Journal of Abnormal Psychology
2002, Vol. 111, No. 4, 598–609

0021-843X/02/$5.00 DOI: 10.1037//0021-843X.111.4.598

Modeling Individual Differences in Perceptual and Attentional Processes Related to Bulimic Symptoms

Richard J. Viken, Teresa A. Treat, Robert M. Nosofsky, Richard M. McFall, and Thomas J. Palmeri
Indiana University

Attentional and perceptual differences between women with high and low levels of bulimic symptoms were studied with techniques adapted from cognitive science. Stimuli were pictures of young women varying in body size and facial affect. A multidimensional scaling analysis showed that the high-symptom women were significantly more attentive to information about body size and significantly less attentive to information about affect. In prototype classification tasks, the high-symptom women used significantly more information about body size and significantly less information about affect. There were strong associations between individual differences in attention in the similarity task and decision making in the classification tasks. The study shows the potential utility of cognitive science methods for the study of cognitive factors in psychopathology.

Bulimia nervosa is a serious behavioral health problem characterized by frequent bouts of uncontrollable binge eating, excessive reliance on compensatory weight-control strategies (e.g., vomiting, laxative use, intensive exercise), and an overemphasis on one's body shape and weight in self-evaluations. Research on bulimia, influenced by the "cognitive revolution" in clinical psychology, increasingly has focused on (a) the role of cognitive factors in the development and maintenance of bulimic symptoms and (b) the development of effective cognitive–behavioral treatments for these symptoms (e.g., Cooper, 1997; Mizes & Christiano, 1995; Williamson, Muller, Reas, & Thaw, 1999). Treatment research, however, has tended to overrun the foundational knowledge coming from the basic etiological research. The present study attempts to advance basic research on the role of cognitive processes in bulimia by using theoretical constructs and methods adapted from cognitive science.

Cognition and Bulimia

According to Cooper (1997), most clinical theories of the role of cognition in bulimia can be traced to Garner and Bemis's (1982) cognitive–behavioral model of anorexia, which was based, in turn, on Beck's (Beck, Rush, Shaw, & Emery, 1979) cognitive theory of depression. Garner and Bemis's model asserted that anorexia is maintained by distorted automatic thoughts, core beliefs, and underlying assumptions about weight, shape, food, and eating. Fairburn, Cooper, and Cooper (1986) extended Garner and Bemis's anorexia model to an analysis of bulimia, taking the view that preoccupation with shape and weight is central in bulimia.

Vitousek and colleagues (Vitousek, 1996; Vitousek & Hollon, 1990) proposed a schema-based account of cognition's role in eating disorders. In their model, symptomatic behavior is maintained by "*organized cognitive structures (schemata)* around the issues of *weight* and its *implications for the self* that influence . . . perceptions, thoughts, affect, and behavior" (Vitousek & Hollon, 1990, p. 192). Self- and weight-related schemata (and their interactions) are assumed to serve organizing and simplifying functions for the individual. Symptoms are maintained through schema-consistent processing of information, which guides bulimics' *attention* to and *classification* of shape-, weight-, and eating-related information. The Vitousek et al. approach is of particular relevance to the current study, because they assumed that schemas are not necessarily accessible through introspective self-reports (see also Williamson et al., 1999). They recommended using performance-based methods, borrowed from cognitive psychology, to assess cognitive processing consistent with the existence of these schemata.

Support for the role of beliefs, assumptions, and automatic thoughts in maintaining bulimic behaviors has come from experimental evidence that women with eating disorders are more likely than control participants to report distorted and negative beliefs, automatic thoughts, self-statements, and assumptions about shape, food, weight, eating, and themselves (e.g., Cooper, 1997; Cooper & Hunt, 1998; Mizes & Christiano, 1995; Williamson et al., 1999; Zotter & Crowther, 1991). Experimental manipulations designed to elicit negative weight- and body-related emotions also have yielded support for the hypothesized pattern of self-reported thoughts. For example, bulimics reported more negative affect and negative eating-, weight-, and body-related thoughts than controls when asked to describe their cognitions while looking at themselves in a mirror, while eating or drinking something caloric or fatty, or while weighing themselves (Bonifazi & Crowther, 1996; Cooper, Clark, & Fairburn, 1993; Cooper & Fairburn, 1992b).

