman & Förster, 2005) as has regulatory fit (Memmert, Unklebach, & Ganns, 2010). Regulatory fit has also been argued to enhance cognitive flexibility (Maddox et al., 2006; Zhang & Chan, 2012). Thus there is convergence between results obtained with positive mood manipulations (e.g. Ashby et al., 1999) and with regulatory focus and fit manipulations. In fact Zhang and Chan (2012) replicated the results of Dreisbach and Goschke (2004) with promotion and prevention regulatory focus states. In Chapter 4 the majority of participants had a dominant chronic promotion focus, a finding that is corroborated in other research using participants from individualistic cultures (Elliot, Chirkov, Kim & Sheldon, 2001; Lee, Aaker & Gardner, 2000). It is possible that if most students in North American universities and colleges have a chronic promotion focus that a positive mood manipulation could create either a strong promotion focus or a state of regulatory fit.

Chapter 4 manipulated promotion and prevention regulatory focus states, but found that mood accounted for the variance in poor exemplar typicality ratings. Specifically, current self-reported negative mood was negatively related to poor exemplar typicality ratings. It seems likely that the prevention focus manipulation created increased negative mood/anxiety in participants. It is possible that writing about "duties and responsibilities" in the future created anxiety in first year undergraduate students, for instance by activating cognitive evaluative processes that made some students feel like they were failing at meeting their prevention-based goals, as predicted by self-discrepancy theory (Higgins, 1987). This finding is in line with research by Mikulincer and colleagues (Mikulincer, Paz, Kedem, 1990a; Mikulincer, Kedem, & Paz, 1990b). Mikulincer et al. (1990a; 1990b), who reported that state and trait anxiety was connected to reduced poor exemplar typicality ratings. Unlike Mikulincer et al. (1990a), I did not try to create an evaluative state amongst participants. Participants in Chapter 4's study were told there were no correct or incorrect answers. In contrast Mikulincer et al. (1990a) explicitly attempted to create an evaluative atmosphere to amplify the effects of anxiety on the rating task. My research demonstrates that an evaluative framework need not be explicitly promoted in order for negative affectivity to influence poor exemplar typicality ratings.

Higgins (2001) argues that the high anxiety group in Mikulincer et al. (1990) were likely to have been in a prevention focus, and that it was the prevention focus, and not the anxiety that influenced the typicality ratings. This argument is made in light of the findings of Crowe and Higgins (1997), who reported that participants in a prevention focus created less inclusive category groupings than participants in a promotion focus. Further, this effect was reported to be independent of mood, as mood was measured at several times throughout the task. Although my research did not find an effect of motivational state that was independent of mood, it is still possible that all of these results are concordant with one another, but that the varied results are due to differences in methodology and measurement. Future research should seek to disentangle nonemotional motivation from emotions resulting from success and failure.

5.5 Implications for category learning performance

The finding that positive mood influenced performance on a rule-based category learning task but not a non-rule-based category learning task supports the hypothesis that these tasks tap different abilities. This evidence can also be used to support the hypothesis that distinct verbal and nonverbal category learning systems exist (Ashby et al., 1998). For instance it was originally hypothesized that the nonverbal system should not be influenced by executive functioning. However research is accumulating suggesting that the two systems have more in common than previously thought, and that executive functioning is important for both. Maddox, Pacheco, Reeves, Zhu, and Schnyer (2010) reported age-related declines in performance on both RB and NRB category learning tasks. Further, they reported that Stroop and WCST performance correlated with performance on both types of tasks. Maddox et al. (2010) argue that set-shifting is important for accurate performance on both RB and NRB tasks. Set-shifting is important for performance on RB learning tasks because it enables participants to find the correct rule. Set-shifting is important for performance on NRB category learning tasks because it allows participants to shift away from verbal strategies. Schnyer, Maddox, Ell, Davis, Pacheco, and Verfaelliee (2009) studied a group of patients with ventral PFC damage, and reported that performance was impaired on both RB and NRB category learning tasks, which provides support for the hypothesis that the PFC is important for both the verbal and the implicit systems, or at least, for RB and NRB learning tasks.

The modeling results in Chapter 3 revealed that positive mood participants showed increased evidence of correct strategy usage in both the RB and NRB conditions, although behavioral data did not demonstrate a positive mood advantage in the NRB condition. Because computational modeling goes beyond performance to show the acquisition of optimal strategies, these results are particularly compelling. This finding lends support to the idea that set-shifting is important for both category learning tasks, because positive mood has been found to increase set-shifting (Dreisbach & Goschke, 2004). Future research should examine whether positive mood performance advantages are found on different NRB learning tasks with longer learning periods.

5.6 Future Directions

While the studies in this dissertation conceptualized mood according to valence (positive or negative), some researchers argue that motivational intensity, not valence, determines whether attention is broadened or narrowed (Harmon-Jones & Gable, 2008; Harmon-Jones, Price, & Gable, 2012). In the motivational dimension model of affect, low intensity motivational states (approach or avoidance) are argued to broaden attention, while high intensity motivational states (approach or avoidance) are argued to narrow attention. This is based on the reasoning that low intensity mood states do not motivate one to approach desired end states, but high intensity states do. Thus if one is focused on a desired end state (like a delicious piece of cake), one is narrowed in on the desired end state and not open to other possibilities. In contrast low intensity approach-related states indicate that things are going well, and thus it is safe to be open to new possibilities (e.g. Carver, 2003).

Gable and Harmon-Jones (2010a) argue that the positive mood that is typically manipulated in studies tends to be low in motivational intensity, because the stimuli used to evoke positive mood were not "post-goal or not goal relevant" (p. 325). This argument is in line with the dopaminergic hypothesis of positive mood, because that theory specifies that it is mild to moderate changes in positive mood that increase cognitive flexibility (Ashby et al., 1999). Gable and Harmon-Jones (2010c) reported that sadness (a low intensity state) resulted in broadened attention, whereas disgust (a high intensity state) narrowed attention. However one issue with this research is that there are inconsistencies in the use of mood manipulations across studies. For instance in one experiment funny cat videos are operationalized as low in motivational intensity (Gable & Harmon-Jones, 2008, Experiment 1), but in another experiment cute baby animals are operationalized as being high in motivational intensity (Gable and Harmon-Jones, 2008; Experiment 3). My experiment in Chapter 3 used a video of a cute laughing baby to evoke positive mood. If cute babies evoke high intensity approach motivation across species, then it can be argued that high intensity positive mood was induced (and consequently that the attention of participants in this condition was narrowed). However it is difficult to argue that funny cat videos are low in motivational intensity while cute baby animals are high in it, and it is also difficult to align the results of Chapter 3 with the idea that attention was narrowed in positive mood participants. Despite these inconsistencies, future research investigating the influence of mood on cognitive processes should take motivational intensity into account when designing experiments so that the potential influence of motivational intensity can be assessed more readily.

5.7 Conclusions

This is the first series of experiments to examine the influence and relationship between mood and performance on category learning tasks, and this dissertation's unique contribution to knowledge is that positive mood enhances performance on rule-based category learning tasks. Further, my results show that depressive symptoms are negatively related to performance on rule-based category learning tasks, but positive mood contributes more unique variance to performance than depressive symptoms.

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Appendices

Appendix A: Penn State Worry Questionnaire used in Chapter 2.

Meyer, T. J., Miller, M. L., Metzger, R. L., & Borkovec, T. D. (1990). Development and validation of the penn state worry questionnaire. Behavior Research and Therapy, 28, 487-495.

Instructions: Rate each of the following statements on a scale of 1 ("not at all typical of me") to 5 ("very typical of me").

1. If I do not have enough time to do everything, I do not worry about it. _____

2. My worries overwhelm me. _____

3. I do not tend to worry about things. _____

4. Many situations make me worry. _____

5. I know I should not worry about things, but I just cannot help it. _____

6. When I am under pressure I worry a lot. _____

7. I am always worrying about something. _____

8. I find it easy to dismiss worrisome thoughts. _____

9. As soon as I finish one task, I start to worry about everything else I have to do. _____

10. I never worry about anything. _____

11. When there is nothing more I can do about a concern, I do not worry about it anymore. _____

12. I have been a worrier all my life. _____

13. I notice that I have been worrying about things. _____

14. Once I start worrying, I cannot stop. _____

15. I worry all the time. _____

16. I worry about projects until they are all done. _____

Appendix B: BIS/BAS Questionnaire used in Chapters 2 and 4.

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS scales. *Journal of Personality and Social Psychology*, 67, 319-333.

BIS/BAS

Each item of this questionnaire is a statement that a person may either agree with or disagree with. For each item, indicate how much you agree or disagree with what the item says. Please respond to all the items; do not leave any blank. Choose only one response to each statement. Please be as accurate and honest as you can be. Respond to each item as if it were the only item. That is, don't worry about being "consistent" in your responses. Choose from the following four response options:

1 = very true for me
2 = somewhat true for me
3 = somewhat false for me
4 = very false for me

1. A person's family is the most important thing in life.
2. Even if something bad is about to happen to me, I rarely experience fear or nervousness.
3. I go out of my way to get things I want.
4. When I'm doing well at something I love to keep at it.
5. I'm always willing to try something new if I think it will be fun.
6. How I dress is important to me.
7. When I get something I want, I feel excited and energized.
8. Criticism or scolding hurts me quite a bit.
9. When I want something I usually go all-out to get it.
10. I will often do things for no other reason than that they might be fun.
11. It's hard for me to find the time to do things such as get a haircut.
12. If I see a chance to get something I want I move on it right away.
13. I feel pretty worried or upset when I think or know somebody is angry at me.
14. When I see an opportunity for something I like I get excited right away.
15. I often act on the spur of the moment.

16. If I think something unpleasant is going to happen I usually get pretty "worked up."
17. I often wonder why people act the way they do.
18. When good things happen to me, it affects me strongly.
19. I feel worried when I think I have done poorly at something important.
20. I crave excitement and new sensations.
21. When I go after something I use a "no holds barred" approach.
22. I have very few fears compared to my friends.
23. It would excite me to win a contest.
24. I worry about making mistakes.

Scoring

Items other than 2 and 22 are reverse-scored.

BAS Drive: 3, 9, 12, 21

BAS Fun Seeking: 5, 10, 15, 20

BAS Reward Responsiveness: 4, 7, 14, 18, 23

BIS: 2, 8, 13, 16, 19, 22, 24

Items 1, 6, 11, 17, are fillers.

Appendix C: PANAS Mood Scale used in Chapters 2, 3, and 4.

Watson, D.,Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. Journal of Personality and Social Psychology, 54(6), 1063-1070.

The PANAS

This scale consists of a number of words that describe different feelings and emotions. Read each item, and then mark the appropriate answer in the space next to that word. Indicate to what extent you have felt this way ***right now, that is at the present moment***. Use the following scale to record your answers.

1	2	3	4	5
very slightly or not at all	a little	moderately	quite a bit	extremely

________interested	________irritable
________distressed	________alert
________excited	________ashamed
________upset	________inspired
________strong	________nervous
________guilty	________determined
________scared	________attentive
________hostile	________jittery
________enthusiastic	________active
________proud	________afraid

Appendix D: Stimulus parameters for the rule-based and non-rule-based category sets used in Chapter 2, Study 2, and Chapter 3.

Rule-based Category Set					
Category A Stimuli			**Category B Stimuli**		
Stimulus	**Frequency**	**Orientation**	**Stimulus**	**Frequency**	**Orientation**
1	283.8460133	-24.56300957	41	319.3785576	53.24238592
2	276.1225535	97.00693267	42	308.6047207	115.8039403
3	279.286904	-48.9443983	43	322.2350621	9.876615775
4	266.1785457	166.8635214	44	305.2867591	87.91707132
5	290.2247953	215.4030348	45	309.1792953	226.7368235
6	271.7570989	74.1700582	46	325.0817444	115.6382904
7	271.2612246	102.0911086	47	320.5455444	133.9862819
8	268.4519829	163.2142623	48	316.1964926	279.3326036
9	271.786766	-15.3873503	49	307.6897982	2.983472443
10	280.6156419	234.9824086	50	328.25006	159.7867858
11	278.0100402	196.3919967	51	335.9716659	155.264361
12	276.8577927	40.86790811	52	328.598592	47.00197604
13	273.7139204	-23.14104699	53	320.6748883	128.616499
14	289.7222719	248.0725067	54	321.84533	98.83918294
15	261.7537936	161.738353	55	323.749982	156.8985557
16	280.5081194	88.20461269	56	324.0989995	160.2878353
17	269.7348719	156.0337873	57	320.417003	83.08315314
18	276.1902066	287.2454369	58	313.2896274	229.8267174
19	275.0993669	-39.6412487	59	327.6880318	10.65074923
20	287.123303	209.9715879	60	324.0664411	185.5598301
21	282.7021015	-42.51908936	61	311.8659338	69.239177
22	261.3764317	82.89150632	62	325.0576269	203.6632243
23	293.0069585	150.4444213	63	313.0725469	22.74620519
24	292.8680139	144.0368391	64	325.864941	61.30196056
25	290.1204498	87.1400317	65	317.3117443	179.1732226
26	271.9360476	44.3866242	66	319.5901952	204.9056857
27	274.9907137	58.27213831	67	328.5276356	68.82101009
28	268.9337482	146.9918492	68	314.0393546	64.36204639
29	271.9787983	155.6017496	69	306.2907393	76.64492031
30	279.0071465	158.8556302	70	309.8575362	161.1674514
31	260.3049691	100.967234	71	318.7128888	138.7313717
32	261.3294168	143.5239126	72	330.2678946	87.06740326
33	283.1108725	244.1779493	73	316.6723589	183.994948
34	288.8519437	41.01991073	74	318.5456244	79.43798295
35	273.946041	203.140319	75	323.8792694	124.5656651
36	288.5698567	163.2343911	76	302.9410884	92.85328747
37	273.5385075	59.79198383	77	324.1729031	55.76495776
38	279.9134468	121.1809873	78	323.1260289	131.0135311
39	297.1142236	152.2617164	79	335.380337	128.6668018
40	287.2954522	177.6313886	80	309.921267	102.0079193

