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The reinforcing effects of making sense : positive, negative or both

Alisha Wray

Alisha Wray

Candidate

Psychology

Department

This dissertation is approved, and it is acceptable in quality and form for publication:

Approved by the Dissertation Committee:

, Chairperson

THE REINFORCING EFFECTS OF MAKING SENSE: POSITIVE NEGATIVE OR BOTH

BY

ALISHA WRAY

B.A., Psychology, University of New Mexico, 2004
M.S., Psychology, University of New Mexico, 2008

DISSERTATION

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ABSTRACT

Many researchers have devoted attention to the human tendency to find coherence or make sense of events in the environment. Until recently, however, there was no direct empirical evidence that making sense could function as a reinforcer. Wray, Dougher, and Bullard (2008) provided preliminary evidence that solvable conditions are preferred over unsolvable conditions indicating that making sense is reinforcing. Results from the current study replicate these findings with two additional behavioral measures. Results further indicate that both solvable and neutral conditions are preferable to unsolvable conditions. However, results show there is little difference in preference for solvable over neutral conditions. All findings held across both concurrent and forced choice procedures. Results suggest that avoiding conditions that cannot be solved is negatively reinforcing, and that, for some participants, engaging in sense-making is positively reinforcing. This evidence suggests that it may be useful to define making sense functionally, as two

distinct behaviors, according to whether it is being maintained by positive versus negative reinforcement.

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CHAPTER 1

INTRODUCTION

Many researchers have devoted attention to the human tendency to find coherence or make sense of events in the environment, and many terms have been used to describe this behavior such as: cognitive coping (e.g., anticipatory coping, planning, problem solving, rehearsal) (e.g., D'Zurilla & Goldfried, 1971; Taylor, Pham, Rivkin, & Armor, 1998), forming a self narrative (Gergen & Gergen, 1988; McAdams, 1985; Pennebaker & Seagal, 1999), making/finding meaning (Janoff-Bulman & Frieze, 1983), post traumatic growth (Calhoun & Tedeschi, 2000; Tedeschi & Calhoun, 2003), developing a sense of coherence (Antonovsky, 1979), story-telling (Zettle, 2007), self-focus, (Carver & Scheier, 1981; Duval & Wicklund, 1972; Pyszczynski & Greenberg, 1986), making sense or reason giving (Hayes, Barnes-Holmes, & Roche, 2001; Hayes, Strosahl, & Wilson, 1999), repetitive thought (Watkins, 2008), and rumination (Martin & Tesser, 1996; Nolen-Hoeksema, 1991; Papageorgiou, & Siegle, 2003; Papageorgiou, & Wells, 2003; Papageorgiou, & Wells, 2001). The plethora of terms that have been used to refer to sense-making highlight the need for a functional definition rather than one based upon topographical or structural features. Functional definitions are particularly useful because they can increase prediction and most importantly influence over behaviors of interest (Skinner, 1957). Accordingly, sense-making should be defined by the conditions under which the behavior is evoked; situations that give rise to the many terms listed above.

All of the terms above, refer to cognitive, or verbal, behaviors that are evoked in problem situations. Skinner (1953) defined a problem as a situation in which, "the organism has no behavior immediately available which will reduce the aversive stimulation or provide escape from aversive stimulation" (p. 246). Functionally, making sense can be conceptualized as operant verbal behavior that is engaged in when an environmental event (i.e., a problem situation) evokes such behavior and is established and maintained by reinforcement.

Making Sense and its Reinforcing Functions

Empirical evidence indicates organisms desire to understand their environments, because this understanding increases how effectively they can influence their environment (for a review see Mineka & Hendersen, 1985), which is likely positively reinforcing. Rothbaum, Weisz, and Snyder (1982) propose two forms of control that humans are motivated to obtain. The first, primary control, which is defined as any attempt to change the environment to better suit one's needs or desires, has been discussed extensively elsewhere (Abramson, et, al., 1978; Klinger,1975; Pyszczynski & Greenberg, 1987; Wortman & Brehm, 1975). Secondary control is defined as any attempt to adapt to one's environment when it cannot be changed. Rothbaum and collegues assert that when primary control cannot be established, making sense can function to increase controllability via secondary control. Similarly, in the absence of objective causality, humans perceive relationships among stimuli to be causal (Bruner & Revusky, 1961; Chapman & Chapman, 1967; Golding & Rorer, 1972; Kelley, 1967; 1972; 1973; Starr & Katkin, 1969; Ward & Jenkins, 1965). Furthermore, individuals are particularly motivated to assign causality to aversive events that are relevant to them (e.g., Schachter & Singer, 1962; Peterson & Seligman, 1984).

This ability has been found to lead to psychological, as well as physiological benefits. For example, making sense after aversive or traumatic events can lead to better psychological adjustment including reducing the likelihood of depression or PTSD development (e.g., Mendola, Tennen, Affleck, McCann, & Fitzgerald, 1990). Additionally, making sense has been associated with increased health benefits such as improved immune system functioning (e.g., Affleck, Tennen, Croog, & Levine, 1987a; 1987b; Bower, Kemeny, Taylor, & Fahey, 1998). In addition, Pennebaker and Segal (1999) found that a variety of populations (e.g. maximum-security prisoners, distressed crime victims, chronic pain sufferers), benefit from writing about aversive events which facilitates making sense. In these populations, writing produced psychological, behavioral, and health benefits (for a review see Pennebaker & Seagal, 1999). Likewise, making sense facilitates coherent self narratives and is associated with mental well-being (Pals, 2006) and self-esteem (Bird & Reese, 2006; McAdams, Reynolds, Lewis, Patten, & Bowman, 2001). Thus, sense-making appears to be helpful in increasing controllability, which has many psychological and physiological benefits.

In addition to positive reinforcement, evidence suggests that making sense functions as negative reinforcement by allowing for the avoidance of, or escape from, aversive stimulation associated with an unresolved problem. As mentioned previously, Skinner (1953; 1957) specifically implicated the role of arousal associated with uncertainty in making sense, and evidence suggests ambiguity is experienced as aversive, particularly when in conjunction with an aversive event (Averill, 1973; Burger & Arkin, 1980; Glass & Singer, 1972). For example, two studies demonstrated the mediating effect of ambiguity in the experience of an aversive event (Sosnowski, 1983; 1988). Results showed that ambiguity surrounding an aversive event is more arousing (i.e., significantly higher skin conductance levels and nearly significant higher heart rate responses) than certainty about an aversive event, suggesting that uncertainty in and of itself is aversive. Therefore, individuals may be motivated to obtain control in their environments, so that they reduce ambiguity, and making sense may be one avenue for doing so. Taken together, these findings suggest that making sense may function to increase predictability and controllability while simultaneously reducing uncertainty and the arousal associated with it.

Gergen and Gergen (1988) proposed another reinforcing function of sense-making. They assert that cognitive accounts of the environment that are coherent, or are considered to "make sense," are reliant upon what the verbal community views to be "sensible" and "accurate" (Gergen & Gergen, 1988; Loftus, 1979; Wegner, Giulliano, & Hertel, 1985; Spence, 1985). Coherent self-narratives are essential in establishing credibility in the social community and in maintaining relationships implicating sense-making as one avenue for obtaining positive reinforcement. Similarly, making sense appropriately can reduce social criticism that is experienced as aversive, which would be negatively reinforcing. Thus, the verbal community serves to establish and maintain appropriate verbal behavior through reinforcement and extinguishes and/or punishes inappropriate behavior.

Although much data suggests that sense-making is reinforcing, until recently there was no direct empirical evidence that making sense could function as a reinforcer. However Wray, Dougher, and Bullard (2008) investigated this hypothesis by comparing college students' preferences for a solvable laboratory computer task with response-contingent feedback to a formally similar but unsolvable task, on which equal or greater amounts of positive feedback were presented independent of participant's performance.

Results suggest that making sense was preferred by the majority of participants when equal amounts of positive feedback were presented and was reinforcing to approximately half of participants *even when* greater amounts (20% more) of positive feedback were presented in the unsolvable condition. Thus, some individuals valued making sense, (i.e., solvable conditions) even when doing so was costly (i.e., less frequent positive feedback).

In a similar way, while evidence exists that sense making is effective, it since has been shown to result in negative outcomes or aversive consequences (Borkovec, Robinson, Pruzinsky, & Depree, 1983; Carver & Scheier, 1981; Duval & Wicklund, 1972; Hayes, et al., 2001; Hayes, et al., 1999; Martin & Tesser, 1996; Nolen-Hoeksema, 1991; Papageorgiou, & Siegle, 2003; Papageorgiou, &Wells, 2003; Papageorgiou, & Wells, 2001; Pyszczynski & Greenberg, 1986; Tallis & Eysenck, 1994; Watkins, 2008). Ingram (1990) reviewed findings that repeatedly demonstrate an association between sense-making and a variety of clinical problems including anxiety (Buss, 1980; Carver & Scheier, 1986; Sarason, 1975; 1986; Wine, 1971; 1982), alcohol abuse (Hull, 1981), and most extensively, depression (Lewinsohn, Hoberman, Teri, Hautzinger, 1985; Musson & Alloy, 1988; Pyszczynski & Greenberg, 1987).

Studies show that experimentally-induced rumination increases depressed mood and over-general negative memories (e.g., Park, Goodyer, & Teasdale, 2004) and reduces the amount of positively reinforcing activities one is capable of, or motivated to, engage in (e.g., Brockner & Hulton 1978; Lyubomirsky & Nolen-Hoeksema, 1993). Similarly, a growing body of literature finds that sense making about one's depression can interfere with psychological treatments. For example, Addis and Jacobson (1996) demonstrated that sense-making was correlated with poorer outcomes in behavioral activation treatment, and that certain reasons (i.e., childhood and relationship reasons) are associated with poorer outcome in both cognitive and behavioral treatments. Furthermore, making sense tends to decrease with psychological treatment (Natale, Dahlberg, & Jaffe, 1978). These findings indicate that increased sense-making may be not only ineffective in solving psychological problems, but may be quite costly. Said another way, maladaptive sense-making behaviors such as rumination, worry, and selective attention to negative events that are observed in clinical problems may be maintained by the rewarding consequences of coherence even when it increases negative affect.

Distilling the literature above, making sense is often, but not always, adaptive for solving problems. Specifically, making sense may be iatrogenic in certain contexts or when applied to psychological problems (e.g., Hayes et al., 1999; Ingram, Lumry, Cruet, & Sieber, 1987; Pennebaker & Seagal, 1999). Yet often individuals maintain sense-making despite accompanying aversive consequences and its ability to interfere with treatment suggesting that individuals are motivated to make sense to such an extent that they do so at the expense of their own autonomy, self-worth, or well being. Thus, it appears that making sense continues despite many unconstructive outcomes or aversive consequences, because it has extremely powerful reinforcing properties.