Although the results of research on beliefs, thoughts, and preoccupations generally have been consistent with theoretical expec-

Richard J. Viken, Teresa A. Treat, Robert M. Nosofsky, Richard M. McFall, and Thomas J. Palmeri, Department of Psychology, Indiana University.

Teresa A. Treat is now at the Department of Psychology, Yale University. Thomas J. Palmeri is now at the Department of Psychology, Vanderbilt University.

We appreciate the assistance of Kelly Graf in data collection.

Correspondence concerning this article should be addressed to Richard J. Viken, Department of Psychology, 1101 East 10th Street, Bloomington, Indiana 47405-7007. E-mail: viken@indiana.edu

tations, the overwhelming reliance on self-report of cognition has been a limitation of this work. One problem with self-reported cognition is shared method variance or criterion contamination in the measures. It is not surprising, for example, that participants who report preoccupations with body shape, weight, eating, and food on diagnostic instruments also are found to be more likely to self-report on cognitive measures that they are troubled by thoughts, beliefs, and assumptions related to shape, weight, eating, and food (Vitousek & Hollon, 1990). Research on cognitive factors in eating disorders would be strengthened if symptomatology and cognition were assessed by procedures that share little or no method variance.

Research on self-reported cognition has also assumed that pathological beliefs, assumptions, and automatic thoughts are accessible through verbal self-report measures. This assumption may be reasonable when concurrent "think aloud" or event-sampling techniques are used and the contents of consciousness are of interest. However, self-reported cognitions usually are assessed retrospectively, and many cognitive theories of psychopathology posit cognitive processes that operate outside of conscious awareness. The retrospective self-report methods common in clinical research contrast sharply with the methods and assumptions of most contemporary cognitive scientists, who avoid the use of self-reported cognition, in part on the basis of evidence that humans can perceive and organize information, make and execute decisions, and learn without awareness (Lang, 1988; MacLeod, 1993; Nisbett & Wilson, 1977; Williams, Watts, MacLeod, & Mathews, 1997; Wilson, 1994). Most cognitive scientists focus on cognitive processes such as perceptual organization, classification, learning, and memory, all of which are assumed to be assessed most accurately through performance-based measures that sample cognitive processing directly (McFall, Treat, & Viken, 1997, 1998).

Toward Performance Measures of Cognition in Bulimia

Over the past 15 years, researchers increasingly have used performance-based methods to assess relationships between bulimic behaviors and cognitive processes, particularly attention and memory. An emotional Stroop paradigm (Williams, Mathews, & MacLeod, 1996), for example, often has been used to investigate attentional processes. When compared to control participants, women reporting bulimic behaviors tend to take longer to name the color of body-, weight-, and eating-related words than neutral words; the strength of this effect is correlated with the severity of the eating problem; and these differences diminish with effective treatment (Cooper, Anastasiades, & Fairburn, 1992; Cooper & Fairburn, 1992a, 1994; although, see Black, Wilson, Labouvie, & Heffernan, 1997, for conflicting results).

Other researchers have examined attentional processes using variations on a dichotic-listening paradigm. In one study (Schotte, McNally, & Turner, 1990), for example, bulimic and control participants repeated aloud a passage presented to one ear while a distractor passage was presented to the other ear. As predicted, bulimics detected the word "fat" more frequently than the word "pick" in the distractor channel, whereas controls detected these words with equal probability. Finally, there is evidence of memory biases in women reporting symptoms of eating disorders consistent with their presumed attentional processes. Typically, eating disordered women are found to have better recall of food- or fat-related stimuli than neutral stimuli, whereas controls show similar recall of both stimulus types (Baker, Williamson, & Sylve, 1995; Hermans, Pieters, & Eelen, 1998; Sebastian, Williamson, & Blouin, 1996).

Performance tasks like the Stroop and the dichotic listening task enrich the study of cognitive factors in eating disorders by moving beyond introspective self-report. Once the decision is made to develop performance measures, however, clinical scientists should avail themselves of the rich array of concepts, tasks, and analytical techniques that cognitive scientists have developed for characterizing cognitive processes such as perceptual representation, classification, learning, memory, and decision making. If we are to understand the role of cognitive factors in psychopathology, it will be important to study individual differences in the full range of processes that are known to be important in cognitive functioning. For example, Stroop-type tasks suggest that in eating disordered subjects, food- or weight-related stimuli may disrupt attention to other information on a time scale of milliseconds. However, more enduring differences in allocation of attention, perceptual organization, categorization, learning, and memory also should play a role, and cognitive science has well-developed methods for studying each of these. Although cognitive science methods traditionally have been used to study normative processing of simple, artificial stimuli, there is no reason, in principle, why clinical scientists could not use these same methods to study the links between individual differences in cognitive processing of complex social stimuli, on the one hand, and the symptoms of clinical disorders, such as bulimia, on the other hand.