Non-rule-based Category Set					
Category A Stimuli			Category B Stimuli		
Stimulus	**Frequency**	**Orientation**	**Stimulus**	**Frequency**	**Orientation**
1	281.7	177.5	41	295.6	62.78
2	306.6	219.5	42	287.9	52.18
3	202.1	119	43	409.4	170.9
4	154.2	25.89	44	377.6	158.8
5	189.8	88.98	45	531.5	286.6
6	278.9	205.4	46	488.5	253.2
7	217.7	96.32	47	383.6	169.7
8	260	158.5	48	297.8	33.97
9	221.3	94.36	49	317.3	78.83
10	330.2	194.8	50	403.9	160.4
11	326	235.5	51	464	247.5
12	420.4	343.9	52	323.9	80.73
13	261.4	150.9	53	289	36.72
14	206.7	101	54	227.2	-26.7
15	184.5	73.3	55	388.5	155.6
16	317.9	190.7	56	224.9	-32.13
17	292	212.1	57	308.3	44.57
18	340	208.9	58	422.7	177.8
19	194	100.6	59	518.7	288.5
20	210.5	121.9	60	416.3	157.6
21	273	184.3	61	333.2	78.77
22	137.4	71.98	62	372	133.4
23	321.5	238.4	63	388	155.9
24	245.8	157.8	64	368.3	127.8
25	209	105.7	65	344.4	103.1
26	311.5	160.4	66	268.4	37.72
27	205.5	93.75	67	420.4	173.3
28	288.3	214.1	68	336.9	115
29	324.8	183.8	69	235.9	-3.019
30	290.9	154.9	70	350.3	87.22
31	250	158.1	71	322.3	89.1
32	210.4	83.96	72	318.7	86.3
33	243.4	131.9	73	318.2	72.52
34	215.6	105.5	74	392.3	142.4
35	349	254.3	75	254.6	-0.7396
36	358.1	227.3	76	344	115
37	345.5	232.6	77	263.2	17.73
38	392.3	279.1	78	270.5	53.76
39	313.6	222.8	79	414.2	192.6
40	209.6	128.4	80	271	49.43

Appendix E: Intercorrelations between all Chapter 2 Questionnaires.

Study 1 Intercorrelations between questionnaires							
	BDI-II	GBI-D	PSWQ	HPS	GBI-H	BAS	BIS
BDI-II	-----	-----	-----	-----	-----	-----	-----
GBI-D	.552***	-----	-----	-----	-----	-----	-----
PSWQ	.439***	.319**	-----	-----	-----	-----	-----
HPS	-.061	-.004	-.086	-----	-----	-----	-----
GBI-H	.250*	.724***	.124	.245*	-----	-----	-----
BAS	.117	.124	.035	.264*	.263*	-----	-----
BIS	.203	.149	.405***	.156	.112	.416***	-----

Notes: *** p < .001, ** p < .01, * p < .05. BDI-II = Beck Depression Inventory II, GBI-D= General Behavior Inventory Depression, PSWQ = Penn State Worry Questionnaire, HPS = Hypomanic Personality Scale; GBI-H = General Behavior Inventory – Hypomania, BAS = Behavioral Activation Scale, BIS = Behavioral Inhibition Scale.

Study 1 Intercorrelations between questionnaires - HRB							
	BDI-II	GBI-D	PSWQ	HPS	GBI-H	BAS	BIS
BDI-II	-----	-----	-----	-----	-----	-----	-----
GBI-D	.500**	-----	-----	-----	-----	-----	-----
PSWQ	.645***	.426*	-----	-----	-----	-----	-----
HPS	-.016	-.002	-.065	-----	-----	-----	-----
GBI-H	.354	.673***	.140	.255	-----	-----	-----
BAS	.402*	.257	.361	.273	.363*	-----	-----
BIS	.468*	.332	.493**	.164	.195	.289	-----

Notes: *** p < .001, ** p < .01, * p < .05. BDI-II = Beck Depression Inventory II, GBI-D= General Behavior Inventory Depression, PSWQ = Penn State Worry Questionnaire, HPS = Hypomanic Personality Scale; GBI-H = General Behavior Inventory – Hypomania, BAS = Behavioral Activation Scale, BIS = Behavioral Inhibition Scale.

Study 2 Intercorrelations between questionnaires across conditions

	BDI-II	GBI-D	PSWQ	GBI-H	BAS	BIS	PAN_P	PAN_N
BDI-II	-----	-----	-----	-----	-----	-----	-----	-----
GBI-D	.800***	-----	-----	-----	-----	-----	-----	-----
PSWQ	.475***	.471**	-----	-----	-----	-----	-----	-----
GBI-H	.658***	.824***	.423***	-----	-----	-----	-----	-----
BAS	-.057	-.075	.058	.151	-----	-----	-----	-----
BIS	.220	.116	.458***	.103	-.038	-----	-----	-----
PANAS_P	-.130	-.078	.004	.131	.267*	-.186	-----	-----
PANAS_N	.622***	.590***	.343**	.573***	.004	-.034	.321**	-----

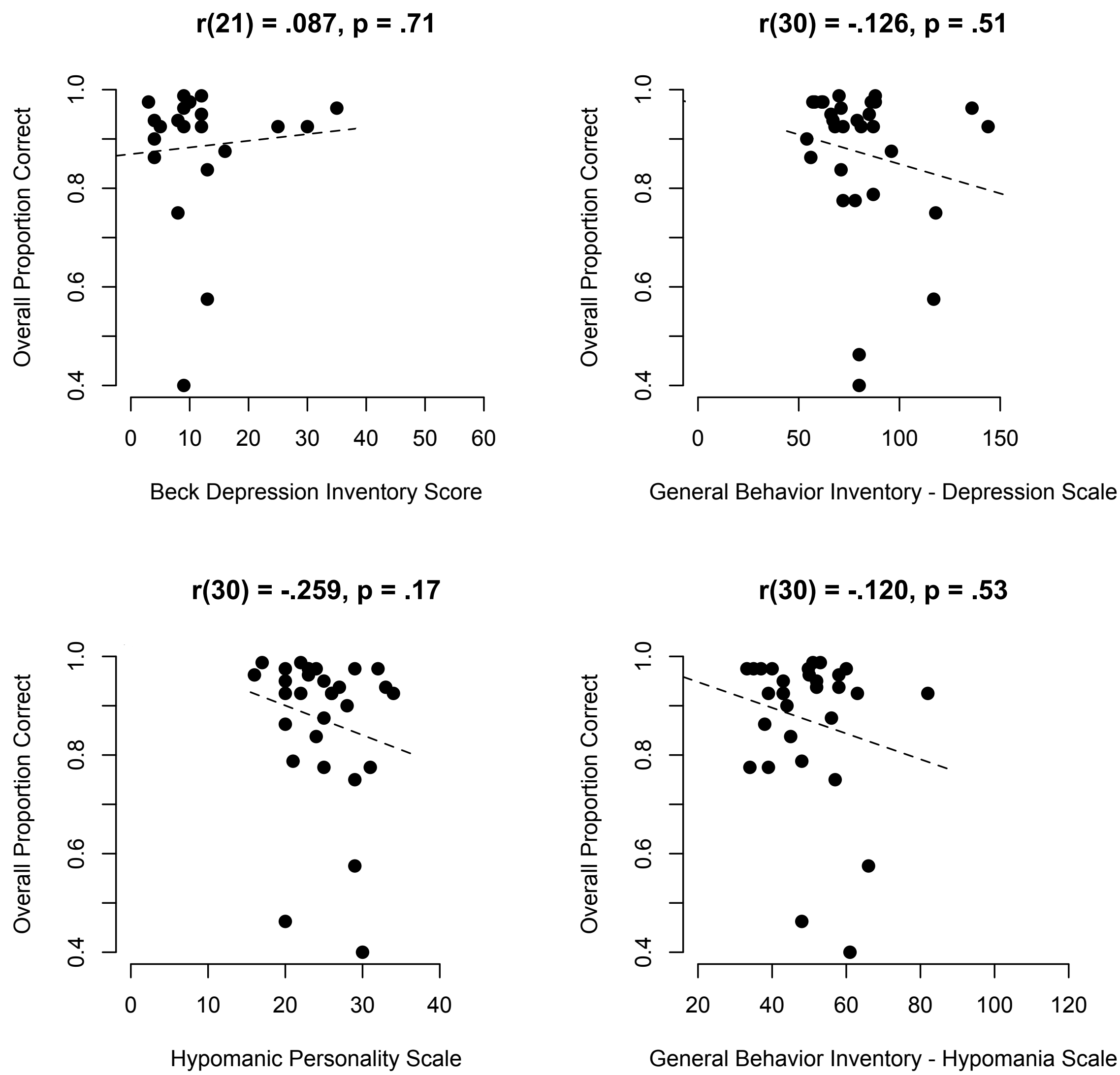
Notes: *** p < .001, ** p < .01, * p < .05. BDI-II = Beck Depression Inventory II,
GBI-D= General Behavior Inventory Depression, PSWQ = Penn State Worry Questionnaire,
GBI-H = General Behavior Inventory – Hypomania, BAS = Behavioral Activation Scale,
BIS = Behavioral Inhibition Scale, PANAS_P = Positive Affect Negative Affect Schedule Positive Scale,
PANAS_N = Positive Affect Negative Affect Schedule Negative Scale.

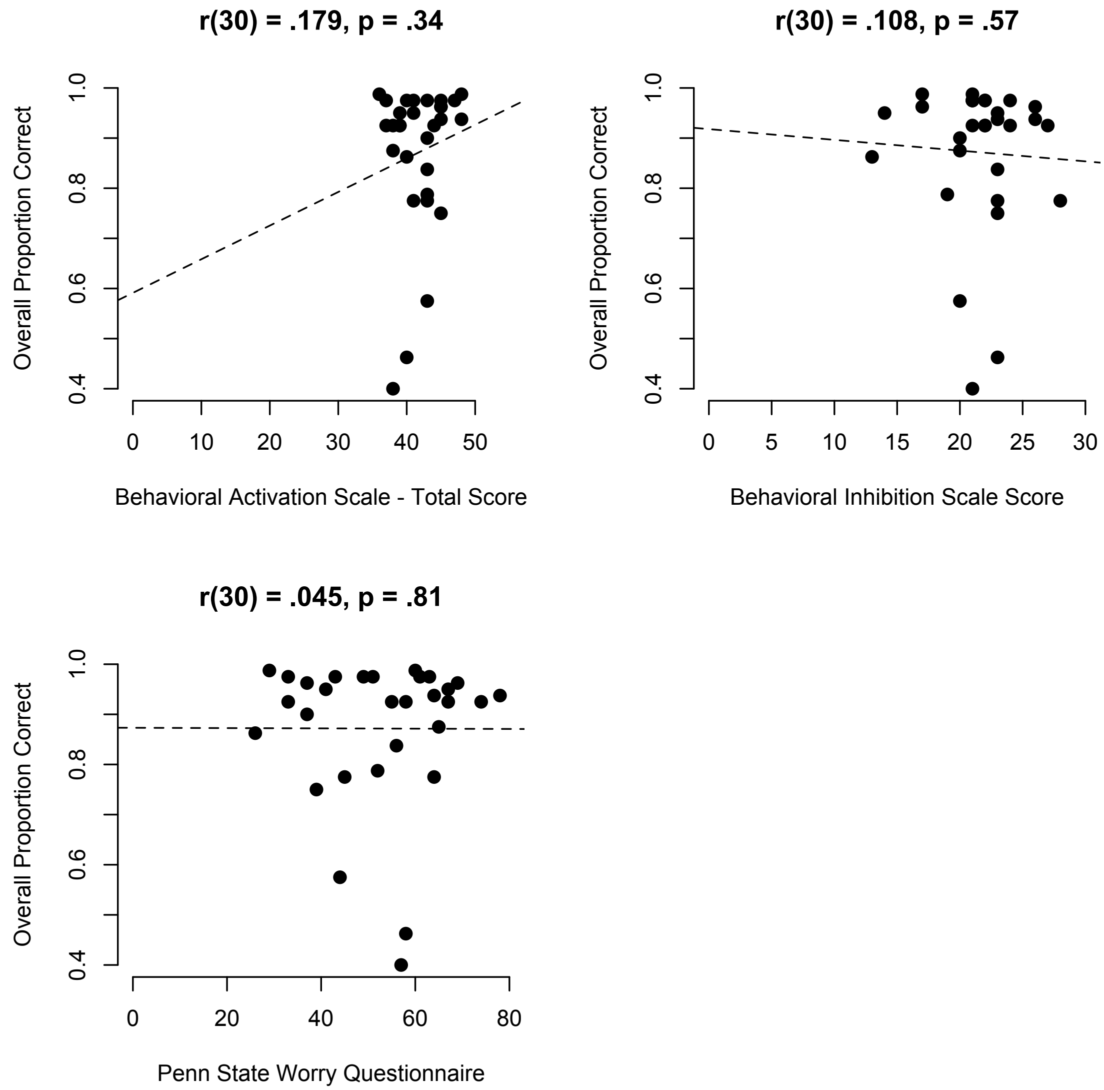
Study 2 Intercorrelations between questionnaires in RB condition