Making Sense as Operant Behavior

Any behavior, including verbal behavior, that is repeatedly reinforced in multiple contexts can become a generalized operant class (Gerwirtz & Stengle, 1968). A commonly cited example of a generalized operant class is imitation; after repeated reinforcement for replicating the behavior of multiple specific models, the act of imitating generalizes such that the behavior ("do what the model does") occurs in the presence of novel models. Similarly, Skinner (1957) proposed that verbal behavior is maintained by a history of social reinforcement. It is likely that making sense has been reinforced in a multiple social contexts (e.g., Gergen & Gergen, 1988), and thus may become a generalized operant class. That is, making sense is not restricted to specific sets of stimuli and can occur with any set of events under appropriate contextual control.

Once making sense is established through a history of reinforcement, it can function as a generalized operant class that emerges without external tangible reinforcement. This allows sense making to become by in large a private verbal behavior that can occur, and consequently be reinforced, anywhere. As such, sense-making can become pervasive (Hayes, et al., 1999).

One example of sense-making occurring in the absence of external reinforcement was provided by Skinner (1936, 1953) and his work with the verbal summator. Skinner found when individuals are asked to report what they hear when listening to ambiguous auditory stimuli (e.g. ooh, uh, ooh, ooh, ah), they often interpreted meaningful stimuli such as words associated with conversations with the experimenter, hunger, or fatigue. For example, Skinner argued that since there is no meaning to be found in the ambiguous stimuli that individuals must be motivated to make sense or that doing so must be reinforcing (Skinner, 1953).

A second example supporting making sense as a generalized operant class can be found in the constraint satisfaction and decision-making literature. In a series of experiments, Holyoak and Simon (1999) presented participants with complicated legal cases that contained contradicting information and asked them to choose a verdict.

Participants were presented with six arguments for each side of a case and were asked to rate the strength of each argument before and after they decided their verdicts. Most participants initially rated the arguments as neutral, but results showed that after reaching a verdict, participants increasingly rated the arguments in favor of their verdicts. In addition, participants reported high levels of confidence in their decisions, despite their initial neutral ratings. These results indicate that individuals are motivated to make sense of their behavior despite a lack of prompting or external reinforcement for doing so.

Finally, Peterson and Seligman (1984) provide a third example of making sense occurring without external reinforcement. Participants were asked to describe the two worst events they have experienced within the last year. The only instructions provided were to keep the description within a 250-300 word limit. Results indicate that participants spontaneously offered causal explanations for the events without prompting to do so, and that the type of explanatory style used for one of these events was highly correlated with the explanation used for the other event. Taken together, these well replicated findings (e.g., Bruner & Revusky, 1961; Chapman & Chapman, 1967; Golding & Rorer, 1972; Kelley, 1967; 1972; 1973; Starr & Katkin, 1969; Ward & Jenkins, 1965) suggest that individuals assign causality to events without external reinforcement providing support for sense-making as a generalized operant class.

If making sense is a generalized operant, it should meet the defining characteristics of operant behavior and be a function of the variables known to impact operant behavior. Specifically, operants develop, can be shaped, and come under stimulus as well as consequential control. Evidence suggests that making sense develops over time. For example, young adults have an increasingly more coherent and established self-narrative as they get older (Habermas & Bluck, 2000; Habermas, & de Silveira, 2008; Luyckx, Schwartz, Goossens, & Pollock, 2008; Nelson & Barry, 2005). Findings also indicate that making sense can be shaped by several environmental factors including parental sense-making style (see McLean, Pasupathi, & Pals, 2007 for review) and the behavior of listeners (Pasupathi, Stallworth, & Murdoch, 1998). Culture, gender, and class also shape making sense (e.g., Chiu, Morris, Hong, & Menon, 2000; McLean, 2008; Miller, 1984; 1987; Nolen-Hoeksema, 1987; 1990; Shweder & Much, 1987; Wang & Conway, 2004; Stewart & Malley, 2004). As demonstrated above, indirect evidence for the reinforcing functions of making sense exists in the literature. Because the hallmark of operant behavior is its ability to be controlled by consequences, this study was designed to further investigate whether making sense functions as a reinforcer.

While Wray et al., (2008) showed sense making is preferred, participant preferences were determined based solely upon self-report. The current study aims to replicate these earlier findings using both self-report and two other behavioral measures of preference including the condition that participants chose most and the condition they chose first. It was anticipated that participants would prefer conditions that were solvable more than unsolvable conditions across all three preference measures.

Additionally, Wray et al. (2008) did not establish whether individuals preferred the solvable condition because it was positively reinforcing or because avoiding the unsolvable condition was negatively reinforcing. A distinction between these two reinforcing functions has important theoretical as well as clinical implications. For example, if a client engages in excessive sense-making to reduce their anxiety related to an inability to control their college-aged child's behavior (e.g., dating partners, substance use, study habits), exercises increasing their ability to tolerate anxiety (e.g., mindfulness) might be implicated. On the other hand, if another client engages in excessive sense-making in order to obtain social approval, which is actually hindering her ability to respond contingently to the interaction, communication skills (e.g., active listening) might be highlighted. Given these implications, the second aim of this study is to replicate the findings of Wray et al., (2008) and to establish whether the preferences observed in the previous study were due to positive reinforcement associated with sense-making or the negative reinforcement associated with avoiding unsolvable situations.

One way to evaluate the role of multiple reinforcing functions is to introduce a neutral task, which provides individuals with an alternative to both the solvable and unsolvable conditions. Differential preference for the solvable task would indicate positively reinforcing functions where as preference for the neutral task would indicate negatively reinforcing functions. Based on the literature suggesting that unsolvable conditions are experienced as aversive, it was expected that individuals would prefer both the solvable and neutral conditions to the unsolvable conditions. Additionally, because solvable conditions allow individuals to access both reinforcing functions simultaneously, it was anticipated that solvable conditions would be preferred most, followed by neutral and unsolvable conditions, respectively. However, because sense-making likely serves both positively and negatively reinforcing functions, it was expected that the differential preference between the solvable and neutral tasks may be more variable.

CHAPTER 2

EXPERIMENT 1

Method

Participants

Fifteen volunteer participants were recruited from the University of New Mexico psychology subject pool through a recruitment website. For their participation they received course credit. Participants were informed that they were participating in a "study that is investigating the way that individuals think during cognitive tasks and the choices that they make based on what they have learned." Accepted Institutional Review Board procedures were followed.

Setting, Apparatus, and Materials

Participants were seated at a table in front of a Hewlett Packard computer (Model type: HP Compaq; Model #: dc5700 Microtower) with a 19 inch (311.35 cm) color computer screen [Measurement was made in non-metric units and converted to the rounded SI equivalent] (Model type: Optiquest; Model # Q19WB-2) in a 1.8 m by 1.2 m experiment room. The participants completed the tasks on a computer program (see procedure section for more detail) that simultaneously recorded all data in an excel file, which was created by the computer programmer.

Comparison and sample stimuli consisted of 36 visual stimuli that were comprised of 3.56 inch x 3.56 inch pictures of women and men with common names. All of the visual stimuli were obtained from publicly accessible internet sites and were modified to be the same in size and resolution. To ensure participant preferences were not based on systematic preference for the specific stimuli, all visual stimuli were randomly assigned to each task for each participant. In addition, all stimuli were rated for attractiveness by seven undergraduate research assistants on a 5-point Likert scale including the following ratings: 1 = very unattractive, 2 = unattractive, 3 = neither unattractive or attractive, 4 = attractive, and 5 = very attractive. The mean attractiveness rating was calculated ($M = 3.08$) and was considered to be within a neutral range. All included stimuli were rated within one point of the mean (i.e., $2.08 < n < 4.08$). Examples of the 36 social stimuli are presented in Figure 1.

Design and Procedure

Design

Experiment 1 used a within-subjects design, in which all of the participants participated in all of the experimental conditions.

General Procedure

The experiment consisted of two phases. In the first phase participants were presented with four conditions: 1) a solvable conditional, arbitrary match-to-sample (MTS) task (S), 2) a neutral task (NT_1), 3) an unsolvable arbitrary match-to-sample task (U), and 4) another neutral task (NT_2). Before beginning Phase 1, participants read the following instructions on the computer screen:

> You will be participating in a study that is investigating people's preferences regarding different kinds of tasks. Starting off, you won't have much choice about which tasks you will perform, but later in the experiment you will be able to choose freely. To gain access to each type of task, you will first be shown a screen with the letters **A** and **S** near the top, and the letters **H**, **J**, **K**, and **L** near the bottom. You can only pick letters that are illuminated. Picking **A** will then allow

you to pick between **H** and **J**, whereas picking **S** will then allow you to pick between **K** and **L**. For now, you will automatically spend some time alternating between the **A** tasks (**H** and **J**), and then you will automatically spend some time alternating between the **S** tasks (**K** and **L**). So just pick the illuminated letters and you'll be on your way. [Press G for more instructions.]

<u>The **H** task and the **L** task</u> require you to figure out relationships. There are several problems where there is a picture on the top of the screen, and three pictures on the bottom of the screen. Your job is to figure out which pictures on the bottom of the screen go with which pictures on the top of the screen. Figure out how things go together as best you can. At the beginning, you will get feedback as to whether you picked the right picture, and can then press the space bar to bring up the next problem. Always use the computer feedback as your guide to figure out the right answer. Only pay attention to the associations and the feedback when choosing. Your advancement to the next phase of the experiment depends upon you accurately learning the relationships, so try your best at all times. To pick the picture on the left press 1, to pick the picture in the middle press 2, and to pick the picture on the right press 3. [Press G for more instructions.]

<u>The **J** task and the **K** task</u> are similar, but only require you to look at a set of pictures, and press 1, 2, or 3, for the picture on the bottom that matches the top picture. Your **<u>ONLY</u>** job in these tasks is to match pictures, then press the space bar to move to the next trial.

You are free to take breaks at any time- just let the experimenter know. Please ask the experimenter if you have any questions now, or at any point during the experiment.

After reading all of the Phase 1 instructions, participants always began with a MTS task that was solvable (S), where correct feedback was delivered contingent upon performance. Participants pressed the "H" key when the "H" was illuminated to gain access to the S task. After completing 10 trials of the S task, they were randomly assigned one of either neutral task (NT_1 or NT_2). Participants pressed the "J" key in the presence of the illuminated "J" for access to the NT_1 and pressed the "K" key in the presence of the illuminated "K" for access to NT_2. After completing 10 trials of the first neutral task, participants were exposed to an unsolvable MTS task (U) and were instructed to press the "L" key when the illuminated "L" was presented to gain access to this task. After completing 10 U trials participants were exposed to the other neutral task that was not randomly assigned following S.