Cognitive Science Methods for Assessing Perceptual Organization

Perceptual Organization

Multidimensional scaling (MDS) is an analytic technique that cognitive scientists use to assess (among other things) the organization, or structure, of participants' perceptions of a defined stimulus set and the attention that participants allocate to different aspects of the stimuli (Ashby, 1992; Nosofsky, 1992b). Clinical and social researchers have suggested that MDS may be useful, as well, for assessing the cognitive characteristics that underlie various clinical disorders (Jones, 1983; Rudy & Merluzzi, 1984; Treat, McFall, Viken, & Kruschke, 2001; Vitousek & Hollon, 1990). For example, MDS has been used to evaluate differences in the organization of alcohol expectancies for heavy and light drinkers (Rather & Goldman, 1994). To date, however, clinical researchers typically have used MDS techniques in an exploratory fashion, hoping to reveal unknown latent structures. Clinical investigators have not used MDS as cognitive scientists typically do, to test predictions about participants' perceptions of stimuli that vary in predetermined ways on theoretically relevant dimensions.

In cognitive science, the inputs to an MDS analysis typically are participants' ratings of the similarity of all possible pairs of items in a carefully designed stimulus set. The outputs are multidimensional spatial representations, or maps, of participants' perceived structure of the relationships among the stimuli. The top panel of Figure 1 presents an idealized MDS solution for participants' perceptions of a set of 24 stimuli (photos of women) that varied

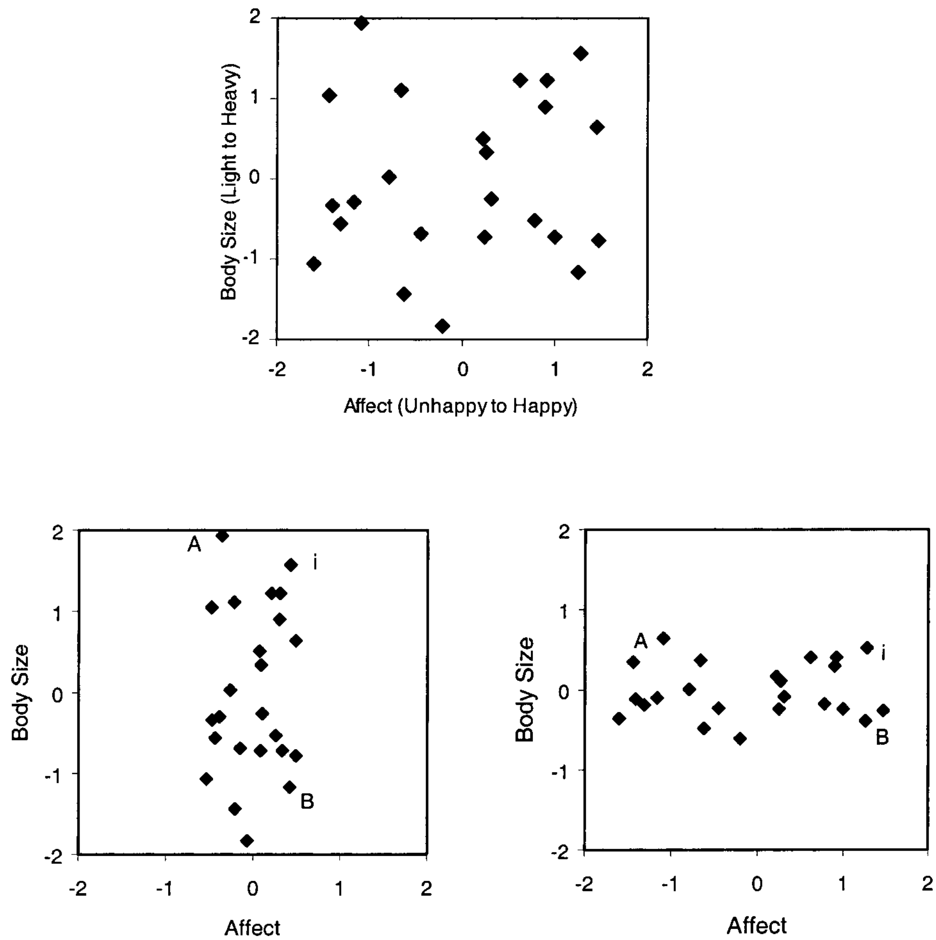

Figure 1. Depiction of idealized scaling solution (in upper panel) and idealized perceptual organizations for body-size- and affect-oriented participants (in lower left and right panels, respectively).