	1	2	3	4	5	6	7	8
BDI-II	-----	-----	-----	-----	-----	-----	----	-----
GBI-D	.687***	-----	-----	-----	-----	-----	----	-----
PSWQ	.380*	.437**	-----	-----	-----	-----	----	-----
GBI-H	.539***	.797***	.423**	-----	-----	-----	----	-----
BAS	-.113	-.159	.056	.138	-----	-----	----	-----
BIS	.040	-.122	.495**	-.119	-.001	-----	----	-----
PANAS_P	-.337*	-.100	-.181	.220	.373*	-.270	----	-----
PANAS_N	.407*	.547**	.147	.605***	.092	-.396*	.378*	-----

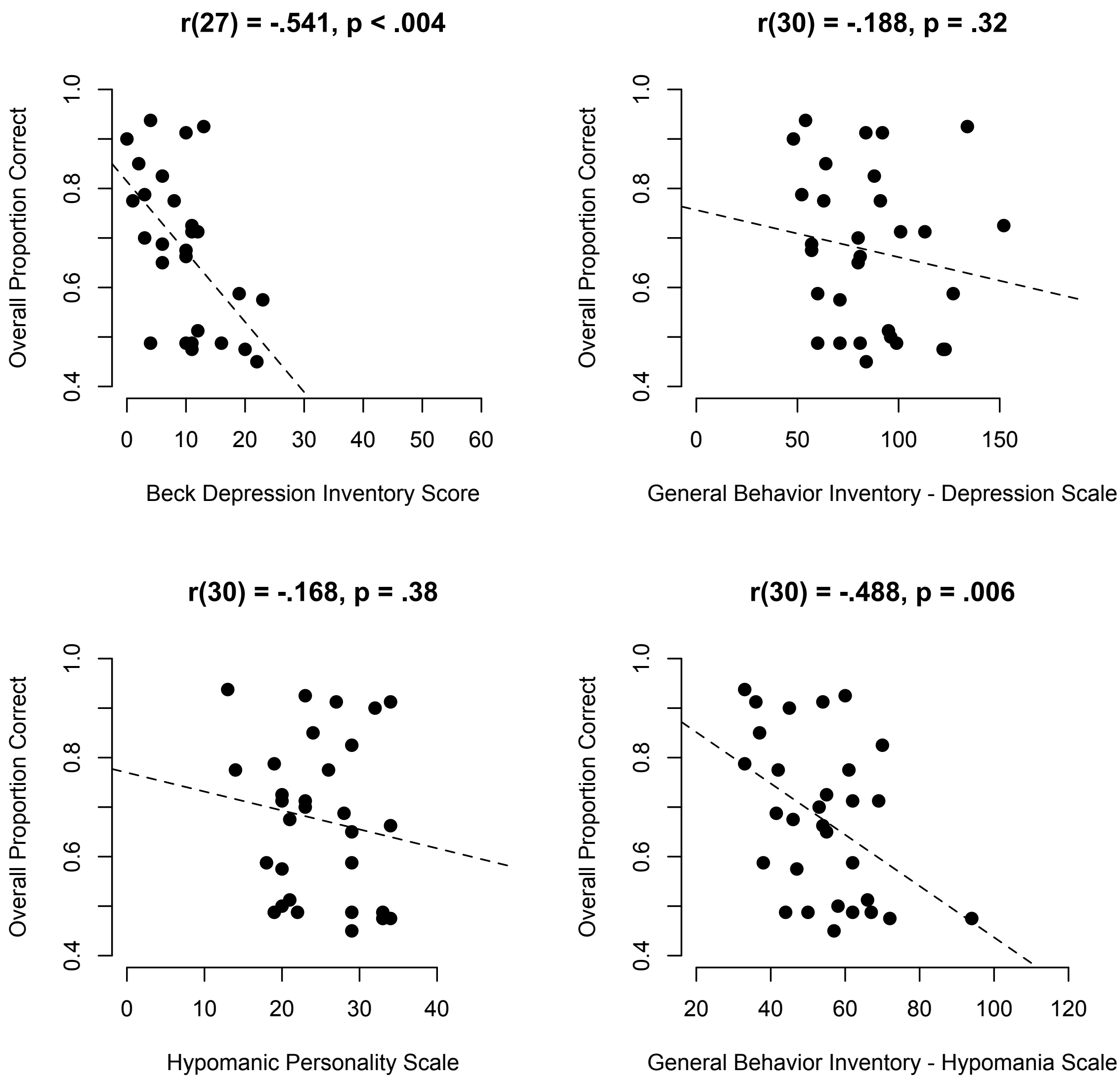
Notes: *** p < .001, ** p < .01, * p < .05. BDI-II = Beck Depression Inventory II, GBI-D= General Behavior Inventory Depression, PSWQ = Penn State Worry Questionnaire, GBI-H = General Behavior Inventory – Hypomania, BAS = Behavioral Activation Scale, BIS = Behavioral Inhibition Scale, PAN_P = Positive Affect Negative Affect Schedule Positive Scale, PAN_N = Positive Affect Negative Affect Schedule Negative Scale.

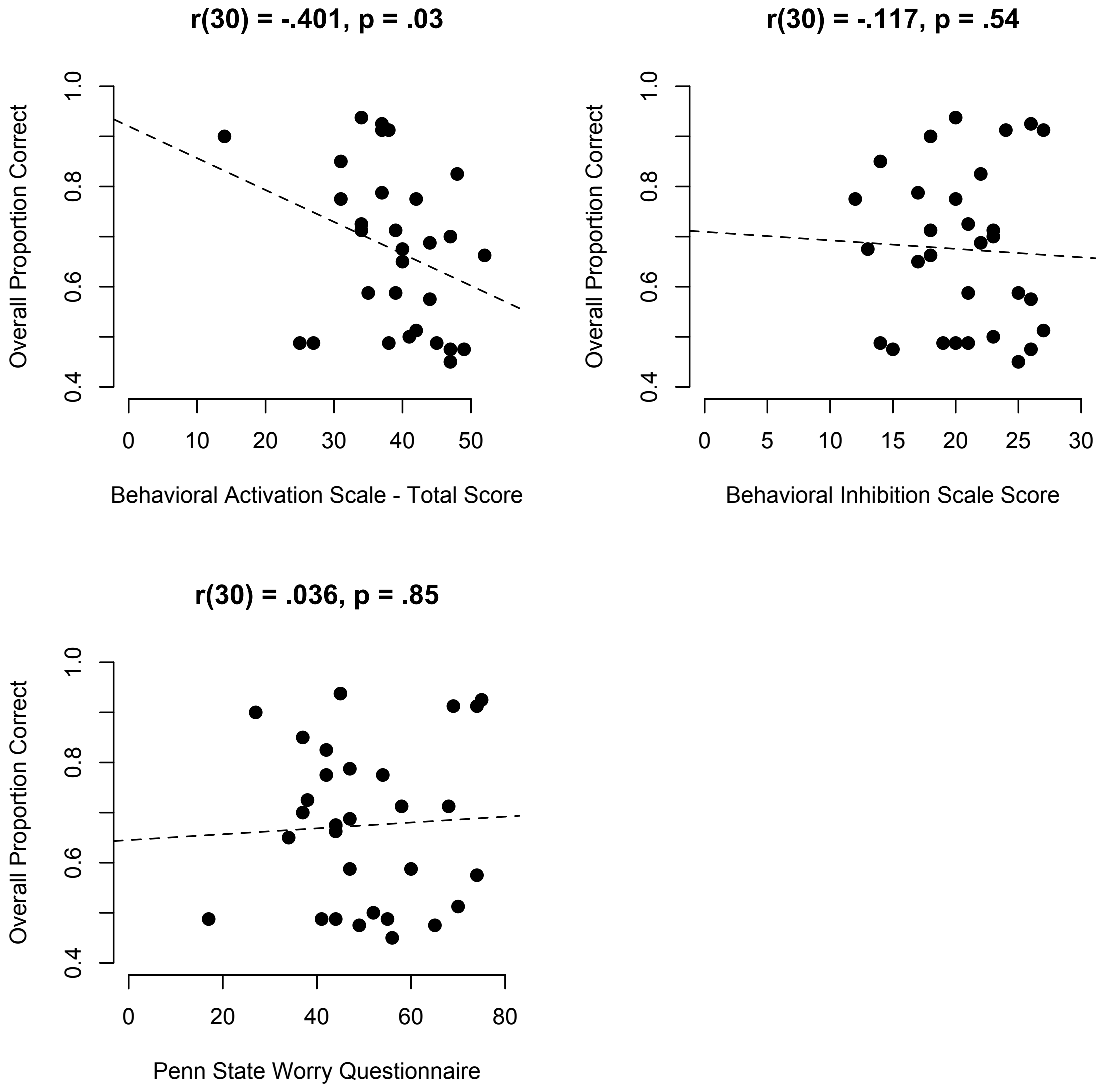
Appendix F: Chapter 2, Study 1 Easy, Rule-based Scatterplots.



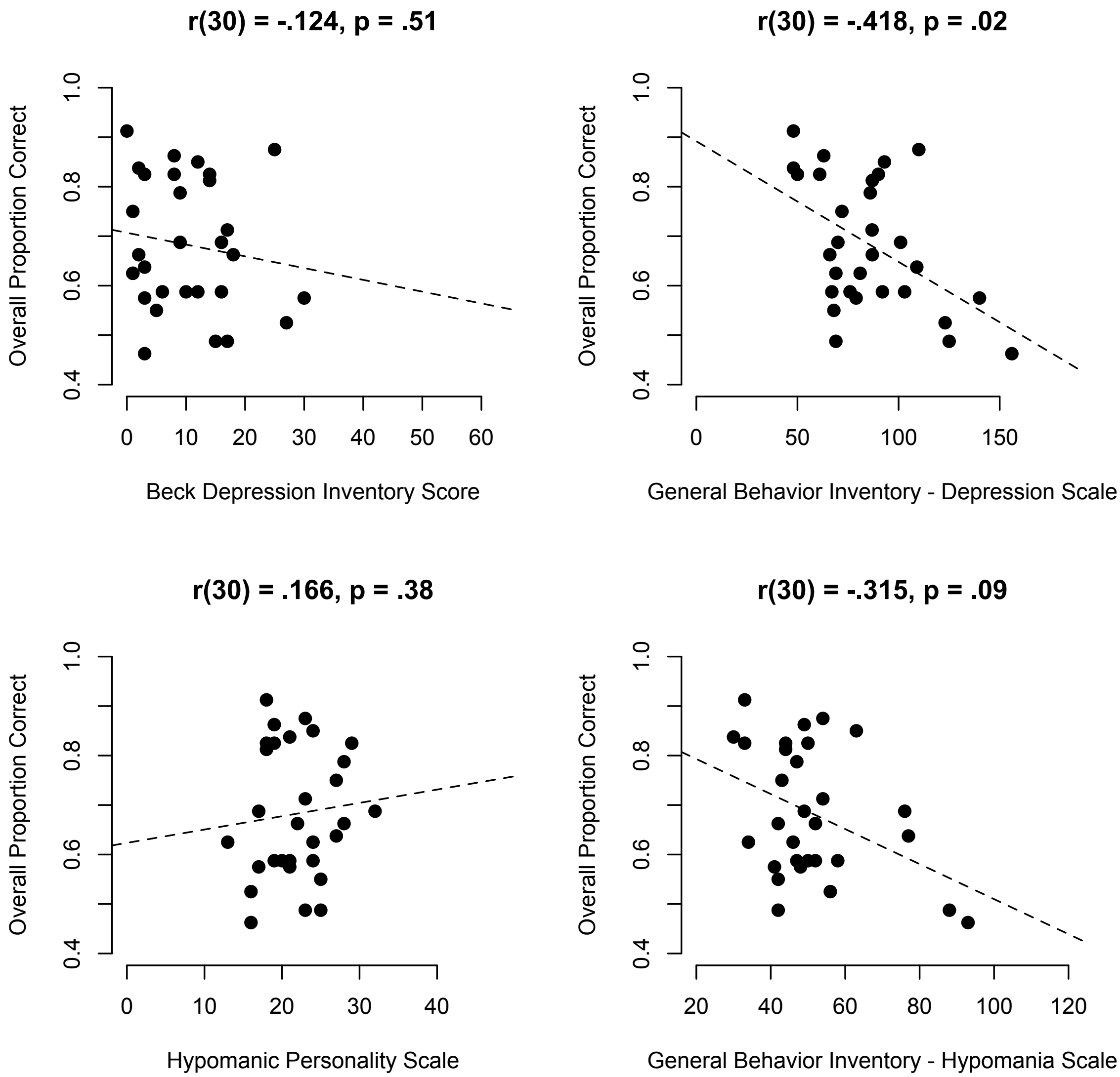

r(30) = .179, p = .34
Overall Proportion Correct
0.4
0.6
0.8
1.0
0
10
20
30
40
50
Behavioral Activation Scale - Total Score
r(30) = .108, p = .57
Overall Proportion Correct
0.4
0.6
0.8
1.0
0
5
10
15
20
25
30
Behavioral Inhibition Scale Score
r(30) = .045, p = .81
Overall Proportion Correct
0.4
0.6
0.8
1.0
0
20
40
60
80
Penn State Worry Questionnaire

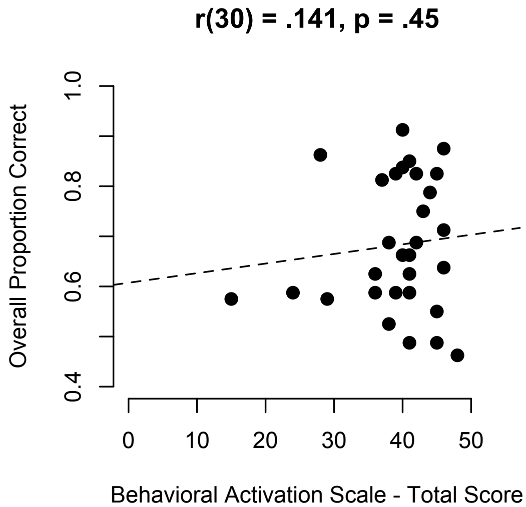
Appendix G: Chapter 2, Study 1 Hard, Rule-based Scatterplots.