The U task delivered "reinforcement" (i.e., correct feedback) according to a pre-determined schedule, which will be outlined in detail below. Specifically, reinforcement delivery was yoked to the performance in the solvable S task. Because the U task is yoked to the S task, the S task was always presented first. To ensure that participants could not easily detect the yoked feedback, neutral tasks were presented in between each task randomly. Participants were cycled through alternating presentations of 10 trials of each task type until they met criterion (i.e., a 70% correct criterion) on the S task. Once participants met criterion on the S task, they were cycled through one more set of ten trials of the remaining three tasks (N_1, N_2, and U) before moving on to Phase 2.

Subsequent to the completion of Phase 1, participants were asked to read the following instructions:

> Great job! You have finished the first phase of the experiment! Now it's time to move on to the second phase of the experiment, in which you will have several opportunities to choose which task to work on. Earlier, you didn't have any choice about which task you would work on, because only one letter was illuminated at a time. Now, you can pick whichever task you want (for the four condition programs **H** (S), **J** (NT_1), **K** (NT_2), or **L** (U). If you pick **H**, then you get to work on the **H** task for awhile. But, if you pick **J**, then you get to work on the **J** task for awhile. The rules for each task are the same as in the earlier phase, but you will not receive any feedback in any of the tasks (H, J, K or L) during these phases. So you get to pick which task you want to work on based on how much you liked them before. You will get to choose which task to work on several times. Please ask the experimenter if you have any questions. [To begin, press G.]

Once participants completed reading these instructions, they were placed in a choice procedure to determine their preferences for each kind of task, which will be discussed in detail below. Once participants completed the choice phase, the experiment terminated, and participants were asked a few questions during the debriefing before being dismissed. Specifically—similar to Wray et al., (2008)—the following questions were asked during the debriefing: 1) "If you had to choose a favorite condition which would it be? Why?"; and 2) "What were the differences, if any, you noticed about the H condition (S) versus the L condition (U)?".

Phase 1

Solvable match to sample task. The arbitrary MTS task, which required sense-making, intended to establish three 3-member stimulus classes. The social stimuli comprised the stimulus classes.

For each participant, nine of the social stimuli were randomly selected and assigned an alphanumeric designation (e.g., A1, A2, A3, B1, B2, etc), where numbers referred to stimulus classes (e.g., class 1, class 2, etc), and letters referred to individual elements (stimulus A, stimulus B) within each class. These designations are for descriptive purposes only, and were not communicated to participants. In the MTS procedures, the arbitrarily designated A stimuli (e.g. A1, A2, or A3) always served as samples, and the comparison arrays always consisted of three figures with the same alpha designation but different numeric designations (e.g. B1, B2, or B3; C1, C2, or C3). An example of a trial with the visual stimuli is presented in Figure 2.

The S task essentially required participants to learn which comparisons to select in the presence of each of three sample stimuli. Thus, correct selections depended on both the sample and comparison stimuli presented on a given trial. As an example, given the sample A1, and comparisons B1, B2, and B3, B1 was the correct selection. Likewise, given the sample A2, and comparisons C1, C2, and C3, C2 was the correct comparison. There were 6 solvable MTS problems (A1- B1; A1- C1; A2- B2; A2- C2; A3- B3; A3- C3). The specific relations trained in the S task are presented in Figure 3.

At the beginning of each trial, one of the three samples was presented at the top of the screen. Once the sample stimulus had been presented, it was followed 1 s later by the three comparisons equally spaced along the bottom of the screen. On all trials, participants chose the left, middle, and right stimulus by pressing the “1,” “2,” and “3” keys respectively. Correct selections produced the written feedback "Correct," and incorrect selections produced "Wrong." "Correct" and "Wrong" were in white font on a grey background. After feedback was delivered, participants pressed the space bar to proceed to the next trial. After the space bar was pressed, the screen cleared, and there was a 1 s inter-trial interval before the next trial. In each training trial, participants were randomly assigned one of the six problems, with replacement, for each solvable trial.

Participants alternated between 10 solvable trials and 10 trials of each of the three remaining tasks (N_1, N_2, and U), which will be explained in detail below. The participants continued cycling through training trials on all four tasks until they responded correctly on five of seven presentations of any relation in the S task. At that point, trial types of the solved relation were eliminated from the training cycle. When a relation was eliminated in the S task, a randomly-determined relation was also eliminated from the remaining three tasks. This continued until participants met criterion on all six relations at which time they cycled through one more round of each of the three remaining tasks.

Neutral task 1. The purpose of the neutral task was to expose participants to a task that was formally similar to the solvable MTS task but that did not encourage making sense behavior. The neutral tasks allow investigation of whether participants prefer conditions that are solvable or if they simply prefer to avoid conditions that are unsolvable. Participants were exposed to randomly presented stimulus configurations resembling the MTS stimulus arrays with the exception that nine new stimuli were used.

Participants did not engage in selecting stimuli as in the S task for the purpose of solving an arbitrary MTS task, but rather were given an identity-matching MTS task. In the identity-matching task, participants were instructed only to match the stimulus on the top of the screen with the identical stimulus on the bottom. This MTS task is based solely on topographical similarity rather than on the arbitrary relations predetermined by the computer program. An example of this trial type can be seen in Figure 4. Participants first selected the matching stimulus in the comparison array and then pressed the space bar to proceed to the next trial. Computer feedback was presented to let participants know if they correctly chose the matching stimulus.

Unsolvable match to sample task. The purpose of the unsolvable MTS task (U) was to expose participants to a task that encouraged making sense behavior, but in which there were no solvable relations. The unsolvable MTS task was identical to the solvable MTS task except that nine new stimuli were used in each and reinforcement was yoked to their performance in the solvable task, independent of their performance. The yoking procedure required the S task to be presented first, which limited counter-balancing of the order of the tasks. However, a yoking procedure was employed to ensure that any observed differences in preference were the result of the manipulated independent variable (i.e., solvability) rather than other confounding variables (i.e., density of reinforcement).

Specifically, yoked reinforcement meant that the number of total trials to meet criterion, and when each trial type was removed, was held constant across all four tasks. Additionally, "Correct" and "Wrong" were presented on the exact same trials in both the S and U tasks (e.g., S task: "Correct," "Wrong," "Wrong,"; U task: "Correct," "Wrong," "Wrong"). Unbeknownst to the participants, making the same selection the entire task would still have resulted in the same feedback. Whereas the solvable MTS task terminated when participants met the training criterion of five of seven correct responses on all trial types, the unsolvable MTS task terminated when participants responded to the same number of trials as was required to meet criterion in the solvable MTS task.

Neutral task 2. The second neutral task was identical to the first neutral task with two exceptions. First, as in all of the other tasks, nine new stimuli were used. Second, participants were not presented with computer feedback, but rather upon each selection were presented with a grey box. Once participants completed all trials in Phase 1, they moved on to Phase 2.

Phase 2

Preference task. In order to assess participants' differential preferences for the four tasks, they entered a second phase. Participants were given a set of choices based upon a concurrent chaining procedure, which is a commonly employed method for testing preference. Participants were given a total of 12 concurrent choices among all four conditions. Participants saw the keys associated with all four tasks and selected whichever key matched the task they preferred. Following each selection, participants were presented with ten additional trials of the chosen task for a total of 120 trials in this phase of the experiment. In order to reduce the likelihood that participant preference might be affected by reinforcement during this preference phase, no feedback was presented. Following completion of the 120 trials, participants completed Phase 2, were debriefed and dismissed.

Data Analysis and Treatment

As already mentioned, the dependent variable of the present study was participants' choice of conditions in the second phase. Participant preferences were subjected to both within- and between-subject analyses. Within-subject analyses included frequency counts of the condition participants selected most often, the condition participants selected first, and the condition participants verbally reported to be their favorite. Chi square analyses were not performed based on any within-subject data because of the low number of participants in the unsolvable and no preference cells, which would have violated assumptions of the test.

Additionally, participants may vary in how consistently they prefer each condition. As such, the level of consistency among the three different preference measures for each participant was analyzed. Participants were classified as "consistent" when agreement occurred in at least two of the three preferences measures (i.e., 1 - condition type picked most, 2 - condition type picked first, and 3 - verbally reported favorite condition). Frequency counts and percentage of participants that were consistent and inconsistent are reported.

It was thought that participants might vary in their level of awareness about the solvability of each task. As such, the final within-subject variable analyzed was participant "awareness." Participants' verbal report to the debriefing question (i.e., What were the differences, if any, you noticed about the H condition (S) versus the L condition (U)?) was coded as "aware" if participants reported that S was more consistent (e.g., "easier to solve," "pattern stayed the same") *and* U was inconsistent (e.g., "pattern changed," "not coherent"). After participants were classified as "aware," their preference for the S, N and U tasks were examined.

Finally, total preferences across participants were compared using a repeated-measures analysis of variance test. Examination of preference for S, N and U tasks were of interest. Because multivariate approaches, as opposed to mixed model approaches, are less likely to inflate Type I error rates, when few contrast comparisons are examined, adjustments to decrease the liklihood of Type I errors may not be necessary (Maxwell & Delaney, 2004). Based on these recommendations, a multivriate approach was utilized.

However, prior to comparing participant preferences for S, U or neutral tasks, participant preference for each neutral task was investigated with a paired-sample *t* test. Because no significant differences emerged between the neutral tasks, all neutral data was collapsed into one neutral task by averaging each participant's preferences for N_1 and N_2 as is customary when collapsing data in repeated measures ANOVA tests (J. Tybur, personal communication, June 21, 2010). For example, if a participant chose N_1 three times and N_2 five times, that participant's combined neutral task score would be four. Each participant's N_1 and N_2 data was averaged for a combined neutral score.

Because a significant main effect was achieved in the omnibus test, two subsequent contrast comparisons were tested. The first comparison was a test between the S and N task, which revealed no significant differences. As such, the final comparison was between both the S and N tasks and the U task. Only these two comparisons were made in order to reduce the number of comparisons subjected to analysis, which inflates the probability of making a Type I error. Additionally, because only two comparisons were made, and the more conservative approach was utilized, additional adjustments (e.g., Bonferroni) were considered overly conservative and thus not utilized (Maxwell & Delaney, 2004).

Results

Participant Demographics

Data from 15 participants were subjected to analysis and all demographic information can be seen in Table 1. Two of the fifteen participants were male and participant ages ranged from 18-47 years of age. The majority of participants self-identified as Caucasian (53%). Participants' years of education ranged from one to five years of college education.

Task Results

The mean number of trials required for participants to meet the percentage correct criterion was 62.46 (SD = 16.45). Conditions N_1, N_2, and U were yoked to equate the number of trials in the previous phase and thus matched that of the S task. As such, on average participants completed approximately 240 trials prior to moving on to Phase 2.

Prior to comparing participant preferences for S, U or neutral tasks, participant preference for each neutral task was investigated. No significant differences emerged between the neutral task with feedback (NT_1 M = 3.07, SD = 1.33) and the neutral task with no feedback (NT_2 M = 3.07, SD = 1.49), p = .708. As such, both neutral tasks were combined for all remaining analyses.