systematically along two dimensions: the women's facial affect (happy to sad) and their body size (heavy to light). In this two-dimensional mapping of participants' "psychological space," the distance between any two stimuli is inversely related to participants' perception of their similarity; stimuli scaled closer together on one dimension are perceived by participants to be more similar on that dimension.

Weighted MDS (WMDS, also known as the INDSCAL model; Carroll & Chang, 1970) is a variant of MDS that represents information about individual differences in perceptual organization. WMDS assumes that all participants have a shared perception of the *relative* position of stimuli along a specified set of stimulus dimensions. Within this group configuration, however, the WMDS algorithm also allows individuals to stretch or shrink the *absolute* distances among the stimuli. Thus, WMDS captures the differential attention weight, or importance, that each participant attaches to each of the underlying stimulus dimensions. In other words, WMDS estimates participant-specific attention weights for each dimension in the group's shared multidimensional space. The assumption of a shared perceptual space is not as restrictive as it might seem, because individual participants may have attention weights of zero for particular dimensions. Through the use of attention weights of zero, the inclusive group space can accommodate the perceptions of diverse individuals who have no overlap in their perceptions of the relative position of stimuli (i.e., no overlap in the dimensions for which they have nonzero attention weights). The bottom panel of Figure 1 illustrates two contrasting patterns of attention weights for a group configuration, as might be revealed by WMDS (the reader should ignore the A, B, and *i* designations for now). The plot on the left depicts a perceptual organization for a participant with an extreme "body-size orientation." This participant's attention weights reflect a stretching of the body-size dimension and a shrinking of the affect dimension. This perceptual organization emphasizes differences between heavy and light stimuli while minimizing differences between happy and sad stimuli. In contrast, the plot on the right illustrates the perceptual organization of a participant with an extreme "affect orientation." This participant's attention weights reflect a stretching of the affect dimension and a shrinking of the body-size dimension. This perceptual organization emphasizes differences between happy and sad stimuli while minimizing differences between heavy and light stimuli.

Because WMDS captures individual differences in participants' attention to stimulus dimensions of interest (e.g., body size vs.

affect), it allows us to array participants according to their perceptual organizations. At one extreme, for example, are the body-size-oriented participants who base their similarity ratings almost entirely on body-size information; at the other extreme are the affect-oriented participants who base their ratings almost exclusively on affect information. Between these two extremes are participants who use both body-size and affect information. "Flattened subject weights" (FSW) provide a quantitative index of each participant's *relative* attention to the two stimulus dimensions. In the present study, for example, negative FSWs were associated with greater relative attention to body size. We predicted that participants with high levels of bulimic symptoms would attend more to body-size information and less to affect information, relative to controls, and therefore would have more negative FSWs. A more complete description of MDS models can be found elsewhere (Treat et al., 2002).

Interrelatedness of Cognitive Processes

Formal information-processing models in cognitive science portray perceptual organization as a critical determinant of the cognitive processes that presumably lie "downstream" in the system. Research has shown, for example, that MDS-derived representations of participants' perceptual organizations can be used to predict performance on tasks designed to assess such downstream processes as classification, learning, and memory (Kruschke, 1992; Nosofsky, 1986, 1987, 1992a; Nosofsky, Kruschke, & McKinley, 1992). The present study used WMDS estimates of each participant's perceptual organization to predict subsequent performance on two prototype classification tasks. In classification tasks, participants typically are instructed to place each member of a set of stimulus items into one of two or more categories, each represented by a label or prototypic exemplar (Cohen & Massaro, 1992). In the present study, for instance, participants were instructed to classify each of 22 stimuli (photos of women) as one of two types: Type A, represented by a photo of a happy, light woman; or Type B, represented by a sad, heavy woman. Thus, participants could base their classification decisions on affect, body size, or some combination of these attributes (or any other attribute that participants perceived as differentiating the two prototypes). Participants later repeated this classification task with two new category prototypes (Type X, a happy, heavy woman; Type Y, a sad, light woman). In classification tasks, it is common to distinguish two types of individual differences: differences in response bias (an overall tendency to classify stimuli with one prototype or the other) and differences in sensitivity to stimulus information. In the example above, bias would be reflected in a tendency to classify more (or less) than the average number of stimuli as Type A. Sensitivity to affect would imply that the participant consistently classified happy stimuli as Type A and sad stimuli as Type B. Sensitivity to body size would imply that the subject consistently classified light stimuli as Type A and heavy stimuli as Type B. We expected that sensitivity to body size and affect in the classification tasks should be correlated with attention to the same attributes in the similarity task.