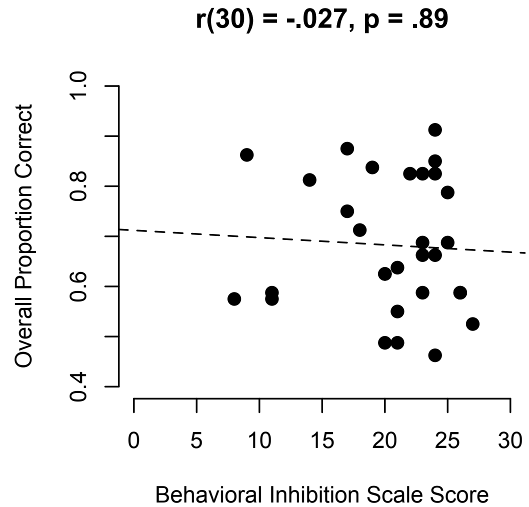


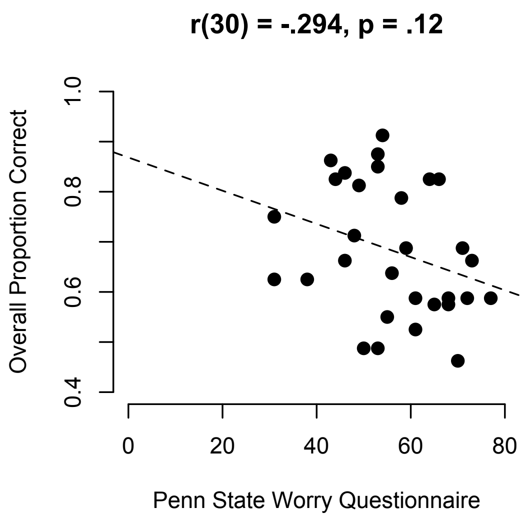

r(30) = -.401, p = .03
Overall Proportion Correct
0.4
0.6
0.8
1.0
0
10
20
30
40
50
Behavioral Activation Scale - Total Score
r(30) = -.117, p = .54
Overall Proportion Correct
0.4
0.6
0.8
1.0
0
5
10
15
20
25
30
Behavioral Inhibition Scale Score
r(30) = .036, p = .85
Overall Proportion Correct
0.4
0.6
0.8
1.0
0
20
40
60
80
Penn State Worry Questionnaire

Appendix H: Chapter 2, Study 1 Non-rule-based Scatterplots.




r(30) = .141, p = .45
Overall Proportion Correct
0.4
0.6
0.8
1.0
0
10
20
30
40
50
Behavioral Activation Scale - Total Score


r(30) = -.027, p = .89
Overall Proportion Correct
0.4
0.6
0.8
1.0
0
5
10
15
20
25
30
Behavioral Inhibition Scale Score


r(30) = -.294, p = .12
Overall Proportion Correct
0.4
0.6
0.8
1.0
0
20
40
60
80
Penn State Worry Questionnaire

Appendix I: Chapter 2, Study 1 Tests for the Difference between Two Independent Correlation Coefficients Results.

Questionnaire/Measure	**HRB**	**ERB**	**Zdiff**
Beck Depression Inventory Total	-.541**	.087	-2.22*
	n = 27	*n* = 21	*p* = .03
Penn State Worry Questionnaire Total	.036	.045	-.033
	n = 30	*n* = 30	*p* = .49
General Behavior Inventory - Depression	-.188	-.126	-0.234
	n = 30	*n* = 30	*p* = .41
General Behavior Inventory - Hypomania	-.488**	-.120	-1.52
	n = 30	*n* = 30	*p* = .13
Hypomanic Personality Scale	-.168	-.259	0.351
	n = 30	*n* = 30	*p* = .73
Behavior Inhibition Scale	-.103	.108	-1.05
	n = 30	*n* = 30	*p* = .30
Behavior Activation Scale Total	-.401	.179	-2.23*
	n = 30	*n* = 30	*p* = .03

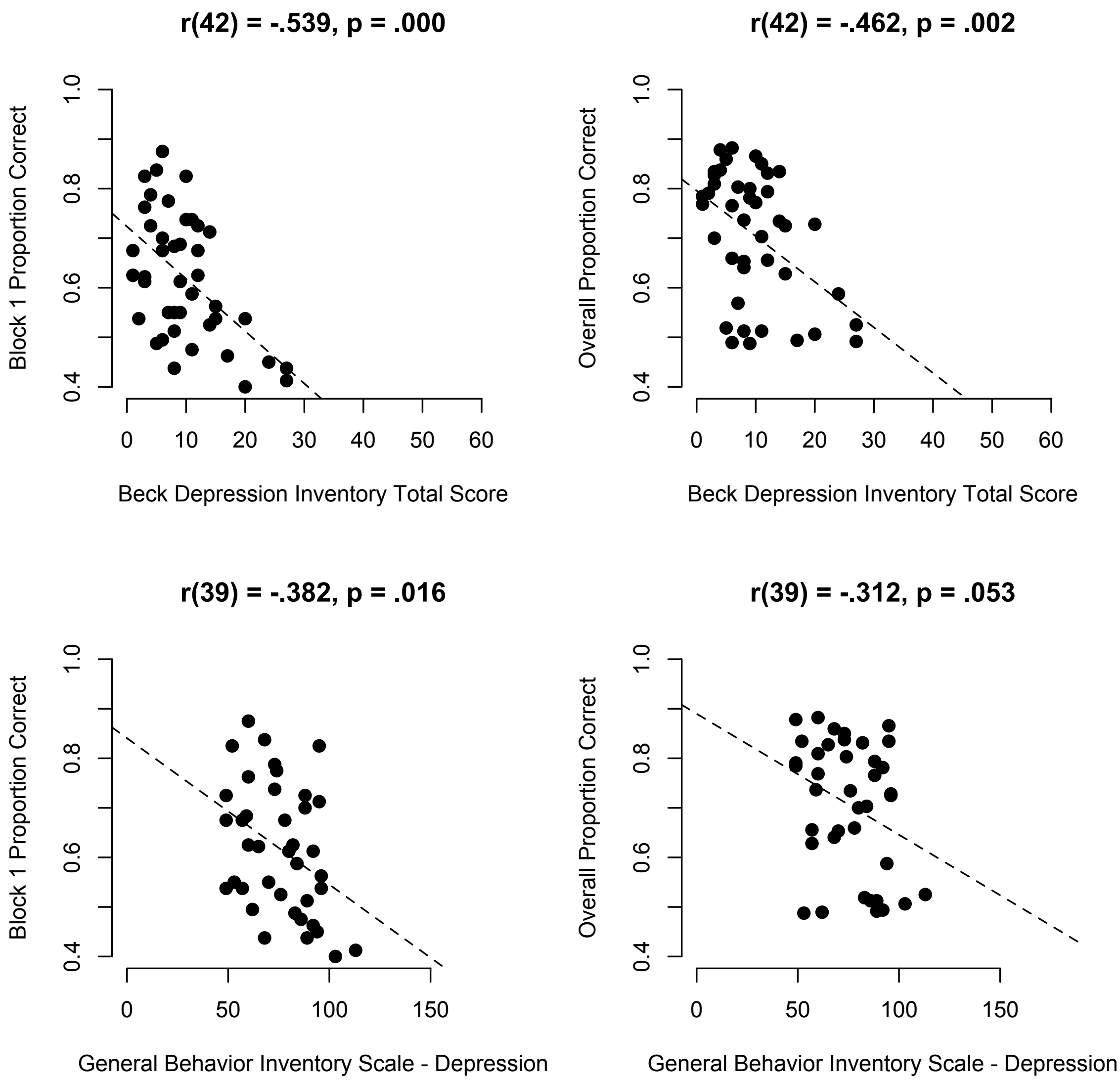
Note: ** p < .007; * p < .05, 2-tailed

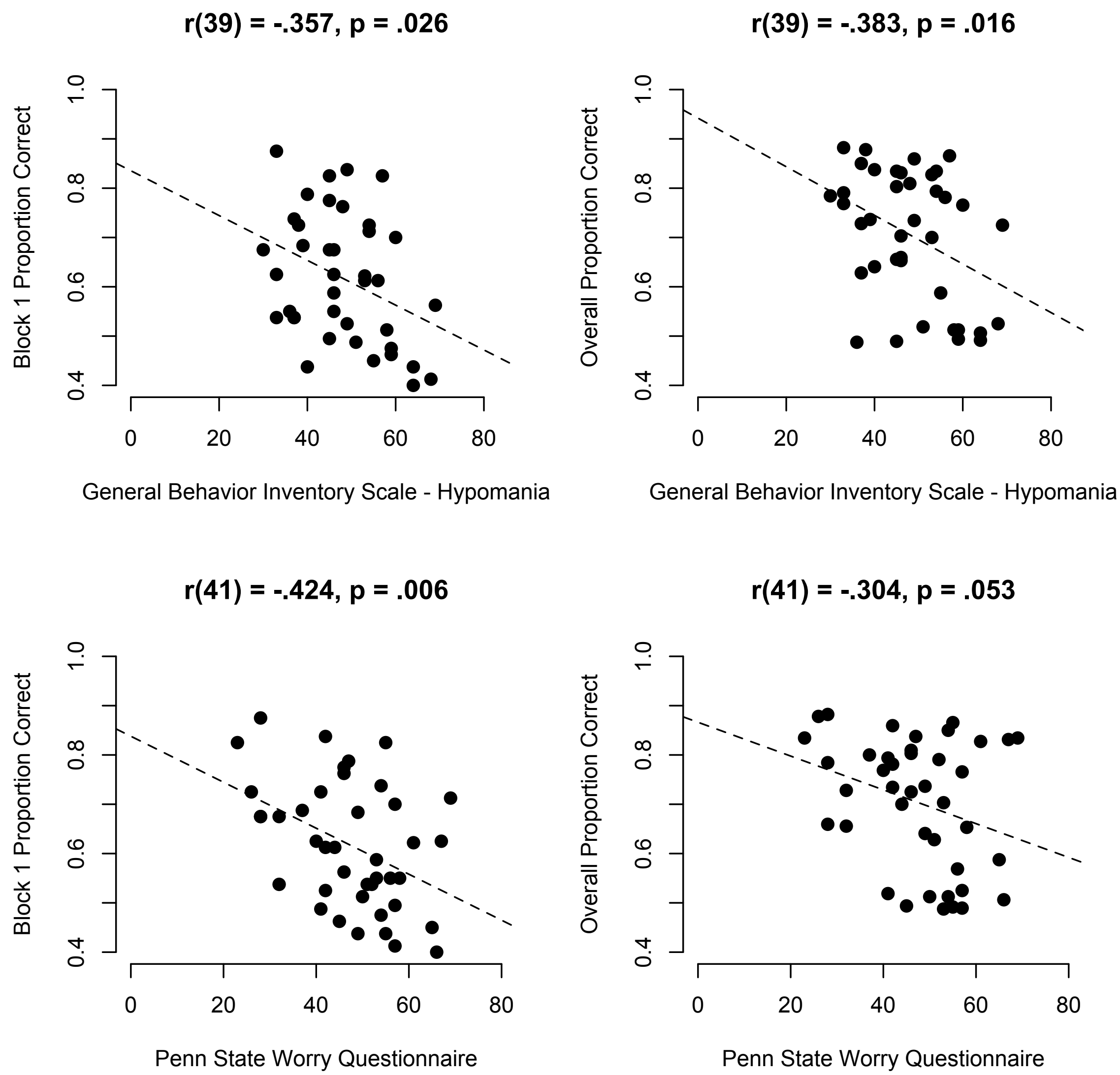
Questionnaire/Measure	**HRB**	**NRB**	**Zdiff**
Beck Depression Inventory Total	-.541**	-.124	-1.71
	n = 27	*n* = 30	*p* = .09
Penn State Worry Questionnaire Total	.036	-.294	1.25
	n = 30	*n* = 30	*p* = .21
General Behavior Inventory - Depression	-.188	-.418	0.94
	n = 30	*n* = 30	*p* = .35
General Behavior Inventory - Hypomania	-.488**	-.315	-0.76
	n = 30	*n* = 30	*p* = .45
Hypomanic Personality Scale	-.168	.166	-1.24
	n = 30	*n* = 30	*p* = .22
Behavior Inhibition Scale	-.103	-.027	-0.28
	n = 30	*n* = 30	*p* = .78
Behavior Activation Scale Total	-.401	.141	-2.08*
	n = 30	*n* = 30	*p* = .04