Within-subject Analyses

As detailed in Tables 2 and 3, only 1 of the 15 participants (7%) preferred the U task and no participants chose it first. In contrast, 13 participants chose either the S (6 or 40%), N (5 or 33%), or S and N tasks equally (2 or 13%) most often. One participant (7%) had no preference across task type. With respect to first preference, all 15 participants chose S (8 or 53%) and N (7 or 47%) tasks first. Individual data is presented in Table 6. In addition to analyzing participants' behavioral preferences, participants' verbal report was analyzed (see Table 6 for individual data). Analysis of verbal report revealed that 11 participants preferred S or N tasks, whereas only four preferred the U task indicating a clear preference for S or N tasks as opposed to the U task.

Participant consistency in preference across the three modalities was analyzed (see Table 6 for more detail). As mentioned above, participants were classified as consistent when agreement occurred in at least two of the three preference modes (i.e., 1 - condition type picked most, 2 - condition type picked first, and 3 - verbally reported favorite condition). Analyses revealed that 14 of 15 (93%) participants were consistent indicating a high degree of agreement among preference modes (see Table 4).

Additionally, in the open-ended question regarding "awareness," four participants were considered aware (see Appendix for individual participant data). Furthermore, it is noteworthy that all four of the participants who could differentiate between the S and U tasks chose to work on either the S or N conditions most and first, and only one of them self-reported that they preferred U the most. In other words, if participants could determine that the U task was not solvable, they consistently preferred the solvable or neutral conditions (S and N).

Between-subject Analyses

As detailed in Table 5, the omnibus test revealed significant differences in preference among the three conditions. As such, the two follow-up comparisons were conducted. First, no significant difference emerged between the S and N tasks. Second, a significant difference emerged between the U task and the combined S and N tasks. In other words, participants preferred the S and N tasks more than the U task, but not significantly more than each other.

Discussion

Results indicate that across three types of preference measures, participants reliably preferred solvable *or* neutral conditions to a condition that is not solvable. These results suggest that unsolvable conditions are aversive, and it is reinforcing to avoid them. However, there was not a clear preference for S tasks when compared to N tasks indicating that although some individuals find sense making positively reinforcing, many find simply avoiding unsolvable conditions rewarding. Comparisons of within-subject consistency in preference indicated a high degree of consistency. Additionally, when data was averaged across participants, preference for solvable or neutral to unsolvable conditions was statistically significant.

However, as can be seen from the individual data reported in Table 6, within-subject preferences were not as robust as anticipated. For example, participants often chose their most preferred condition only once or twice more than all other conditions. One possible reason for the failure to obtain robust preferences was the few number of choices given in Phase 2 of Experiment 1. It was suspected that increasing the number of choices would increase the likelihood that stable within-subject effects would emerge. Another possible reason for less robust differences was the preference methodology that was employed. Although concurrent chaining procedures are the most widely used method for investigating preference, it does not allow for direct comparison between two conditions. Other procedures such as forced choice procedures allow for more direct comparisons, which might highlight the distinction among each task type. Based on this assumption, it was thought that imposing forced choices might improve the likelihood of robust within-subject preferences. In an attempt to obtain more robust within-subject preferences, minor revisions related to these two observations were made and additional data were collected in a second study.

CHAPTER 3

EXPERIMENT 2

Methods

Participants

Twenty volunteer participants were recruited from the University of New Mexico psychology subject pool through a recruitment website. For their participation they received course credit. Participants were informed that they were participating in a "study that is investigating the way that individuals think during cognitive tasks and the choices that they make based on what they have learned." Accepted Institutional Review Board procedures were followed.

Setting, Apparatus, and Materials

The setting, apparatus, and materials were identical to those used in Experiment 1 with the following exceptions. A few minor changes were made to the computer program to increase the number of choices and include forced, rather than, concurrent choices. These changes are detailed below.

Design and Procedure

Design

Experiment 2 used a within-subjects design, in which all of the participants participated in all of the experimental conditions.

General Procedure

The general procedure of Experiment 2 was consistent with that of Experiment 1 with the exception of the following minor revisions. In order to increase the stability in within-subject preference, during Phase 2, the number of choices was increased from 12 to 40 total choices. Additionally, in order to highlight the distinction among each comparison type, we imposed forced rather than concurrent choices. Specifically in Phase 2, participants were given four forced choices: 1) S or U; 2) S or NT_1; 3) U or NT_2; 4) NT_1 or NT_2). Participants were given 10 choices of each possible pair—for a total of 40 choices—and three trials of each choice—for a total of 120 trials—before completing phase 2.

Phase 1

The methods for Phase 1 of Experiment 2 are identical therefore are not discussed here.

Phase 2

Preference task. In order to assess participants' differential preference for the four tasks, they entered a second phase. Participants were given a set of choices based upon a forced choice procedure, which is another commonly employed method for testing preference. Participants were given a total of 40 forced choices among pairs of all four conditions. Participants were given four forced choice combinations: 1) S or U; 2) S or NT_1; 3) U or NT_2; 4) NT_1 or NT_2). Participants were given 10 choices of each possible pair—for a total of 40 choices—and three trials of each choice—for a total of 120 trials—before completing phase 2. Participants saw the keys of whichever tasks were being offered—two tasks per choice trial—illuminated and pressed whichever key matched the task they preferred. Following each selection participants were presented with three additional trials of the chosen task for a total of 120 more trials.

Data Analysis and Treatment

The dependent variable remained participants' choice of conditions in Phase 2 and was analyzed similarly to Experiment 1 (see Experiment 1 Data Analysis and Treatment for details). However, because there were forced choices, as opposed to concurrent choices, each choice pair was analyzed separately.

Results

Participant Demographics

Data from 20 participants were subjected to analysis and all demographic information can be seen in Table 1. Four of the 20 participants were male and participant ages ranged from 18-30 years of age. The majority of participants' self-identified as Hispanic/Mexican American (55%). Years enrolled in the university ranged from one to five years.

Task Results

The mean number of trials required for participants to meet the percentage correct criterion was 72.25 (SD = 42.03). Conditions N_1, N_2, and U were yoked to equate the number of trials in the previous phase and were the same as the number of S trials. As such, on average participants completed approximately 280 trials prior to moving onto Phase 2.

Prior to comparing participant preferences for S, U or neutral tasks, participant preference for each neutral task was investigated. No significant differences emerged between the neutral task with feedback (NT_1 M = 12.40, SD = 4.47) and the neutral task without feedback (NT_2 M = 10.75, SD = 2.84), t (19) = 1.40, p = .179. As such, both neutral tasks were combined for all remaining analyses.

Within-subject Analyses

As detailed in Tables 2 and 3, with respect to the S and U forced choice, 11 of the 20 participants (55%) preferred the S task more often than the U task, eight (40%) preferred U more than S, and one (5%) had no preference. Similarly, when presented with the forced choice between S and U, 13 (65%) participants chose S first. When presented with the S versus N forced choice, the majority of participants preferred the N task (11 or 55%), seven (35%) participants preferred the S task, and two participants (20%) had no preference. Additionally, when presented with the U and N forced choice, 14 (70%) preferred the N task, three (15%) participants preferred the U task, and three (15%) had no preference. In other words, participants continued to show a preference for solvable and neutral tasks as compared to the unsolvable task.

The majority of participants verbally reported that they preferred S (4 or 20%) or N (12 or 60%) tasks, whereas only four participants (3 or 15%) preferred the U task or had no preference (1 or 5%). See Table 7 for participants' verbal reports. These results indicate a clear preference for S or N tasks as opposed to the U task.

Analysis of participants' consistency can be seen in Table 4. Fourteen participants (70%) were consistent and six participants (30%) were inconsistent, indicating a high degree of agreement among preference measures.

Similarly to Experiment 1, only a few participants were classified as "aware." However, both of the participants that could differentiate between the S and U tasks did not choose to work on the U condition most or first or verbally report it as their favorite. In fact, both participants reported the neutral condition to be their favorite. Data from "aware" participants suggests that if participants could determine the unsolvability of the second condition they consistently preferred the solvable or neutral conditions.

Between-subject Analyses

Total participant preferences for S, N, and U were subjected to a repeated-measures ANOVA. As detailed in Table 5, the omnibus test revealed significant differences in preference among the three conditions. As such, the two follow-up comparisons were conducted. First, no significant difference emerged between the S and N tasks. Second, a significant difference emerged between the U task and the combined S and N tasks. In other words, participants continued to prefer the S and N tasks more than the U task, but not significantly more than each other.

Discussion

Results indicate that across three types of preference modalities, participants equally prefer solvable or neutral conditions, to the unsolvable condition. Preference for S and N to U was statistically significant across participants. However, within-subject preferences continued to be less robust than was anticipated as can be seen from the individual data reported in Table 7.

Based on the data from the first two experiments, we suspected that participants were having difficulty discerning that the U task is not solvable. In particular, few participants could be classified as "aware" suggesting that most participants were unable to discern the solvability of the S and U task. One possible reason for this difficulty may be that participants were consistently requiring few trials to reach the 70% correct criterion in Experiments 1 and 2. As such, increasing the difficulty of the task—in order to increase the number of trials participants would have to interact with each condition—might improve participants' ability to discern the solvability of these tasks. Additionally, although multiple safeguards were imposed to reduce the effect of participant learning history on preference, using social stimuli increased the likelihood that individual learning histories may have influenced their preferences. The use of abstract stimuli was thought to reduce the likelihood that idiosyncratic reasons were responsible for the lack of robust within-subject preferences. As an attempt to obtain more robust preferences, a few minor revisions were made to the general procedures and additional data were collected in Experiment 3.

CHAPTER 4

EXPERIMENT 3

Method

Participants

Seventeen volunteer participants were recruited from the University of New Mexico psychology subject pool through a recruitment website. For their participation they received course credit. Participants were informed that they were participating in a "study that is investigating the way that individuals think during cognitive tasks and the choices that they make based on what they have learned." Accepted Institutional Review Board procedures were followed.

Setting, Apparatus, and Materials

The setting, apparatus, and materials were the same as those used in Experiment 1 and 2 with only the following exceptions. Comparison and sample stimuli consisted of 36 abstract visual stimuli and contextual stimuli consisted of nonsense syllables that were used in Wray et al., (2008). Neutrally-rated abstract stimuli ($M = 2.86$; $1.86 < n < 3.86$) rather than social stimuli were used in the computer tasks for two primary reasons; no improvement was observed when social stimuli were used in our previous work (e.g., Wray et al., 2008), and abstract stimuli would rule out the impact of participants' idiosyncratic learning histories as a reason for the lack of robust preference. Example stimuli can be seen in Figure 5.

Design and Procedure

Design

Experiment 3 used a within-subjects design, in which all of the participants participated in all of the experimental conditions.