We used a utilization coefficient procedure (Macho, 1997) to evaluate whether participants' classifications were relatively more sensitive to body size or to affect. In individual analyses for each participant, the 22 classification stimuli were treated as cases. Participants' classification judgments were regressed on the standardized affect and body-size norms for the stimuli. The resulting regression coefficients reflected the probability of classifying a stimulus into the two categories as predicted by stimulus values on affect or body size. For instance, a participant who classified stimuli only on the basis of affect would receive a large positive regression coefficient for affect and a very small coefficient for body size.

We also fit Nosofsky's (1987) weighted prototype model of classification to participants' judgments in these classification tasks. The weighted prototype model predicts the probability of classifying a particular stimulus into a given prototype category. In our classification tasks, for example, the model allowed us to predict the probability that Participant S would place photo *i* in Category A (or B). According to the model, the probability of placing stimulus *i* in Category A is a function of the similarity of stimulus *i* to the Type A prototype, relative to its similarity to the Type B prototype. To get an intuitive grasp of the model's predictions, consider Figure 1 again. The bottom panel presents the idealized perceptual organizations for body-size-oriented and affect-oriented participants (on the left and right, respectively). Both graphs also show the locations of stimulus *i* (a happy, heavy woman) and Prototypes A (a sad, heavy woman) and B (a happy, light woman). Note that the coordinates of the two prototypes (A and B) differ along both the affect and body-size dimensions. Stimulus *i* is closer to (i.e., is perceived as more similar to) Prototype A than Prototype B in the psychological space on the left; however, it is closer to Prototype B in the space on the right. Assuming no response biases (i.e., no systematic difference in the unconditional probabilities of giving A or B responses), the model predicts that the body-size-oriented participant is more likely to classify stimulus *i* in Category A and that the affect-oriented participant is more likely to classify stimulus *i* in Category B. That is, the body-size-oriented participant will classify the happy, heavy stimulus with the heavy prototype, whereas the affect-oriented participant will classify the same stimulus with the happy prototype.

This study evaluates three primary research questions: Do bulimic (high-symptom) participants show greater differential attention to body-size as opposed to affect information, when compared to control participants? Second, do bulimic participants show greater use of body size as opposed to affect information in classification, when compared to control participants? Third, do individual differences in attention and classification converge across tasks designed to assess these cognitive processes in accordance with formal mathematical models of similarity and classification? The study not only tested our theoretical predictions about the links between perceptual organization and classification but, at a more general level, it also evaluated the utility of adapting concepts and methods from cognitive science to study clinical problems.

Method

Participants

Three hundred fifty-five women enrolled in introductory psychology voluntarily completed the Bulimia Inventory (BULIT; Smith & Thelen, 1984), a 36-item questionnaire assessing symptoms of bulimia. The BULIT has been shown to have a high reliability (.87) across a 2-month period and good predictive validity with regard to independent interview-based diagnoses (Smith & Thelen, 1984; Welch & Hall, 1989). Women with BULIT scores >88 (the cutoff recommended by Smith and Thelen for screening purposes) were considered to be high in bulimic symptoms and to satisfy our criterion for subclinical bulimia. Women with BULIT scores less than 45 were considered to be low in bulimic symptoms and were identified as prospective controls. Women in these bulimic and control groups subsequently were contacted by phone and invited to participate in a laboratory study in exchange for course credit. Thirty-eight of these women (18 bulimics and 20 controls) completed the laboratory procedures 2 to 4 weeks after the screening. The average age of these participants was 23.18 years (SD = 7.27).