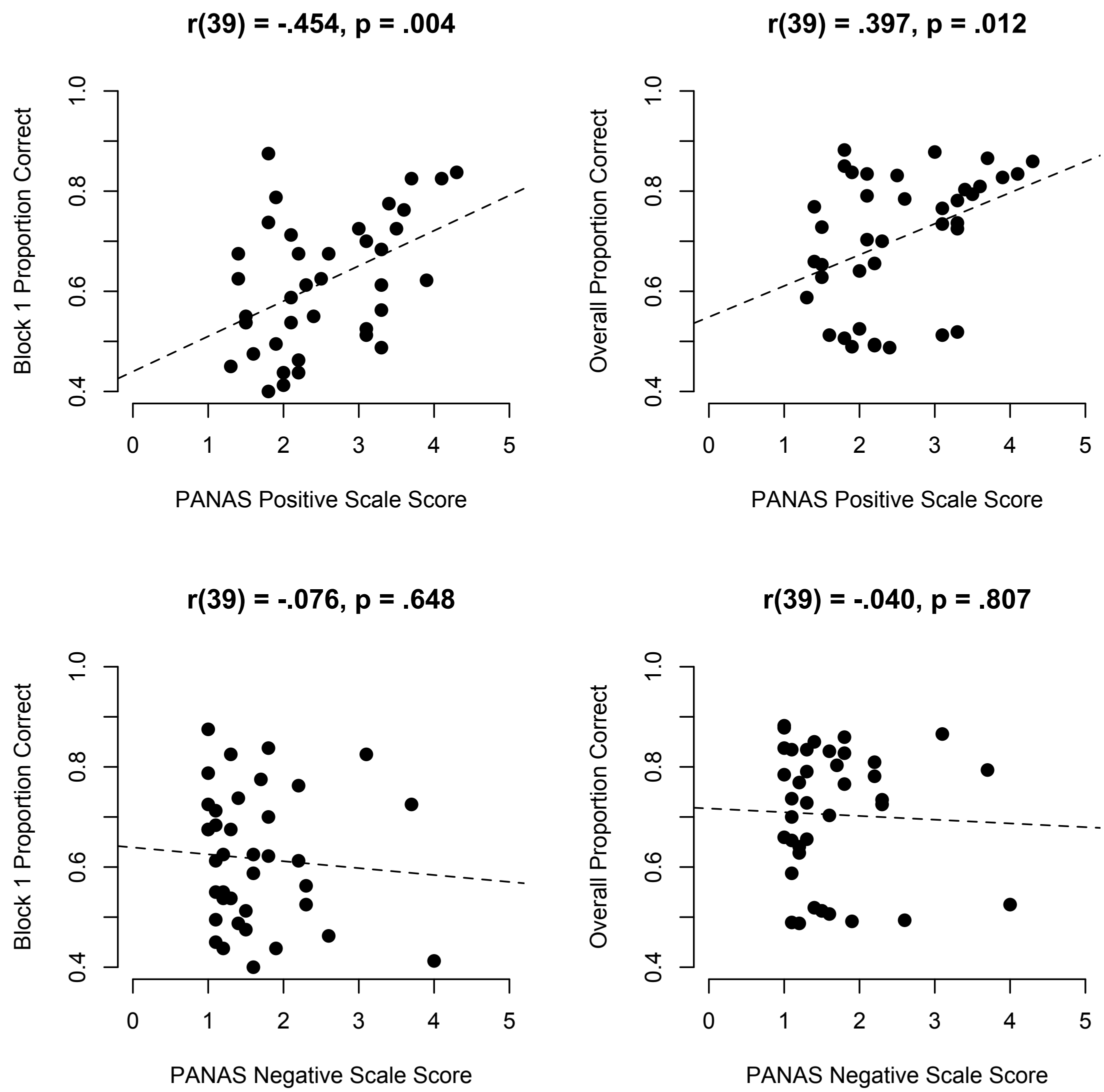
Note: ** p < .007; * p < .05, 2-tailed

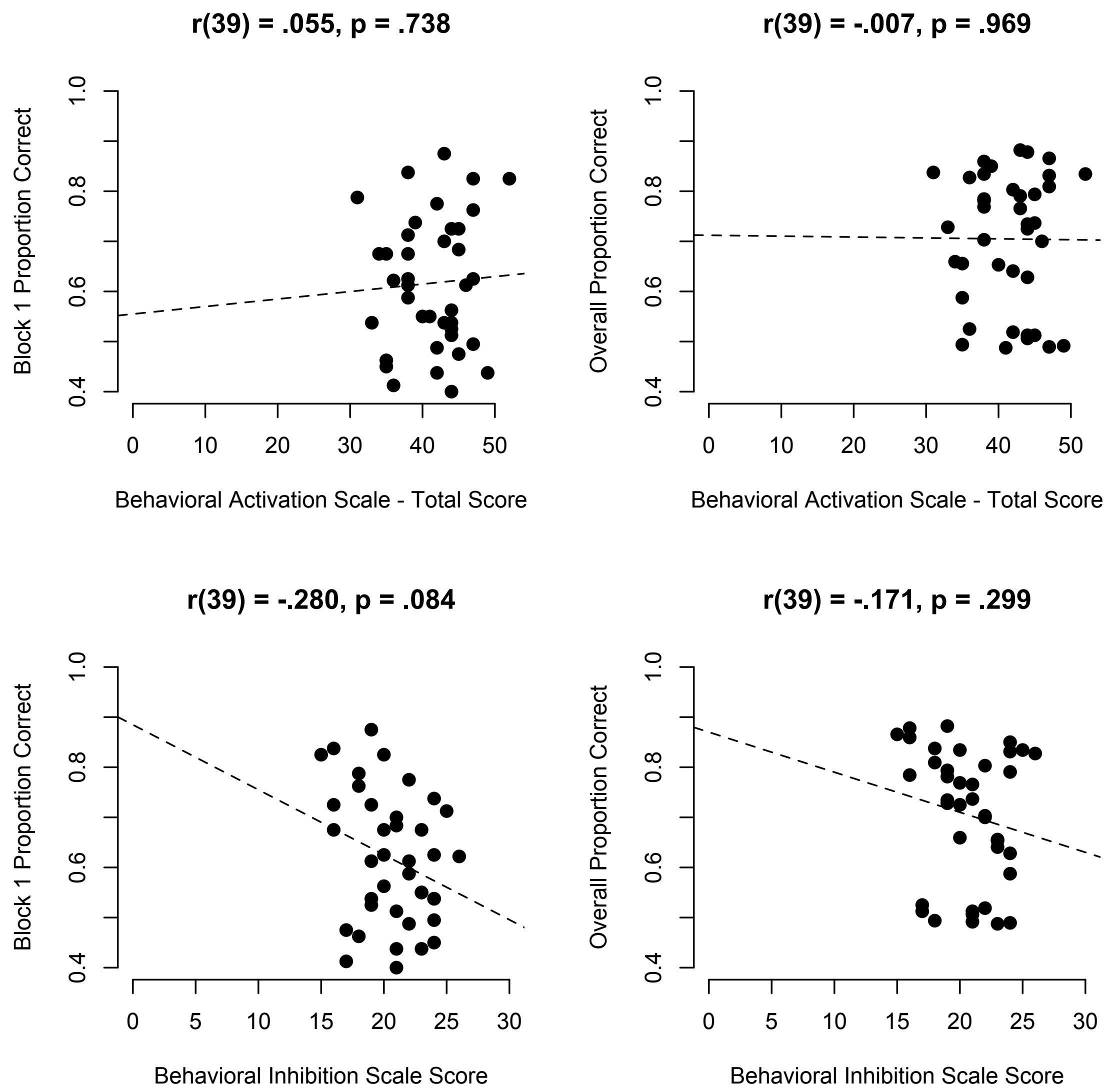
Questionnaire/Measure	ERB	NRB	Zdiff
Beck Depression Inventory Total	.087	-.124	0.70
	n = 21	*n* = 30	*p* = .49
Penn State Worry Questionnaire Total	.045	-.294	1.28
	n = 30	*n* = 30	*p* = .20
General Behavior Inventory - Depression	-.126	-.418	1.17
	n = 30	*n* = 30	*p* = .24
General Behavior Inventory - Hypomania	-.120	-.315	0.76
	n = 30	*n* = 30	*p* = .45
Hypomanic Personality Scale	-.259	.166	-1.59
	n = 30	*n* = 30	*p* = .11
Behavior Inhibition Scale	.108	-.027	0.50
	n = 30	*n* = 30	*p* = .62
Behavior Activation Scale Total	.179	.141	0.14
	n = 30	*n* = 30	*p* = .89

Appendix J: Chapter 2, Study 2 Rule-based Block 1 and Overall Scatterplots.