General Procedure

The general procedure of Experiment 3 was consistent with that of Experiment 1 with the exception of the following revisions. Because few trials were necessary for participants to reach the 70% correct criterion in Experiments 1 and 2, we increased the difficulty of the task. Based on the work of Wray et al., (2008), increasing the difficulty of the task by adding a contextual stimulus, would increase the number of trials participants would have to interact with each condition by approximately 150 trials; on average participants required 200 trials to reach the 70% correct criterion in a conditional, arbitrary match to sample task. In order to increase the number of trials without significantly increasing the amount of participant time commitment—and because there were no significant differences in preference between the two neutral tasks in either of the first two experiments—we presented only the neutral task without feedback.

Before beginning Phase 1, participants read the following instructions:

> You will be participating in a study that is investigating people's preferences regarding different kinds of tasks. Starting off, you won't have much choice about which tasks you will perform, but later in the experiment you will be able to choose freely. To gain access to each type of task, you will the letters **C** (S), **V** (N), and **B** (U) to gain access to each of those conditions which appear near the bottom. You can only pick letters that are illuminated. For now, you will automatically spend some time alternating between each of the tasks (**C, V** and

B). So just pick the illuminated letters and you'll be on your way. [Press G for more instructions.]

The **C** task and the **B** task require you to figure out relationships. There are several problems where there is a picture on the top of the screen, a nonsense word in the middle, and three pictures on the bottom of the screen. Your job is to figure out which pictures on the bottom of the screen go with which pictures on the top of the screen. You will need to pay attention to both the pictures and the nonsense words to solve the problem. Figure out how things go together as best you can. You will get feedback as to whether you picked the right picture, and can then press the space bar to bring up the next problem. Always use the computer feedback as your guide to figure out the right answer. Only pay attention to the associations and the feedback when choosing. Your advancement to the next phase of the experiment depends upon you accurately learning the relationships, so try your best at all times. To pick the picture on the left press 1, to pick the picture in the middle press 2, and to pick the picture on the right press 3. [Press G for more instructions.]

The **V** task is similar, but only requires you to look at a set of pictures, and press 1, 2, or 3, for the picture on the bottom that matches the top picture. Your **ONLY** job in these tasks is to match pictures, then press the space bar to move to the next trial.

You are free to take breaks at any time- just let the experimenter know. Please ask the experimenter if you have any questions now, or at any point during the experiment.

After reading all of the Phase 1 instructions, participants always began with a MTS task that was solvable (S), where correct feedback was delivered contingent upon performance. Participants pressed the "C" key when the "C" was illuminated to gain access to the S task. After completing 10 trials of the S task, they were presented with the neutral task (N). Participants pressed the "V" key in the presence of the illuminated "V" for access to the N task. After completing 10 trials of the neutral task, participants were exposed to an unsolvable MTS task (U) and were instructed to press the "B" key when the illuminated "B" was presented to gain access to this task.

Identical to the first two experiments, the U task delivered "reinforcement" (i.e., correct feedback) according to a pre-determined schedule based upon their performance in S. Participants were cycled through alternating presentations of 10 trials of each of the three task types until they met criterion (i.e., a 70% correct criterion) on the S task. Once participants met criterion, they were cycled through one more cycle of the remaining two tasks before moving on to Phase 2.

Subsequent to the completion of Phase 1, participants were asked to read the following instructions:

> Great job! You have finished the first phase of the experiment! Now it's time to move on to the second phase of the experiment, in which you will have several opportunities to choose which task to work on. Earlier, you didn't have any choice about which task you would work on, because only one letter was illuminated at a time. Now, you can pick whichever task you want (for the three conditions **C (S), V (N)**, or **B (U)**. If you pick **C**, then you get to work on the **C** task for awhile. But, if you pick **V**, then you get to work on the **V** task for awhile. The rules for each

task are the same as in the earlier phase, but you will not receive any feedback in any of the tasks (C, V, or B) during these phases. So you get to pick which task you want to work on based on how much you liked them before. You will get to choose which task to work on several times. Please ask the experimenter if you have any questions. [To begin, press G.]

Once participants had read the instructions, they were placed in a choice procedure to determine their preferences for each kind of task, which will be detailed to follow. Once participants completed the choice phase, the experiment terminated, and participants were asked the same two questions during the debriefing before being dismissed.

Phase 1

Solvable match to sample task. The conditional, arbitrary MTS task remained the first condition in Phase 1. The conditional MTS task intended to establish three conditional 3-member stimulus classes. The nonsense syllables served as contextual stimuli, and the abstract figures comprised the stimulus classes.

For each participant, nine abstract figures were randomly selected and assigned an alphanumeric designation (e.g., A1, B2, etc), where numbers referred to stimulus classes (e.g., class 1, class 2, etc), and letters referred to individual elements (stimulus A, stimulus B) within each class. These designations were for descriptive purposes only, and were not communicated to participants. In the MTS procedures, the arbitrarily designated A stimuli (e.g. A1, A2, or A3) always served as samples, and the comparison array always consisted of three figures with the same alpha designation but different numeric designations (e.g. B1, B2, or B3; C1, C2, or C3).

The procedures essentially required participants to learn which comparisons to select in the presence of each of three samples and each of three contextual stimuli. Thus, correct selections depended on both the contextual stimulus and the sample presented on a given trial. The specific relations trained using this procedure are presented in Figure 6. As an example, in the presence of the contextual stimulus, ZAK, participants were trained to select the comparisons with the same numeric designation as the samples. Thus, given the nonsense syllable ZAK, sample A1, and comparisons B1, B2, and B3, B1 was the correct selection. Likewise, in the presence of ZAK, sample A3, and comparisons C1, C2, and C3, C3 was the correct comparison. However, in the presence of the contextual stimulus HEF, a different set of relations will be trained. For example, in the presence of HEF, sample A1 and comparisons B1, B2, and B3, B2 was the correct comparison. A typical MTS trial is presented in Figure 3.

At the beginning of each trial, one of the three contextual stimuli and one of the three samples were presented at the top of the screen, followed 1 sec later by the three comparisons equally spaced along the bottom of the screen. On all trials, participants chose the left, middle, and right stimulus by pressing the left, middle, and right arrow keys, respectively. Correct selections produced the written feedback "Correct" on the computer screen, and incorrect selections produced "Wrong." After feedback was delivered, the screen cleared, and there was a 1 sec inter-trial interval before the next trial. In total, there were 18 relations learned, each of which was represented by 6 trial types. That is for every relation, there were six possible arrangements of the comparison arrays, and each was a different trial type. For example, when each sample stimulus is presented, the B comparison stimuli could be arranged in the following six arrangements:

1) B1, B2, B3; 2) B1, B3, B2; 3) B2, B3, B1; 4) B2, B1, B3; 5) B3, B2, B1, and 6) B3, B1, B2. All 18 relations were randomly presented until participants responded correctly on five of seven (approximately 70% correct) presentations of any relation. At that point, trial types of those relations were eliminated from the training cycle. This continued until participants met criterion on all relations.

Neutral task. Only one neutral task was implemented in Experiment 3 in order to reduce the amount of time required to complete the study while allowing for task difficulty to be increased, which seemed reasonable since no differences in preference had emerged between the neutral conditions in either of the previous studies. The neutral task in Experiment 3, was identical to the second neutral task (NT_2) used in both Experiment 1 and 2, which was the identity MTS task that did not provide feedback.

Unsolvable match to sample task. The unsolvable MTS task (U) was identical to those in the first two experiments where reinforcement was yoked to their performance in the solvable task, independent of their performance. Once participants finished, they moved on to the choice phase of the study.

Phase 2

Preference task. In order to compare directly the utility of forced choice and concurrent choice procedures, in the third study, we implemented both preference tests (see Phase 2 section for more detail). Specifically in Phase 2, participants were given 10 concurrent choices (i.e., S or U or N) and three forced choice combinations: 1) S or U; 2) S or N; 3) U or N. Participants were given three trials of each condition following their concurrent choices for a total of 30 trials following their concurrent choices. For the forced choice presentations, participants were given three choices of each possible pair—

for a total of 9 forced choices—and three trials following each choice—for a total of 27 trials—following their forced choice selections. In total, participants made 19 total choices and completed 57 post-selection trials before completing

Data Analysis and Treatment

The dependent variable remained participants' choice of conditions in Phase 2 and was analyzed similarly to Experiment 1 and 2 (see Experiment 1 Data Analysis and Treatment for details). However, because there were concurrent and forced choices, each choice type will be analyzed separately.

Results

Participant Demographics

Data from 17 participants were subjected to analysis and all demographic information can be seen in Table 1. Three of the 17 participants were male and participant ages ranged from 18-29 years of age. The majority of participants self-identified as Caucasian (58%). Participants' years of college education ranged from one to five years.

Task Results

The mean number of trials required for participants to meet the percentage correct criterion was 196.65 (*SD* = 86.94) indicating our attempt to increase the number of trials was successful. Conditions N and U were yoked to equate the number of trials in the previous condition and thus were the same as S. As such, on average participants completed approximately 600 total trials prior to moving onto Phase 2.

Within-subject Analyses

As detailed in Tables 2 and 3, with respect to the concurrent choices, only two of the seventeen participants (12%) preferred the U task most and only one participant (6%) chose it first. Contrastingly, 14 participants chose either the S (4 or 24%), N (9 or 53%), or S and N tasks equally (1 or 6%) most often. One participant (6%) had no preference across task type. With respect to first preference, 16 participants chose S (9 or 53%) or N (7 or 41%) tasks first.

Forced choice data indicates a similar pattern. With respect to the S and U forced choice, 10 of the 17 participants (59%) preferred the S task more often than the U task, and seven (41%) preferred the U task most often. Similarly, when presented with the forced choice between S and U, 11 (65%) participants chose S first. When presented with the S versus N forced choice, the majority of participants preferred the N task (11 or 65%) and six (35%) participants preferred the S task. Additionally, when presented with the U and N forced choice, 13 (76%) preferred the N task most, and four (24%) participants preferred the U task most. In other words, in both forced and current chaining procedures, participants continued to show clear preference for solvable and neutral tasks as compared to an unsolvable task. Consistent with Experiment 2, participants slightly preferred the neutral tasks to the solvable tasks.

In addition to analyzing participants behavioral preferences participants' verbal report of preference was assessed during debriefing (see Table 8). Fourteen participants preferred S (8 or 47%) or N (35%) tasks, where as only three preferred the U (18%) task indicating a clear preference for S or N tasks as opposed to the U task.

Participants' consistency among different preference measures was subjected to analysis. As can be seen in Table 4, twelve (71%) participants were consistent and five

(29%) participants were inconsistent indicating a high degree of agreement among preference modes.

Additionally, in the open ended question regarding "awareness," two participants were classifies as "aware." It is noteworthy that both of the participants that could differentiate between the S and U tasks did not choose to work on the U condition most or first, and both verbally reported that S was their favorite condition. In other words, "aware" participants continued to prefer the solvable or neutral conditions.