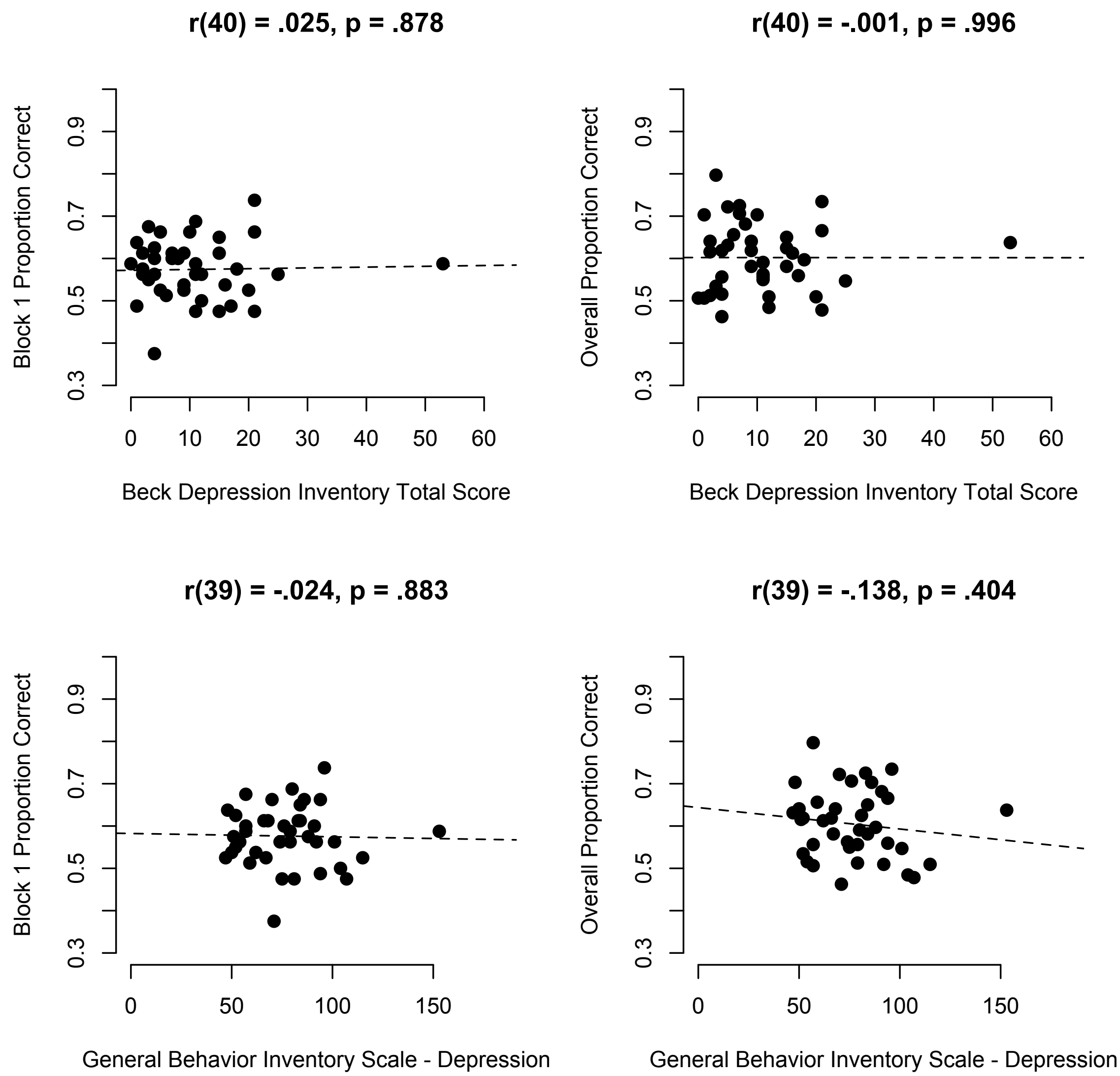


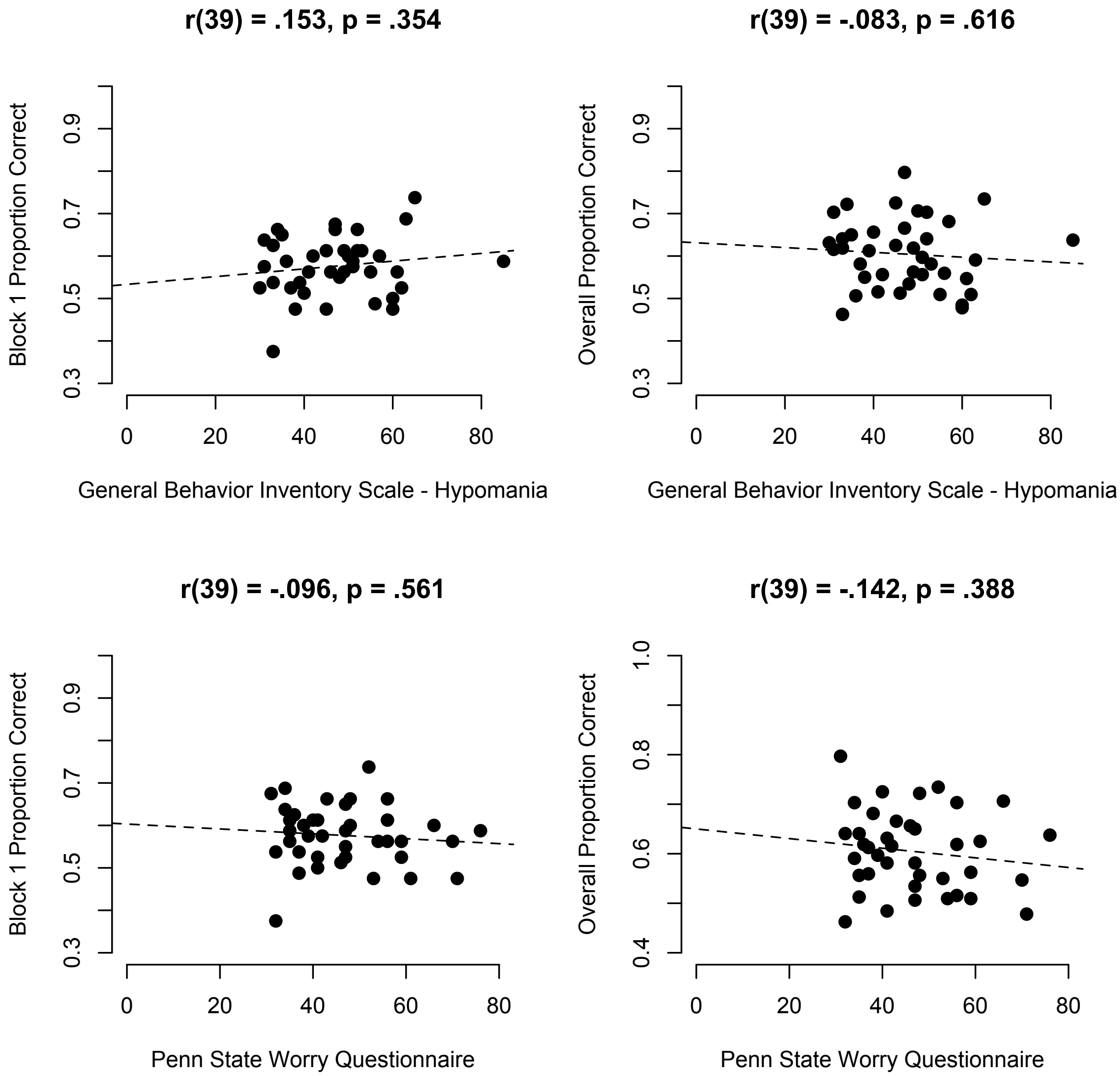

r(39) = -.357, p = .026
r(39) = -.383, p = .016
Block 1 Proportion Correct
Overall Proportion Correct
0.4
0.6
0.8
1.0
0
20
40
60
80
General Behavior Inventory Scale - Hypomania
General Behavior Inventory Scale - Hypomania
r(41) = -.424, p = .006
r(41) = -.304, p = .053
Block 1 Proportion Correct
Overall Proportion Correct
Penn State Worry Questionnaire
Penn State Worry Questionnaire

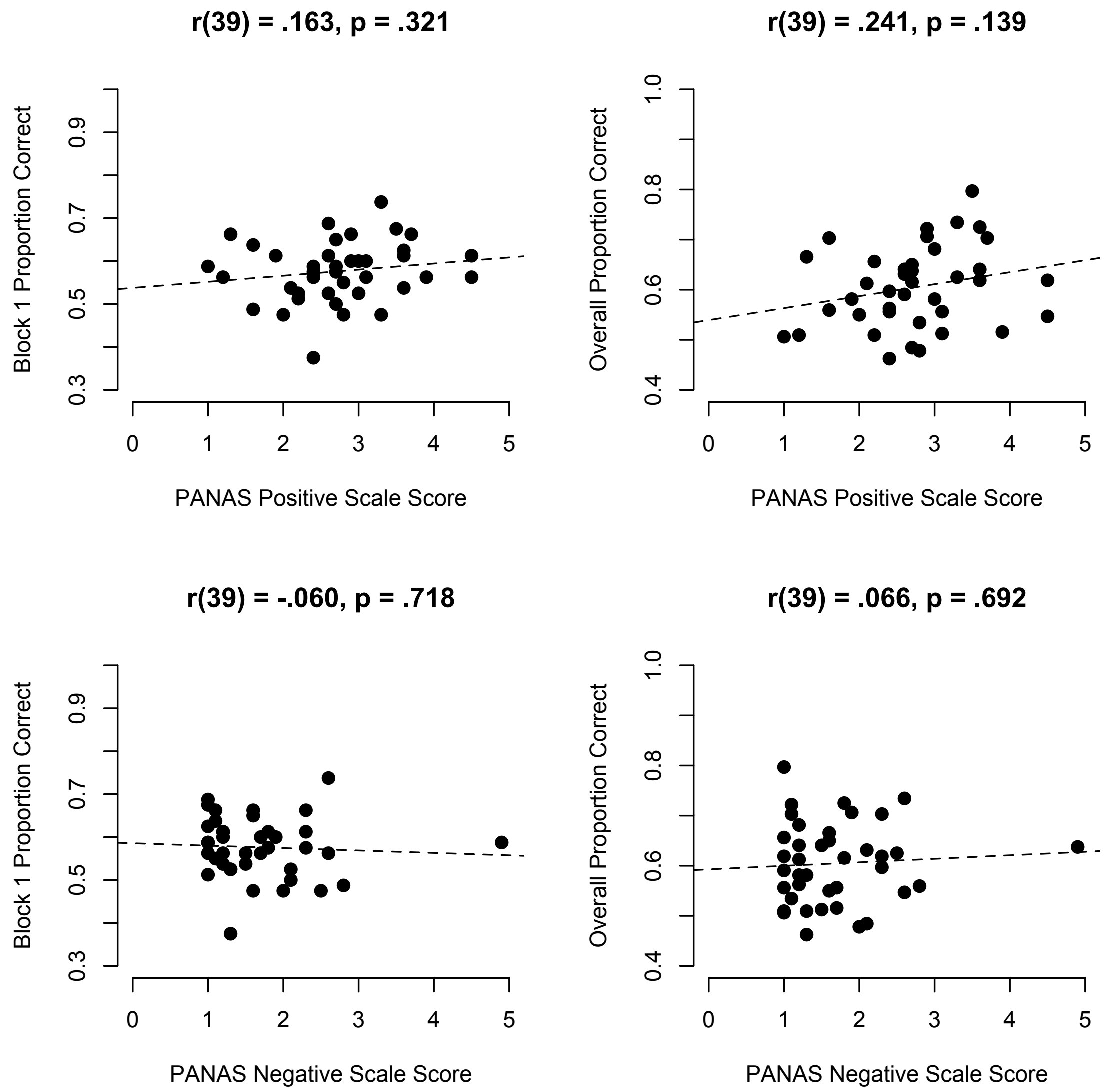

r(39) = -.454, p = .004
Block 1 Proportion Correct
PANAS Positive Scale Score
r(39) = .397, p = .012
Overall Proportion Correct
PANAS Positive Scale Score
r(39) = -.076, p = .648
Block 1 Proportion Correct
PANAS Negative Scale Score
r(39) = -.040, p = .807
Overall Proportion Correct
PANAS Negative Scale Score


r(39) = .055, p = .738
r(39) = -.007, p = .969
Block 1 Proportion Correct
Overall Proportion Correct
1.0
0.8
0.6
0.4
0
10
20
30
40
50
Behavioral Activation Scale - Total Score
r(39) = -.280, p = .084
r(39) = -.171, p = .299
5
15
25
Behavioral Inhibition Scale Score

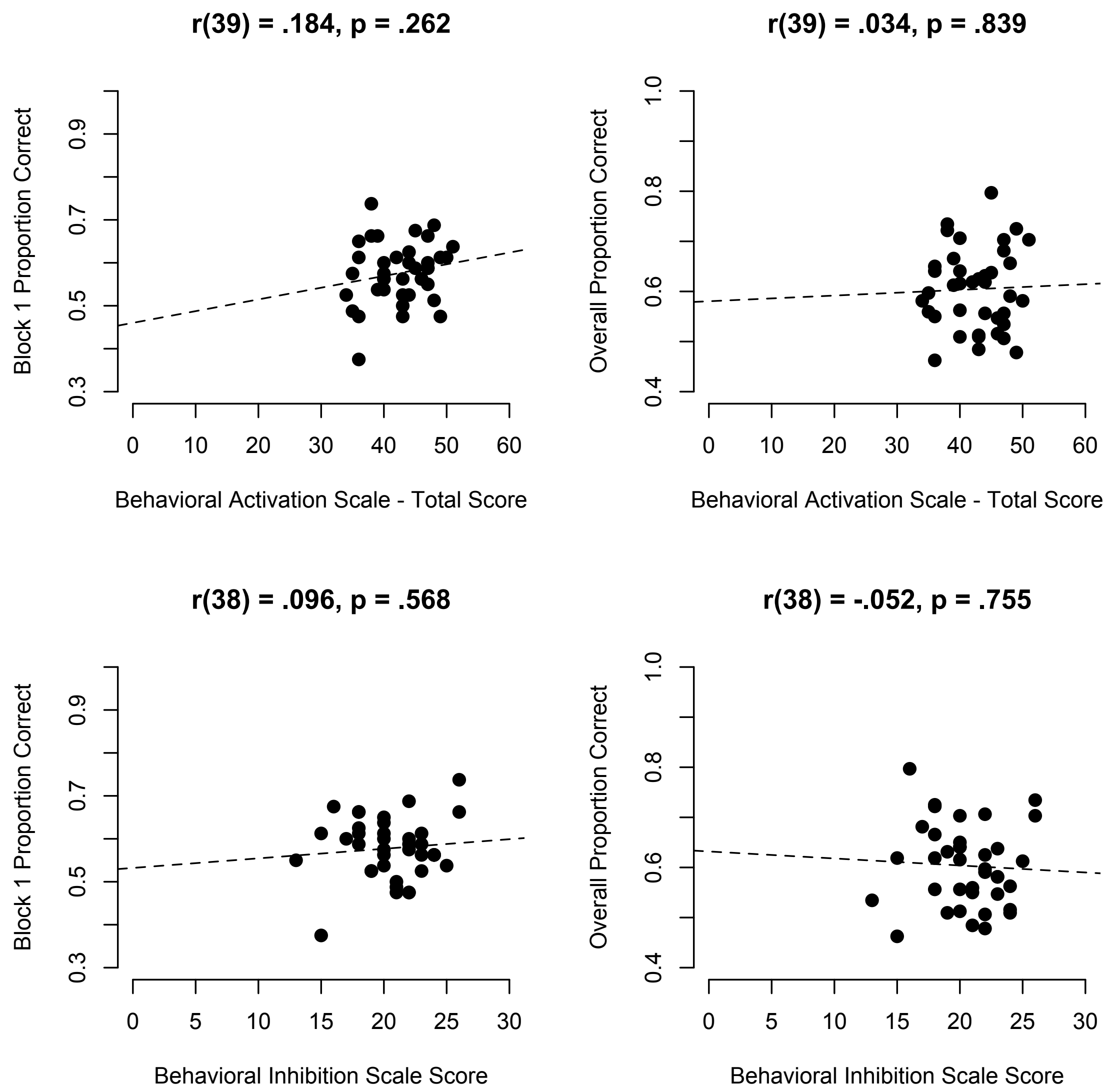
Appendix K: Chapter 2, Study 2 Non-rule-based Block 1 and Overall Scatterplots.




r(39) = .153, p = .354
Block 1 Proportion Correct
0.3
0.5
0.7
0.9
0
20
40
60
80
General Behavior Inventory Scale - Hypomania
r(39) = -.083, p = .616
Overall Proportion Correct
0.3
0.5
0.7
0.9
0
20
40
60
80
General Behavior Inventory Scale - Hypomania
r(39) = -.096, p = .561
Block 1 Proportion Correct
0.3
0.5
0.7
0.9
0
20
40
60
80
Penn State Worry Questionnaire
r(39) = -.142, p = .388
Overall Proportion Correct
0.4
0.6
0.8
1.0
0
20
40
60
80
Penn State Worry Questionnaire



r(39) = .163, p = .321
Block 1 Proportion Correct
0.3
0.5
0.7
0.9
0
1
2
3
4
5
PANAS Positive Scale Score
r(39) = .241, p = .139
Overall Proportion Correct
0.4
0.6
0.8
1.0
0
1
2
3
4
5
PANAS Positive Scale Score
r(39) = -.060, p = .718
Block 1 Proportion Correct
0.3
0.5
0.7
0.9
0
1
2
3
4
5
PANAS Negative Scale Score
r(39) = .066, p = .692
Overall Proportion Correct
0.4
0.6
0.8
1.0
0
1
2
3
4
5
PANAS Negative Scale Score


r(39) = .184, p = .262
Block 1 Proportion Correct
Behavioral Activation Scale - Total Score
r(39) = .034, p = .839
Overall Proportion Correct
Behavioral Activation Scale - Total Score
r(38) = .096, p = .568
Block 1 Proportion Correct
Behavioral Inhibition Scale Score
r(38) = -.052, p = .755
Overall Proportion Correct
Behavioral Inhibition Scale Score

Appendix L: Chapter 2, Study 2 Test for the Difference between Two Independent Correlation Coefficients Results.

Block 1

Questionnaire/Measure	RB	NRB	Zdiff
Beck Depression Inventory Total	-.539**	.025	-2.74*
	n = 42	*n* = 40	*p* = .006
Penn State Worry Questionnaire Total	-.424	-.096	-1.53
	n = 41	*n* = 39	*p* = .13
General Behavior Inventory - Depression	-.382	-.024	-1.61
	n = 39	*n* = 39	*p* = .108
General Behavior Inventory - Hypomania	-.357	.153	-2.24*
	n = 39	*n* = 39	*p* = .03
Behavioral Inhibition Scale	-.280	.096	-1.62
	n = 39	*n* = 38	*p* = .106
Behavioral Activation Scale Total	.055	.184	-0.56
	n = 39	*n* = 39	*p* = .58
PANAS Positive	-.424**	.163	-2.62*
	n = 39	*n* = 39	*p* = .009
PANAS Negative	-.076	-.060	-0.07
	n = 39	*n* = 39	*p* = .95

Note: ** p < .0063; * p < .05, 2-tailed.

Overall Performance

Questionnaire/Measure	RB	NRB	Zdiff
Beck Depression Inventory Total	-.462**	-.001	-2.17*
	n = 42	*n* = 40	*p* = .03
Penn State Worry Questionnaire Total	-.304	-.142	-0.74
	n = 41	*n* = 39	*p* = .46
General Behavior Inventory - Depression	-.312	-.138	-0.78
	n = 39	*n* = 39	*p* = .44
General Behavior Inventory - Hypomania	-.383	-.083	-1.36
	n = 39	*n* = 39	*p* = .17
Behavioral Inhibition Scale	-.171	.052	-0.95
	n = 39	*n* = 38	*p* = .34
Behavioral Activation Scale Total	-.007	.034	-0.17
	n = 39	*n* = 39	*p* = .86
PANAS Positive	.397	.241	0.74
	n = 39	*n* = 39	*p* = .46
PANAS Negative	-.040	.066	-0.45
	n = 39	*n* = 39	*p* = .65

Note: ** p < .0063; * p < .05, 2-tailed.

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Binur, Michelle

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Michelle Binur

On Behalf Of Ruby Nadler
Sent: Wednesday, April 24, 2013 10:27 AM
To: permissions (US)
Subject: re: permissions request

...

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I would like to use my own published work (http://pss.sagepub.com/content/21/12/1770.full) in my ph.d. dissertation, it has been more than 12 months since its publication.

I understand I'm to use the following text: "The final, definitive version of this paper has been published in Psychological Science, 21/12, 12/2010 by SAGE Publications Ltd./SAGE Publications, Inc., All rights reserved. © 2010", as well as the link to the original publication above.

Is there anything else I have to do? I keep getting redirected to the

Thanks,
Ruby Nadler

Appendix N: Chapter 3 Computational Modeling Details.

The table below shows an example of the data that was modeled. 80 lines of data (representing the complete first block of performance) were entered for each participant, along with the category set they completed (RB or NRB), the mood induction condition (positive, neutral, negative), the trial (1 through 80), the stimulus they categorized on each trial (from 1 through 80, randomly assigned on each trial), and their categorization decision on each trial (e.g. A or B, represented by “0” or “1”).

Subject	Category Set	Condition	Trial	Stimulus	Decision
1	RB	positive	1	68	0
1	RB	positive	2	1	1
1	RB	positive	3	42	1
…	…	…	…	…	…
1	RB	positive	80	15	0

The stimulus coordinates (shown in Appendix D) were used to determine the optimal decision bounds for each category learning task (RB or NRB), and these decision bounds were compared to the decision bound that resulted from each participant’s pattern of responses. Each participant’s first block of responses was fit with several different models, one class of which were RB models (and therefore all single-dimensional), and one class of which were NRB models (and therefore all two-dimensional). All RB participants were fit by two suboptimal RB models and an optimal, RB model. All NRB participants were fit with two suboptimal NRB models and an optimal, NRB model. These models work by comparing the response a participant would have given had they used a given strategy, to the response they actually gave. The model fits the participant's data to the extent that the model's predicted response corresponds with the participant's actual response.

The two suboptimal RB models were a “frequency” model, which assumed participants were classifying according to frequency, but not optimally, and an “orientation” model, which assumed participants were classifying according to orientation (which was not the optimal rule). The “optimal” model assumed participants had learned the frequency-based, optimal rule.

The two suboptimal NRB models were a “slope1” model, which had a fixed slope (set to “1”) but a freely varying intercept, and a “X2d” model, which had a freely varying slope and intercept. The “optimal” NRB model assumed that participants used the ideal decision boundary, and had a fixed intercept and slope.

These models were compared to the first block of each subject’s data by minimizing the log likelihood. Model comparisons were carried out with the AIC index, which penalizes a model for the number of free parameters (Ashby, 1992b). AIC is a measure of goodness of fit that takes into account number of free parameters in the model and small values indicate a good fit of the strategy to the data.

The two tables below show the modeling results. Each line is an individual participant. The proportion of participants whose performance were best fit by correct RB models (the two frequency-based models) in the RB condition, and by any two-dimensional model ("sub-optimal" 2d + optimal model + slope1 model) in the NRB category condition was calculated. The proportions shown in Figure 3.3, in Chapter 3, are taken from these results.

Rule-based Block 1 Modeling Results									
				RB Models			NRB Models		
Sub	Cond	Mood	Perf	Orientation	Frequency	Optimal	X2d	Slope1	Best Fit
1	RB	positive	0.56	112.3905	106.7383	110.5678	107.7461	110.4612	freq
7	RB	positive	0.81	119.1173	82.6281	81.9239	80.7592	115.0602	X2d
13	RB	positive	0.78	115.4833	80.4131	79.8871	81.5471	112.0699	optimal
19	RB	positive	0.86	115.7028	65.6719	64.2115	67.6654	111.2918	optimal
25	RB	positive	0.75	119.9544	92.0351	90.0951	90.3262	116.1315	optimal
37	RB	positive	0.68	113.3071	99.7315	99.2643	101.6244	111.1520	optimal
43	RB	positive	0.89	115.7220	60.6581	58.8498	62.5166	111.0667	optimal
49	RB	positive	0.94	116.4563	39.5248	40.8497	39.9278	111.4896	freq
55	RB	positive	0.71	111.4735	86.2032	90.8543	87.5267	108.4114	freq
61	RB	positive	0.69	118.9773	103.3138	101.5173	103.6415	116.0039	optimal
79	RB	positive	0.81	109.7984	77.6283	75.6332	73.0005	101.2124	X2d
85	RB	positive	0.73	118.3154	87.0682	85.1389	87.5944	114.7816	optimal
3	RB	neutral	0.55	114.6237	112.8147	112.6903	114.7902	113.6901	optimal
9	RB	neutral	0.59	117.3373	110.1156	108.7803	111.6606	115.3024	optimal
21	RB	neutral	0.84	115.6930	71.3428	71.0384	72.4953	111.9437	optimal
27	RB	neutral	0.65	116.5109	103.8739	105.9658	103.3178	113.6030	X2d
33	RB	neutral	0.79	116.2182	80.0071	83.0219	79.6610	112.4435	X2d
39	RB	neutral	0.54	122.0090	112.2602	112.7374	102.6023	118.7321	X2d
51	RB	neutral	0.50	31.8372	40.2585	112.7310	115.5372	23.7207	slope1
57	RB	neutral	0.61	112.1784	107.6153	109.4109	109.6138	110.7352	freq
63	RB	neutral	0.61	115.3727	111.3056	109.6368	113.2888	114.0643	optimal
69	RB	neutral	0.76	115.6889	85.0315	85.7430	86.5586	112.5095	freq
75	RB	neutral	0.85	118.2464	60.8101	58.8766	59.8237	113.9774	optimal
81	RB	neutral	0.70	110.1428	102.8383	101.3347	100.2981	106.0720	X2d
87	RB	neutral	0.71	113.5022	97.2749	97.4966	99.0532	110.9625	freq
5	RB	negative	0.54	118.5263	111.8173	112.4386	110.0783	116.1433	X2d
11	RB	negative	0.66	116.2606	100.6671	103.7250	97.5410	112.7936	X2d
17	RB	negative	0.50	118.7574	114.6188	112.8374	115.5205	117.1951	optimal
29	RB	negative	0.51	114.4702	103.6771	112.6548	87.7813	110.4300	X2d
35	RB	negative	0.43	124.8452	115.1284	113.8782	99.2469	122.0389	X2d
41	RB	negative	0.58	116.5365	113.9411	112.1958	115.9097	115.3623	optimal
47	RB	negative	0.65	115.4937	96.0158	97.0081	97.5878	112.7491	freq
53	RB	negative	0.69	114.0016	99.1786	97.4045	100.5613	111.2536	optimal
59	RB	negative	0.65	115.9709	105.1085	103.1456	107.1084	114.0114	optimal
65	RB	negative	0.56	107.1552	109.6678	110.5565	106.6624	105.5220	slope1
71	RB	negative	0.54	120.1685	111.1979	110.2589	108.3297	117.3109	X2d
77	RB	negative	0.73	114.2739	92.3782	95.2517	93.6481	111.3465	freq
83	RB	negative	0.65	116.3874	105.0956	105.5451	106.2905	113.9127	freq

Non-rule-based Block 1 Modeling Results									
				RB Models			NRB Models		
Sub	Cond	Mood	Perf	Orientation	Frequency	Optimal	X2d	Slope1	Best Fit
2	NRB	positive	0.51	112.2287	116.7150	112.7199	114.2276	113.5276	ori
8	NRB	positive	0.55	125.6485	86.9157	112.7377	82.2700	113.9842	X2d
14	NRB	positive	0.76	113.5694	102.4819	92.2215	92.8022	92.9548	optimal
20	NRB	positive	0.65	117.8893	104.2196	105.4592	104.3741	107.3336	freq
26	NRB	positive	0.51	113.2178	113.0456	112.7085	114.1397	112.1405	slope1
32	NRB	positive	0.65	115.1062	109.0090	105.2689	107.3117	106.5981	optimal
38	NRB	positive	0.54	114.1521	114.8830	111.4613	114.8832	112.9352	optimal
50	NRB	positive	0.68	121.6983	81.0306	103.0343	82.3262	104.6642	freq
56	NRB	positive	0.50	114.5160	116.0949	113.3641	116.2963	114.5042	optimal
62	NRB	positive	0.70	118.8689	94.9176	100.0848	93.6960	102.0687	X2d
68	NRB	positive	0.71	116.8250	85.1399	95.4759	81.7804	94.7715	X2d
74	NRB	positive	0.50	117.2965	109.1226	114.0364	109.3620	112.6958	freq
80	NRB	positive	0.70	119.3986	78.9121	99.1344	78.8410	99.3489	X2d
86	NRB	positive	0.60	115.8587	112.6860	109.9954	113.3572	111.8483	optimal
4	NRB	neutral	0.66	101.1077	116.9507	101.5199	97.9163	102.8069	X2d
10	NRB	neutral	0.66	122.3760	82.9895	106.1917	84.9678	107.8405	freq
16	NRB	neutral	0.46	114.1909	117.5830	114.8116	114.1475	115.4884	X2d
22	NRB	neutral	0.58	116.7434	106.6699	110.3830	108.4020	110.3194	freq
28	NRB	neutral	0.60	121.7714	95.3916	109.4477	97.3804	111.1692	freq
34	NRB	neutral	0.45	115.0944	104.2758	114.7685	100.8767	109.6241	X2d
40	NRB	neutral	0.65	121.5445	83.9800	102.5411	85.1019	104.5299	freq
44	NRB	neutral	0.59	115.1374	110.8957	109.5261	111.5610	110.3761	optimal
46	NRB	neutral	0.54	119.2733	111.7909	112.8080	113.5618	114.7434	freq
52	NRB	neutral	0.68	122.6023	70.6046	103.1147	72.3229	104.4293	freq
58	NRB	neutral	0.68	116.0680	89.0431	99.1051	87.8122	97.7865	X2d
64	NRB	neutral	0.53	118.5361	113.1406	113.2357	114.8673	115.0070	freq
70	NRB	neutral	0.69	122.3229	73.7306	102.6870	75.4419	103.9936	freq
76	NRB	neutral	0.74	119.4456	83.8398	96.2422	81.7838	97.9007	X2d
82	NRB	neutral	0.56	118.5618	108.4634	110.9377	110.3988	112.5540	freq
6	NRB	negative	0.61	114.7259	111.1927	109.5784	111.5203	110.0786	optimal
12	NRB	negative	0.68	115.8833	105.1134	103.0394	102.9439	103.8520	X2d
18	NRB	negative	0.55	117.4972	113.1035	112.4136	115.0968	114.2382	optimal
24	NRB	negative	0.68	117.5795	84.5940	101.8565	84.5711	100.5944	X2d
30	NRB	negative	0.56	117.5984	109.1970	111.7289	111.1940	112.5557	freq
36	NRB	negative	0.68	118.8662	96.3377	102.3839	96.0567	104.0238	X2d
42	NRB	negative	0.63	120.6717	98.3163	109.7972	100.2982	111.0935	freq
48	NRB	negative	0.66	121.7393	74.9972	104.2620	76.9622	104.5925	freq
54	NRB	negative	0.64	120.0829	72.4161	108.2954	73.9798	105.5625	freq
60	NRB	negative	0.50	115.9014	108.5853	112.7957	110.4407	111.4518	freq
66	NRB	negative	0.63	119.2474	92.2408	106.8823	93.8849	106.6354	freq
72	NRB	negative	0.56	111.5815	106.7358	112.3932	108.6944	108.0442	freq
78	NRB	negative	0.54	120.6818	108.8020	113.1447	109.5940	114.6503	freq
84	NRB	negative	0.60	116.9109	110.7411	109.6751	111.7640	111.3934	optimal

Appendix O: Chronic Regulatory Focus Measure used in Chapter 4.