Between-subject Analyses

Total participant preferences for S, N, and U in both choice procedures were subjected to a repeated-measures ANOVA. Although concurrent chaining data showed that most participants preferred S or N tasks, this effect was not significant. However, because a similar trend was reported in the contrasts—and in an attempt to remain consistent across all the studies—the contrast data was analyzed and is reported in Table 5. With respect to the forced choice data, the omnibus test revealed significant differences in preference among the three conditions (see Table 5). As such, the two follow-up comparisons were conducted. First, no significant difference emerged between the S and N tasks. Second, a significant difference emerged between the U task and the combined S and N tasks. In other words, participants continued to prefer the S and N tasks more than the U task, but not significantly more than each other.

Discussion

Results indicate that across three types of preferences measures, participants equally prefer solvable *or* neutral conditions, which they prefer more than a condition that is not solvable. This preference is consistent across preference measures and holds across both forced and concurrent choice procedures. Between-subject analyses revealed that participants significantly preferred S or N tasks in the forced choice task, but this effect did not reach significance in the concurrent choice procedure. However, within-subject results continue to be less robust than initially anticipated.

Despite increasing the number of trials participants engaged in each task, participants continued to have difficulty discerning that the U task is not solvable. Only two participants could be classified as "aware" suggesting that the majority of participants remained unable to discern the solvability of the S and U task. Additionally, use of abstract stimuli did not appear to alter how robust within-subject preferences were suggesting that either social or abstract stimuli can be utilized without systematically impacting participant preference.

CHAPTER 5

GENERAL RESULTS

Results across all three studies indicate solvable *or* neutral conditions are preferable to unsolvable conditions, which is consistent with findings from Wray et al., (2008). In fact, this finding held across multiple preference measures both replicating and extending the work of Wray et al., (2008). The replication of this effect across all three preference measures suggests that although the within-subject effect was less robust, this is a reliable effect. Additionally, this preference was obtained using both concurrent and forced choice procedures. Three of the four between-subject analyses demonstrated significant preference of S *or* N tasks as opposed to the U task.

However, within-subject data shows that there was no clear preference for solvable tasks over neutral tasks in any preference modality. Between-subject results indicate that there was not a significant preference between these two tasks in any of the three studies. In sum, results reliably show that participants prefer solvable *or* neutral tasks to tasks that are not solvable. Additionally, no clear preference was observed in Experiment 1 or 2 for neutral tasks with or without feedback. This finding suggests that feedback is not systematically altering preference in identity matching tasks.

Within-subject preferences across all three experiments were less robust than expected. Participants consistently chose their preferred condition only once or twice more than the other conditions indicating that participants may have only slightly preferred solvable to unsolvable conditions. This finding may be related to the difficulty participants had in discerning the unsolvability of the U task, which was observed in all three studies. Specifically, only 6 out of 52 participants were classified as "aware," indicating that the vast majority of participants were unaware of the U tasks' unsolvability. Across all three choice modalities, for each of the six "aware" participants (for a total of 18 choices), only 1 of 18 choices was for the U task. This finding suggests that increasing "awareness" of the unsolvability of the task improves the robustness of the effect.

Table 1

Demographic Information

	Experiment 1 (n = 15)	*Experiment 2 (n = 20)*	*Experiment 3 (n = 17)*
Age	26.36 (11.53)	20.85 (2.57)	21.24 (1.78)
Ethnicity (%)			
White	53	20	24
Hispanic	33	55	59
Black	7	0	0
Asian/Pacific Islander	0	0	6
Native American	7	5	6
Biracial / Other	0	20	6
Sex (%)			
Female	87	80	82
Male	13	20	18
Years of Education	14.73 (1.49)	14.36 (1.57)	14.82 (1.33)

Table 2

Number of Participants that Chose Each Condition Type Most Across Experiments

	Experiment 1		*Experiment 2*		*Experiment 3*	
S	6	40%			4	24%
N	5	33%			9	53%
U	1	7%			2	12%
S/N NP	2	13%			1	6%
N/U NP	0	0%			0	0%
S/N/U NP	1	7%			1	6%
SvN_S			7	35%	6	35%
SvN_N			11	55%	11	65%
S/N NP			2	20%	0	0%
SvU_S			11	55%	10	59%
SvU_U			8	40%	7	41%
S/U NP			1	5%	0	0%
NvU_N			14	70%	13	76%
NvU_U			3	15%	4	24%
N/U NP			3	15%	0	0%

Table 3

First Choice Across Experiments

	Program 1	*Program 2*	*Program 3*
# S 1st	8	13	9
% S 1st	53%	65%	53%
# N 1st	7		7
% N 1st	47%		41%
# U 1st	0	7	1
% U 1st	0%	35%	6%

Table 4

Consistency in Behavioral Preference and Verbal Report Across Experiments

	Experiment 1	Experiment 2	Experiment 3
Consistent	14	14	12
% Consistent	93%	70%	71%
Inconsistent	1	6	5
% Inconsistent	7%	30%	29%

Note. Participants were classified as consistent if agreement occurred in at least 2 or the 3 modes of preference (i.e., 1. condition type picked most, 2. condition type picked 1st, 3. condition participant verbally reported as their favorite)

Table 5

Between-subject Analyses of Total Choices Across Experiments

	Concurrent Chain				Forced Choice			
Experiment	*F*	Hypothesis *df*	Error *df*	*P*	*F*	Hypothesis *df*	Error *df*	*P*
1-Omnibus	4.80	2	13	.028*				
1-Ψ (S v N)	1.30	1	14	.273				
1-Ψ (S/N v U)	5.45	1	14	.035*				
2-Omnibus					4.35	2	18	.029*
2-Ψ (S v N)					3.46	1	19	.078
2-Ψ (S/N v U)					8.32	1	19	.009*
3-Omnibus	2.74	2	15	.097	6.00	2	15	.012
3-Ψ (S v N)	2.60	1	16	.126	4.12	1	16	.059
3-Ψ (S/N v U)	5.76	1	16	.029*	5.91	1	16	.027*

Note. * $p < .05$; All tests were conducted using repeated measures multivariate ANOVA tests.

Table 6

Consistency in Behavioral Preference and Verbal Report for Experiment 1

Ps ID #	*# Choice S*	*# Choice N*	*# Choice U*	*Consistent*	*Most*	*1st Choice*	*Favorite and why?*
314	2	4	2	All	N	N	N - they were easy
315	4	3	2	All	S	S	N - you have a better chance of getting it right
316	2	4.5	1	All	N	N	N - you just had to match
317	4	3	2	All	S/N	S	S - it didn't make her feel stupid
318	4	2.5	3	2 of 3	S	N	N - like the letter K
319	6	1	5	None	S	N	U - it seemed that more things matched
320	4	3	2	2 of 3	S	S	U - the variety in people
321	2	4.5	1	2 of 3	N	S	N - it was easy
322	4	3	2	2 of 3	S/N	S	N - got the most gratification
323	5	3	1	2 of 3	S	N	S - it felt like there was a pattern
324	5	3.5	0	2 of 3	N	N	U - had to think about it more
325	3	1.5	6	2 of 3	U	S	S - interesting and enough similarities for them to stand out
326	3	4	1	2 of 3	N	N	S - it was attainable, good and not boring
327	4	3	2	2 of 3	S	S	U - got that one quickest
328	3	3	3	2 of 3	NP	S	S - liked memorizing things, felt like she did good

Note. S = solvable, N = average of N_1 and N_2, U = unsolvable. Consistency was determined by 3 modes of preference (i.e., 1. condition type picked most, 2. condition type picked 1st, 3. condition participant verbally reported as their favorite)

Table 7

Consistency in Behavioral Preference and Verbal Report for Experiment 2

Ps ID #	*# Choice S*	*# Choice N*	*# Choice U*	*Consistent*	*Most*	*Favorite and why?*
331	10	8.5	13	Y	U	U - thought she had a strategy
332	5	13	9	Y	N	N - it was the easiest
333	14	5.5	15	N	U	S - able to learn pattern better, consistent
334	10	11	8	N	N	U - it made her think
335	1	15	9	Y	N	N - they were easier
336	8	15	2	Y	N	N - she knew what she was doing
337	6	14.5	5	Y	N	N - they are easier
338	5	14.5	6	Y	N	N - they were obvious
339	11	10.5	8	Y	N	N - you knew the answer right away
340	14	9.5	7	N	S	U - he liked trying to figure it out
341	9	9	13	N	U	S and U - they made his mind work
342	9	13	5	Y	N	N - it was the easiest
343	10	10	10	Y	N	N - liked the people
344	9	15	1	Y	N	N - it was simpler to figure out
345	13	11.5	4	N	N	S - knew the associations
346	11	11	7	Y	N	N - it had feedback and same picture
347	11	11	7	Y	N	N - it was easiest
348	12	8.5	11	Y	S	S - felt like she got more right
349	8	14	4	Y	N	N - it was the easiest
350	10	11.5	7	N	N	S - she liked that it was challenging

Note. S = solvable, N = average of N_1 and N_2, U = unsolvable. Consistency was determined by 3 modes of preference (i.e., 1. condition type picked most, 2. condition type picked 1st, 3. condition participant verbally reported as their favorite)

Table 8

Consistency in Behavioral Preference and Verbal Report for Experiment 3

Ps ID #	*# Choice S*	*# Choice N*	*# Choice U*	*Consistent*	*Most*	*1st Choice*	*Favorite and why?*
373	4	2	3	All	S	S	S - it was straight forward
374	1	3	4	None	U	N	S - liked patterns
375	3	3	3	None	NP	S	U - had interesting pictures
377	3	5	1	None	N	S	U - could figure out by contextual letters
378	2	4	3	2 of 3	N	U	N - it was easy
379	3	6	0	2 of 3	N	S	N - all she had to do was match
380	3	4	2	2 of 3	N	S	S - patterns were easier to figure out
381	6	3	0	2 of 3	S	S	N - it was less confusing
382	4	4	1	2 of 3	S	N	N - that is the only one she always got right
383	2	4	3	2 of 3	N	N	U - the images were the easiest
385	2	4	3	2 of 3	N	S	S - it helped him figure out the others
388	0	4	5	2 of 3	U	N	N - it was easiest
389	4	5	0	2 of 3	N	N	N - just had to match pictures
390	2	5	2	2 of 3	N	S	S - got it quicker
391	3	6	0	All	N	N	N - they were matching
392	4	2	3	2 of 3	S	N	S - it makes you think but it wasn't too easy
393	5	4	0	All	S	S	S - fun figuring out a puzzle

Note. S = solvable, N = neutral, U = unsolvable. Consistency was determined by 3 modes of preference (i.e., 1. condition type picked most, 2. condition type picked 1st, 3. condition participant verbally reported as their favorite)