Event Reaction Questionnaire

This set of questions asks you HOW FREQUENTLY specific events actually occur or have occurred in your life. Please indicate your answer to each question by circling the appropriate number below it.

1. Compared to most people, are you typically unable to get what you want out of life?

1	2	3	4	5
never or seldom		sometimes		very often

2. Growing up, would you ever "cross the line" by doing things that your parents would not tolerate?

1	2	3	4	5
never or seldom		sometimes		very often

3. How often have you accomplished things that got you "psyched" to work even harder?

1	2	3	4	5
never or seldom		sometimes		very often

4. Did you get on your parents' nerves often when you were growing up?

1	2	3	4	5
never or seldom		sometimes		very often

5. How often did you obey rules and regulations that were established by your parents?

1	2	3	4	5
never or seldom		sometimes		very often

6. Growing up, did you ever act in ways that your parents thought were objectionable?

1	2	3	4	5
never or seldom		sometimes		very often

7. Do you often do well at different things that you try?

1	2	3	4	5
never or seldom		sometimes		very often

8. Not being careful enough has gotten me into trouble at times.

1	2	3	4	5
never or seldom		sometimes		very often

9. When it comes to achieving things that are important to me, I find that I don't perform as well as I ideally would like to do.

1	2	3	4	5
never true		sometimes true		very often true

10. I feel like I have made progress toward being successful in my life.

1	2	3	4	5
certainly false				certainly true

11. I have found very few hobbies or activities in my life that capture my interest or motivate me to put effort into them.

1	2	3	4	5
certainly false				certainly true

Source

Higgins, E. T., Friedman, R. S., Harlow, R. E., Idson, L. C., Ayduk, O. N., Taylor, A. (2001). Achievement orientations from subjective histories of success: Promotion pride versus prevention pride. European Journal of Social Psychology, 31, 3-23.

Scoring

```
COMPUTE promote = (6 - resp_1) + resp_3 + resp_7 + (6 - resp_9) + resp_10 + (6 -
resp_11).

COMPUTE prevent = (6 - resp_2) + (6 - resp_4) + resp_5 + (6 - resp_6) + (6 - resp_8).

EXECUTE.
```

Appendix P: Regulatory Focus Essay Manipulation used in Chapter 4.

Within each condition, participants write a short essay for approximately 5-7 minutes (roughly 1 page). Instructions (below) are given at the top of a piece of lined paper.

Promotion: "Think about what you want to achieve a few years from now. Please write down some of the aspirations and ambitions that you hope to achieve."

Prevention: "Think about your responsibilities for the next few years. Please write down some of the duties and obligations that you have to fulfill over the next years.

Appendix Q: Rosch Categories and Exemplars used in Chapter 4.

	Furniture		Fruit		Vehicle		Weapon		Vegetable	
Good	Chair	6.96	Orange	6.93	Bus	6.73	Gun	6.97	Spinach	6.78
	Table	6.90	Banana	6.85	Car	6.76	Knife	6.60	Pea	6.93
Mod	Bench	5.23	Passionfruit	4.78	Scooter	4.76	Missile	5.10	Leek	4.85
	Cupboard	3.73	Papaya	5.42	Subway	4.68	Axe	4.66	Sweet Potato	4.73
	Piano	4.36	Cranberry	4.78	Wheelchair	4.32	Ice Pick	4.86	Mushroom	4.44
Poor	Fan	1.51	Pumpkin	2.61	Feet	2.66	Car	2.69	Rhubarb	4.34
	Rug	3.00	Avocado	2.63	Canoe	3.99	Rope	2.92	Garlic	2.93
	Picture	2.25	Olive	1.79	Camel	2.78	Hand	2.99	Baked beans	3.27
	Clock	2.52	Nut	1.99	Skateboard	2.46	Screwdriver	2.60	Pumpkin	3.26
	Stove	2.60	Tomato	2.42	Rocket	3.26	Airplane	2.91	Pickles	3.43
	Carpenter Tools		**Bird**		**Sport**		**Toy**		**Clothing**	
Good	Saw	6.96	Robin	6.98	Football	6.97	Doll	6.59	Pants	6.88
	Drill	6.41	Eagle	6.25	Tennis	6.85	Teddy bear	6.10	Coat	6.12
Mod	Bench	5.50	Albatross	5.20	Boxing	6.34	Balloon	4.93	Bathing suit	5.56
	Ladder	5.36	Parrot	5.93	Pole vault	5.91	Puzzle	5.18	Shoes	5.27
	Wood	5.23	Owl	5.04	Golf	6.23	Drum	4.77	Stockings	5.21
Poor	Hatchet	2.85	Chicken	3.98	Cards	2.21	Cards	3.44	Hat	3.80
	Cement	3.09	Penguin	3.47	Hunting	3.95	Rope	3.80	Necklace	1.79
	Stapler	3.79	Bat	1.85	Chess	2.93	Books	2.09	Hairband	2.02
	Axe	3.47	Turkey	3.91	Dancing	2.51	Tennis racket	2.6	Cuff links	1.82
	Scissors	2.64	Emu	3.62	Jump rope	3.00	Bike	4.23	Watch	1.85

Note: The second column shows the typicality ratings reported by Rosch (1975), however the ratings have been reversed to match the Likert scale used in the current study.

Appendix R: Correlations between Mood and Motivation Measures in Chapter 4.

	1	2	3	4	5	6
1 RFQ Promotion	--------					
2 RFQ Prevention	.32**	--------				
3 BAS Total	.29**	-0.18	--------			
4 BIS Total	-.29**	0.03	0.08	--------		
5 PANAS Positive	.22*	0.03	.40***	-0.09	--------	
6 PANAS Negative	-.33**	-0.17	0.21	.24*	.44***	--------

Notes: *** p < .001, ** p < .01, * p < .05, RFQ = Regulatory Focus Questionnaire, BAS = Behavioral Activation Scale; BIS = Behavioral Inhibition Scale; PANAS = Positive Affect Negative Affect Scale.

Appendix S: Ethics approval for Experiment 1, Chapter 2 and Chapter 3.

Western

Department of Psychology The University of Western Ontario

[redacted]

Use of Human Subjects - Ethics Approval Notice

Review Number	08 01 03	**Approval Date**	08 01 16
Principal Investigator	John Paul Minda	**End Date**	08 12 31
Protocol Title	Personality, mood, and category learning		
Sponsor	n/a		

This is to notify you that The University of Western Ontario Department of Psychology Research Ethics Board (PREB) has granted expedited ethics approval to the above named research study on the date noted above.

The PREB is a sub-REB of The University of Western Ontario's Research Ethics Board for Non-Medical Research Involving Human Subjects (NMREB) which is organized and operates according to the Tri-Council Policy Statement and the applicable laws and regulations of Ontario. (See Office of Research Ethics web site: http://www.uwo.ca/research/ethics/)

This approval shall remain valid until end date noted above assuming timely and acceptable responses to the University's periodic requests for surveillance and monitoring information.

During the course of the research, no deviations from, or changes to, the protocol or consent form may be initiated without prior written approval from the PREB except when necessary to eliminate immediate hazards to the subject or when the change(s) involve only logistical or administrative aspects of the study (e.g. change of research assistant, telephone number etc). Subjects must receive a copy of the information/consent documentation.

Investigators must promptly also report to the PREB:
a) changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) all adverse and unexpected experiences or events that are both serious and unexpected;
c) new information that may adversely affect the safety of the subjects or the conduct of the study.

If these changes/adverse events require a change to the information/consent documentation, and/or recruitment advertisement, the newly revised information/consent documentation, and/or advertisement, must be submitted to the PREB for approval.

Members of the PREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the PREB.

[redacted]

Clive Seligman Ph.D.

Chair, Psychology Expedited Research Ethics Board (PREB)

The other members of the 2007-2008 PREB are: Mike Atkinson, David Dozois, Bill Fisher and Matthew Maxwell-Smith

CC: UWO Office of Research Ethics

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Appendix T: Ethics Approval for Experiment 2, Chapter 2.

Department of Psychology The University of Western Ontario

[redacted]

Western

Use of Human Subjects - Ethics Approval Notice

Review Number	12 01 18	**Approval Date**	12 01 23
Principal Investigator	Paul Minda/Ruby Nadler	**End Date**	12 05 01
Protocol Title	Personality, mood, and category learning		
Sponsor	n/a		

This is to notify you that The University of Western Ontario Department of Psychology Research Ethics Board (PREB) has granted expedited ethics approval to the above named research study on the date noted above.

The PREB is a sub-REB of The University of Western Ontario's Research Ethics Board for Non-Medical Research Involving Human Subjects (NMREB) which is organized and operates according to the Tri-Council Policy Statement and the applicable laws and regulations of Ontario. (See Office of Research Ethics web site: http://www.uwo.ca/research/ethics/)

This approval shall remain valid until end date noted above assuming timely and acceptable responses to the University's periodic requests for surveillance and monitoring information.

During the course of the research, no deviations from, or changes to, the protocol or consent form may be initiated without prior written approval from the PREB except when necessary to eliminate immediate hazards to the subject or when the change(s) involve only logistical or administrative aspects of the study (e.g. change of research assistant, telephone number etc). Subjects must receive a copy of the information/consent documentation.

Investigators must promptly also report to the PREB:
a) changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) all adverse and unexpected experiences or events that are both serious and unexpected;
c) new information that may adversely affect the safety of the subjects or the conduct of the study.

If these changes/adverse events require a change to the information/consent documentation, and/or recruitment advertisement, the newly revised information/consent documentation, and/or advertisement, must be submitted to the PREB for approval.

Members of the PREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the PREB.

[redacted]

Clive Seligman Ph.D.

Chair, Psychology Expedited Research Ethics Board (PREB)

The other members of the 2011-2012 PREB are: Mike Atkinson (Introductory Psychology Coordinator), Rick Goffin, Riley Hinson Albert Katz (Department Chair), Steve Lupker, and Karen Dickson (Graduate Student Representative)

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Appendix U: Ethics Approval for Chapter 4.

Department of Psychology The University of Western Ontario

[redacted]

Western

Use of Human Subjects - Ethics Approval Notice

Review Number	11 09 24	**Approval Date**	11 09 15
Principal Investigator	Paul Minda/Ruby Nadler	**End Date**	12 04 30
Protocol Title	Categorization lab experiments		
Sponsor	n/a		

This is to notify you that The University of Western Ontario Department of Psychology Research Ethics Board (PREB) has granted expedited ethics approval to the above named research study on the date noted above.

The PREB is a sub-REB of The University of Western Ontario's Research Ethics Board for Non-Medical Research Involving Human Subjects (NMREB) which is organized and operates according to the Tri-Council Policy Statement and the applicable laws and regulations of Ontario. (See Office of Research Ethics web site: http://www.uwo.ca/research/ethics/)

This approval shall remain valid until end date noted above assuming timely and acceptable responses to the University's periodic requests for surveillance and monitoring information.

During the course of the research, no deviations from, or changes to, the protocol or consent form may be initiated without prior written approval from the PREB except when necessary to eliminate immediate hazards to the subject or when the change(s) involve only logistical or administrative aspects of the study (e.g. change of research assistant, telephone number etc). Subjects must receive a copy of the information/consent documentation.

Investigators must promptly also report to the PREB:
a) changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) all adverse and unexpected experiences or events that are both serious and unexpected;
c) new information that may adversely affect the safety of the subjects or the conduct of the study.

If these changes/adverse events require a change to the information/consent documentation, and/or recruitment advertisement, the newly revised information/consent documentation, and/or advertisement, must be submitted to the PREB for approval.

Members of the PREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the PREB.

[redacted]

Clive Seligman Ph.D.

Chair, Psychology Expedited Research Ethics Board (PREB)

The other members of the 2011-2012 PREB are: Mike Atkinson (Introductory Psychology Coordinator), Rick Goffin, Riley Hinson Albert Katz (Department Chair), Steve Lupker, and TBA (Graduate Student Representative)

CC: UWO Office of Research Ethics

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Curriculum Vitae

Name		Ruby T. Nadler
Education	2006	Bachelor of Science (B.Sc.), Psychology Trent University; Supervisor: Dr. Nancie Im-Bolter
	2008	Masters of Science (M.Sc.), Cognitive Psychology The University of Western Ontario; Supervisor: Dr. John Paul Minda
	2013	Doctor of Philosophy (Ph.D.), Cognitive Psychology The University of Western Ontario; Supervisor: Dr. John Paul Minda
Selected Honours And Awards		Province of Ontario Graduate Scholarship 2009-2010
		Natural Science and Engineering Research Council (NSERC) Doctoral Fellowship 2010-2012
Selected Work Experience		Teaching Assistant The University of Western Ontario 2006-2012

Selected Publications

Nadler, R. T., & Minda, J.P. (2011b). The absence of positive affect is associated with complex rule use. In L. Carlson, C. Hölscher, & T. Shipley (Eds.), Proceedings of the 33rd Annual Conference of the Cognitive Science Society (pp. 1757-1762). Austin, TX: Cognitive Science Society.

Nadler, R. T., & Minda, J.P. (2011a). Motivational influences on attentional scope. In L. Carlson, C. Hölscher, & T. Shipley (Eds.), Proceedings of the 33rd Annual Conference of the Cognitive Science Society (pp. 1318-1323). Austin, TX: Cognitive Science Society.

Nadler, R.T., Rahel, R.R., & Minda, J.P. (2010). Better mood and better performance: learning rule-based categories is enhanced by positive mood. *Psychological Science, 21,* 1770-1776.