Figure 1

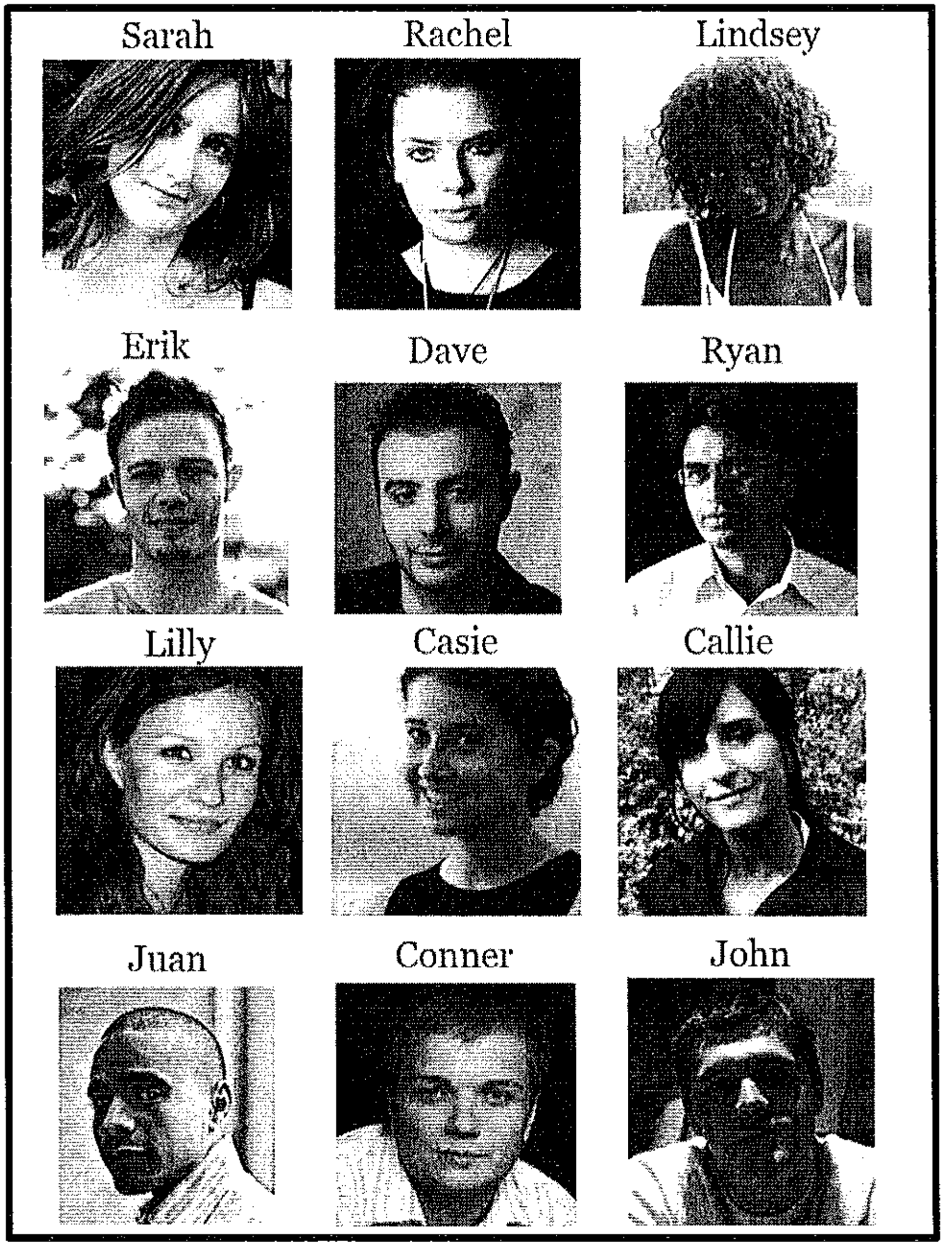
Sarah
Rachel
Lindsey
Erik
Dave
Ryan
Lilly
Casie
Callie
Juan
Conner
John

Figure 2

Figure 3

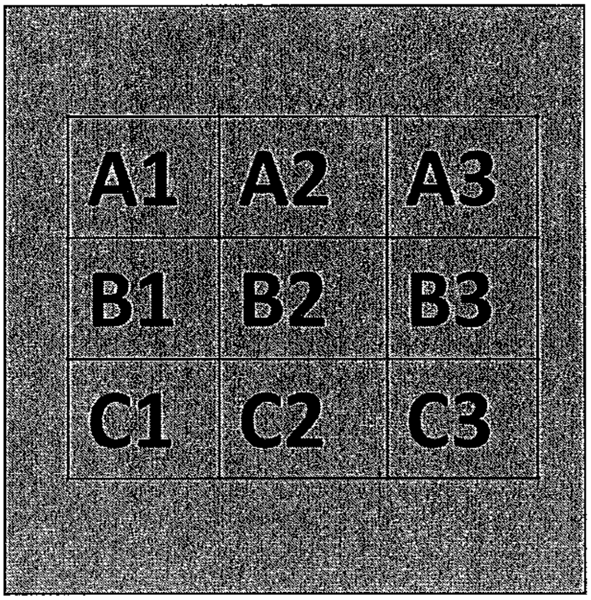

Figure 4

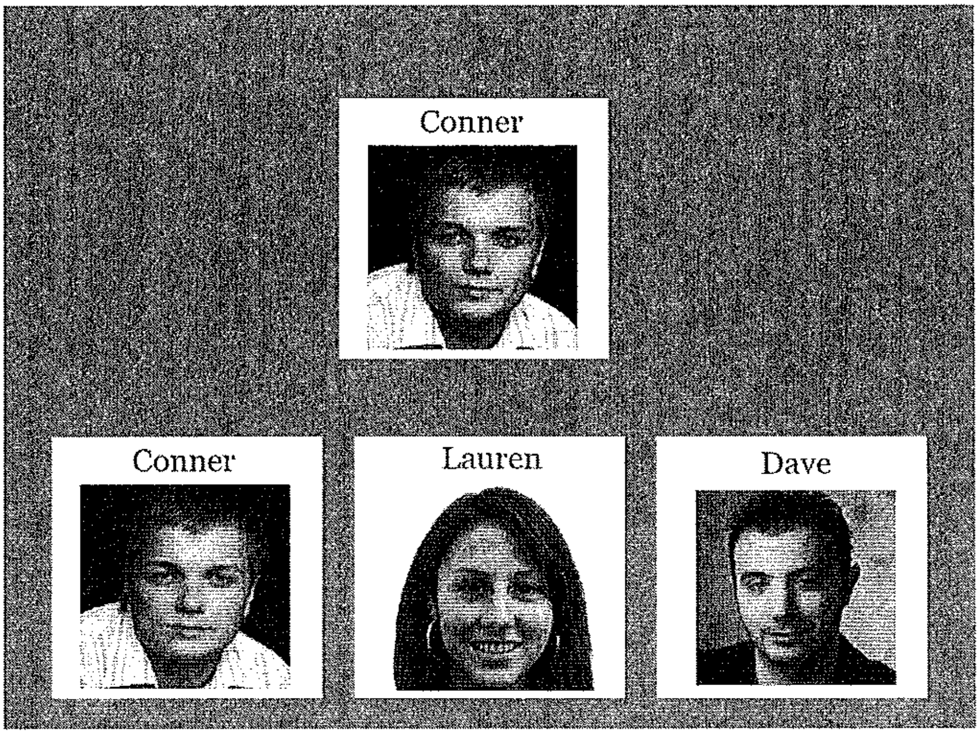

Figure 5

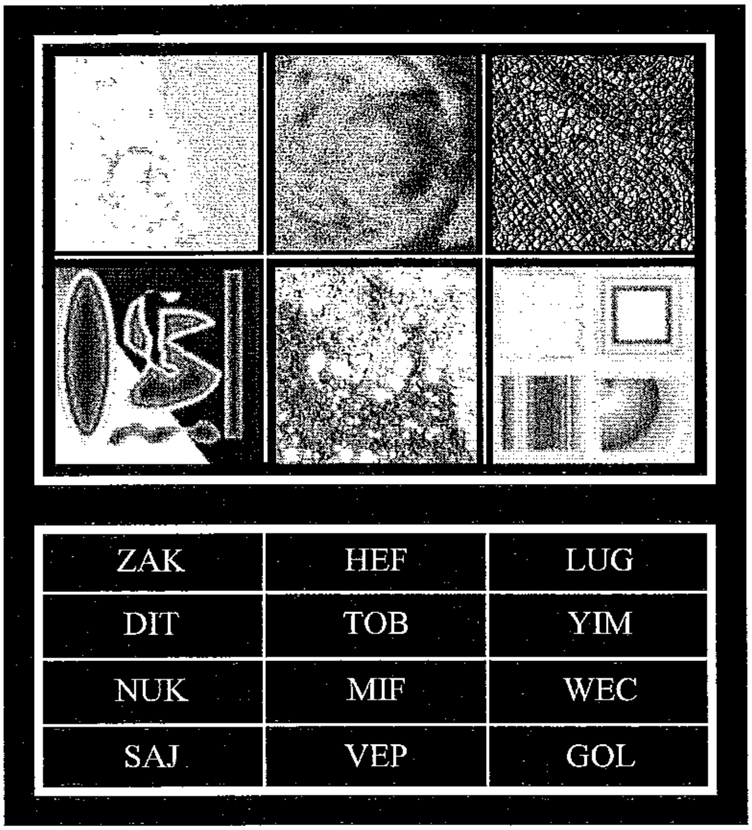

Figure 6

ZAK

A1	B1	C1
A2	B2	C2
A3	B3	C3

HEF

A1	B2	C3
A2	B3	C1
A3	B1	C2

LUG

A1	B3	C2
A2	B1	C3
A3	B2	C1

CHAPTER 6

GENERAL DISCUSSION

Evidence across multiple psychological research domains indicates that making sense likely serves reinforcing functions, and that these functions may explain why it continues despite accompanying aversive consequences (Hayes et al., 1999; Martin & Tesser, 1996; Nolen-Hoeksema, 1991) and in situations where it may not be useful (Addis & Carpenter, 1999; Addis & Jacobson, 1996). In a previous study, Wray et al., (2008) provided preliminary evidence that sense-making is a reinforcer. One aim of this study was to replicate these findings and to extend them by including more rigorous behavioral tests of preference.

Results of the present series of studies generally replicated the findings of Wray et al., (2008) and showed that participants consistently preferred a solvable condition over an unsolvable condition despite equal numbers of trials and levels of reinforcement. Consonant with Wray et al., this preference was replicated by assessing the condition that each individual verbally reported to be their favorite. This preference was also maintained across two other measures of preference, including the condition that each individual chose most often and the condition that each individual chose first. Within participants, participant agreement among the three choice modalities was highly consistent. Similarly, when data was averaged across participants, the main effect of condition was significant in three of the four statistical tests conducted. Taken together, these results provide strong evidence that situations that are solvable are preferred to conditions that cannot be solved.

While Wray et al., (2008) provided support for making sense as a reinforcer, that study did not establish whether individuals preferred the solvable condition because it was positively reinforcing or because avoiding the unsolvable condition was negatively reinforcing. This study aimed to determine whether making sense functions as a negative or positive reinforcer, as there is evidence for both functions within the current literature.

The clear preferences for solvable or neutral tasks over unsolvable tasks indicate that situations that are not solvable are aversive. In particular, the preference for the neutral task indicates that avoiding conditions that are not solvable is reinforcing providing evidence for the negatively reinforcing functions of sense-making. For example, ambiguity or uncontrollable situations have been shown to be aversive. As such avoidance of these situations, and their accompanying emotional states, is likely negatively reinforcing.

Differential preference for the solvable over the neutral tasks indicates that for some individuals there are also positively reinforcing aspects. Consonant with these findings, an organism's ability to impact contingently its environment is critical in positive reinforcement (for review see Mineka & Henderson, 1985). For example, individuals prefer to work for reinforcement, rather than be delivered reinforcement that is not contingent upon their behavior. However, within-subject data across the three iterations highlights that by in large there are not strong preferences for solvable over neutral tasks indicating that for each individual there are likely both reinforcing functions at work. Moreover, the lack of robust differences among the S and N tasks implicates that within individuals both reinforcing functions are influencing participant behavior.

In fact, there appears to be a slight preference for neutral tasks over solvable tasks indicating that the negatively reinforcing aspects of sense-making might be the most powerful for most individuals. Participants that chose neutral tasks often reported that they preferred them most because those tasks were "less confusing," "obvious," or because they were tasks that the participant "only had to match." However, there were individuals that preferred the solvable tasks. Specifically, across all three studies, approximately one-third of participants preferred solvable tasks over neutral tasks. For these individuals, they often reported that the solvable task was "fun to figure out," "attainable and not boring," "had likable patterns," or they felt like they "did a good job." These differences among individuals suggests that making sense may serve different functions for different individuals or at the least that certain reinforcing functions might be more influential to certain individuals.

While these studies clearly indicate making sense is reinforcing, the small number of participants that could discern the unsolvability of the U condition was alarming. Ideally, participants would have been able to report that they did not prefer the unsolvable condition, because they knew it was not solvable. Their inability to do so likely is responsible for the lack of distinct preference among the conditions, which may have been due to the yoking schedule. Although yoking provided the highest level of control across conditions, it may have contributed to participants' belief that the U task was solvable. Specifically, as participants neared the end of the solvable task, they were receiving almost entirely correct feedback, which was identically yoked to the unsolvable condition. Future research should utilize an unsolvable task that is more discernable from the solvable tasks. However, maximizing the ability to discern the unsolvability of the U task might require methodological changes that will sacrifice control among the conditions. Additionally, in an effort to provide a more conservative test of preference, no feedback was presented in the choice trials. This could have reduced their ability to discriminate among the tasks during Phase 2, however given the few number of choice trials, the former explanation seems more likely. Finally, the wording of the instructions may have lead participants to believe both the S and U tasks were solvable. The instructions read to the participants encouraged problem-solving in the S and U tasks and discouraged problem-solving in the neutral tasks. Thus, inadvertently the yoking procedure, lack of feedback in choice trials, and wording of the instructions may have contributed to the inability of most participants to discern that U tasks were not solvable.

Finally, individuals are motivated to assign causality to events that are relevant to them, particularly aversive events (e.g., Schachter & Singer, 1962) and data suggest this is the case (Peterson & Seligman, 1984). Given that ambiguous or unsolvable conditions are likely experienced as aversive, individuals may be particularly motivated to assign meaning under these sets of conditions. Participants' verbal reports indicate that even in the unsolvable task, participants created a sensible narrative about this condition. For example, participants often created idiosyncratic rules about how the task could give conflicting feedback (e.g., "More than one answer was correct in the U task."). This finding is similar to the idea that when situations are uncontrollable, individuals will impose control through verbal means (Rothbaum et al., 1982). This is particularly interesting because the meaning imposed was not accurate, nonetheless may have successfully reduced the uncomfortable emotional state associated with the unsolvable task. This may have contributed to the observed difficulty discerning the unsolvability of the U task as participants were imposing a sensible narrative on an unsolvable situation. The extent to which participants fashioned meaning out of a meaningless situation further indicates the pervasiveness of sense-making processes.

Theoretical and Clinical Implications

There is a substantial body of literature indicating making sense is an adaptive process, however, there is also mounting evidence highlighting that making sense often occurs at maladaptive levels and can be maintained in contexts in which it is not helpful. This well-replicated discrepancy has not been well explained and has important clinical implications. As such a theoretical account of this observed difference seems important.

Given the prevalence of individual variability in preference for solvable or neutral tasks, future studies should evaluate if individuals differ in which reinforcing functions are most powerful. Making sense that is maintained by positive reinforcement may be qualitatively different from that which is maintained by negative reinforcement. Specifically, individuals that engage in sense-making for primarily negatively reinforcing reasons (e.g., escape from aversive private stimuli), may be more inclined to engage in this behavior problematically (e.g., Hayes, et al., 1999). As such, sense-making that is maintained by this form of reinforcement may be functionally distinct and thus lead to very different outcomes similar to those seen in the literature indicating problematic aspects of sense-making. Future investigation of the differences among individuals that engage in sense-making to obtain negative versus positive reinforcement might elucidate the role of each reinforcing function.

Additionally, it might prove fruitful to investigate whether individual difference measures such as intolerance for ambiguity, desire for predictability, or desire for social reinforcement can reliably predict preference for the solvable over neutral conditions. Identification of the individual difference variables that predict sense-making might allow identification of those that are most at risk for maladptive sense-making. Although prediction is not the ultimate goal for clinical psychologists, tools that allow accurate prediction can also inform our understanding of what establishes and maintains engagement of these behaviors at both adaptive and maladaptive levels.

For example, previous researchers have highlighted the role of intolerance of ambiguity and need for predictability as an individual difference variable that might influence decision making and other forms of behavior. Kruglanski and Webster (1996) have defined the concept of Need for Cognitive Closure as individuals' desire for a firm answer to a question and an aversion toward ambiguity. The associated self report measure, the Need for Closure Scale (NCFS), has been shown to be associated with psychopathological populations and non-clinical populations that are at risk for certain clinical problems such as trait anxiety (Colbert, Peters, & Garety, 2006). Personality constructs such as need for closure and neuroticism may predict who is more likely to engage in rigid making sense behavior because it is highly reinforcing, and which individuals may overlook competing reinforcing consequences in certain contexts.

Furthermore, Gergen and Gergen (1988) suggest that coherent self-narratives are essential in establishing credibility in the social community and in maintaining relationships. Individuals likely vary in the extent to which social interaction is rewarding to them, and many clinical problems are defined in part by the extent to which individuals rely on relationships. For example, many DSM-IV-TR defined Axis II disorders are characterized by an over (e.g., Dependent, Borderline, and Histrionic Personality

Disorders) or under (e.g., Schizoid and Antisocial Personality Disorders) reliance on relationships. As such, the importance of reinforcement from social interaction might alter the extent to which making sense might function as a positive reinforcer among individuals.

In addition to individual difference variables, relevant contextual variables could greatly improve our understanding of sense-making as a reinforcer. For example, the presence of a verbal community or a monetary reward might increase the likelihood that positively reinforcing functions would prevail. In contrast, time constraints or punishment for incorrect answers might increase the likelihood that negatively reinforcing functions would be operating. In short, at this time, both the individual variables and the contexts that influence making sense require much empirical attention and would provide windows into the environmental determinants of sense-making.

Conclusion

In summary, sense-making has been shown to be a reinforcer. A thorough understanding of the consequences that maintain sense-making may provide a more efficient and effective definition. The proliferation of terms used to describe making sense highlights the importance of a functional definition. While much work remains before a thorough understanding of the role of reinforcement in sense-making is achieved, defining making sense functionally as two distinct behaviors when it is being maintained by positive versus negative reinforcement holds promise in both basic and especially, in clinical psychology domains.

Appendix

Awareness based on participant verbal report across Program 1, 2 and 3

ID #	*What differences did you notice b/t S and U?*	*Aware?*	*Most*	*1st*	*Favorite*
314	She had more trouble with S, didn't get as many right	N	N	N	N
315	They both had different pictures, in U one top picture did not have a match	N	S	S	N
316	No differences besides people	N	N	N	N
317	Can't remember	N	S/N	S	S
318	S you could tell and U was inconsistent	Y	S	N	N
319	Couldn't figure out S and in U saw pattern then it changed	Y	S	N	U
320	U was easier	N	S	S	U
321	No differences besides people	N	N	S	N
322	Started figuring out U, S was really frustrating	N	S/N	S	N
323	U was only correct if picture was on the right side	N	S	N	S
324	More men on U	N	N	N	U
325	S was mostly smiles and head, U was features	N	U	S	S
326	U was organized in a way that was not coherent	N	N	N	S
327	S was friends, U was families	N	S	S	U
328	S matches consistent, U varied	Y	NP	S	S
331	Different People, thought there was a pattern in U	N	U	S	U
332	S had more similar matches, a better pattern	Y	N	S	N
333	Different sets of faces	N	U	S	S
334	U was figured out easier then S, but didn't see too much differences	N	N	S	U
335	Different people between them	N	N	U	N
336	S was easier to figure out then U	N	N	S	N
337	I don't know	N	N	S	N
338	No difference aside from people	N	N	U	N
339	Different people, different relations	N	N	U	N
340	U top picture would match with several choices	N	S	U	U

Appendix (cont.)

341	Nothing really	N	N	U	S/U
342	Same concepts with different people	N	N	U	N
343	The people	N	N	S	N
344	Different people	N	N	S	N
345	Different people	N	N	S	S
346	S was easier to understand because of feedback	N	N	S	N
347	The people in U, Ryan was inconsistent	N	N	S	N
348	Different people	N	S	S	S
349	Sets of faces and names	N	N	S	N
350	U had the same pictures on top more often	N	N	U	S
373	Just different correct answers, U was harder	N	S	S	S
374	Pics were different, in S 2 pics paired, U changed depending on the top pic	N	U	N	S
375	Different context letters and pictures	N	S	S	U
377	U was easier to figure out with contextual letters	N	N	S	U
378	Different pictures different contextual letters	N	S/U	U	N
379	S was more complicated then U, harder patterns	N	N	S	N
380	I don't really remember	N	U	S	S
381	Different letters and pictures	N	N	S	N
382	S was more pixilated	N	S/N	N	N
383	Different patterns, U was easier to identify	N	S	N	U
385	S was more visual than U	N	S	S	S
388	I don't know	N	N	N	N
389	U had more options then S	N	N	N	N
390	Just the context letters	N	S/N	S	S
391	They had different pictures	N	N	N	N
392	U was inconsistent sometimes	Y	N	N	S
393	Whatever you got right or wrong in S would be right or wrong in U	Y	S	S	S

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