Self-Report Measures

In addition to completing the BULIT during screening, all laboratory participants completed the Eating Attitudes Test (EAT; Garner, Olmsted, Bohr, & Garfinkel, 1982), a 26-item questionnaire covering a broad range of eating disorder symptoms that has shown good criterion validity in predicting eating disorder diagnoses (Garner et al., 1982; Mintz & O'Halloran, 2000), and the Beck Depression Inventory (BDI; Beck, Rush, Shaw, & Emery, 1979). They also reported their height and weight, from which a body mass index (BMI: kg/m^2) was computed for each participant.

Experimental Stimuli

Stimuli were 24 pictures of paid female models recruited from the university population. Each model was photographed under uniform conditions: at a fixed distance; with standard lighting; standing erect, facing the camera; in front of a fixed background; in similar clothing (white short-sleeved t-shirt, black stretch pants, white socks); with minimal make-up; and with hair pulled back from the face. This standardization helped narrow the variability among the models to differences on two stimulus dimensions of primary theoretical interest: the models' body size and facial affect. Body size was chosen because perception of body shape has been a focus of past cognitive research with eating disorders. Body size was allowed to vary naturally. Facial affect was chosen because it is broadly relevant to accurate social perception and is not specifically associated with perceptual processes in eating disorders. Variability in facial affect was manipulated; each model was instructed to display a range of facial expressions, from very sad to very happy, and several photos of each model were taken. This yielded a large pool of photos from which the investigators selected for further evaluation 45 pictures with sufficient variation on the target dimensions and good technical quality.

A normative sample of 29 undergraduate women rated these 45 photos on two 10-point scales: body size (1 = *underweight,* 10 = *overweight*), and affect (1 = *unhappy,* 10 = *happy*). On the basis of mean normative ratings for each stimulus, the investigators selected a final stimulus set of 24 photos of 24 different women, representing the full two-dimensional space of body size and affect. Stimulus selection was based on the goals of ensuring substantial variation on the target dimensions of body size and affect, retaining only one photo from each model, and keeping the body-size and affect dimensions approximately orthogonal in the final stimulus set. The correlation between the normative ratings of affect and body size in this final set was near zero.

Similarity Ratings Task: Measuring Perceptual Organization

On arriving in the laboratory, participants were seated comfortably in front of a computer. They received the following on-screen instructions for the similarity rating task:

> In the first part of the experiment you will be making judgments about the similarity of women depicted on the computer. Pictures of the women will appear in pairs. In some pairs, the women may seem very similar to one another. In other pairs, they may seem very different. You will make a judgment of the similarity of the women on a scale ranging from *very different* (1) to *very similar* (10). The scale will be displayed below the pictures so you can remember it. Enter your response on the keyboard. Try to use the whole scale (1–10) as you find that it applies to the similarity of the women.

Participants viewed the 276 unique pairs of the 24 photos, and rated the similarity of each pair. The pairs were presented in random order with the constraint that no stimulus was shown in two consecutive pairs. Position of each stimulus in the pair (right or left) was also randomly assigned.

Prototype Classification Tasks

After completing the similarity rating task, participants performed two classification tasks. In the first, the computer screen displayed a pair of stimulus photos. One depicted a woman with normative ratings toward the extreme *light* end of the body-size dimension and toward the extreme *happy* end of the facial-affect dimension. This woman was presented as the prototype for Type A women (*light–happy*). The second photo depicted a woman with normative ratings toward the extreme *heavy* and *unhappy* ends of the body-size and facial-affect dimensions. This woman was presented as the prototype for Type B women (*heavy–unhappy*). The only descriptors shown to the participants were Type A and Type B.

After allowing participants to inspect the two prototypes, a third stimulus was displayed in the center of the screen; smaller versions of the prototypes were presented on either side so that participants could refer to them if necessary. Participants were asked to classify the larger, middle stimulus either as a Type A or Type B woman. This classification task was performed for each of the 22 nonprototype stimuli; then it was performed a second time with the same prototypes but with the 22 stimuli presented in a new random order. Because the prototypes differed in both body size and affect, participants' classifications might be influenced by either attribute. For instance, if a classification stimulus showed a *light–unhappy* woman, participants would have to choose between classifying this stimulus as Type A (*light*–happy) or as Type B (heavy–*unhappy*).

The second classification task was patterned after the first, except that it presented participants with two new prototypes: Type X (*heavy–happy* woman); and Type Y (*light–unhappy* woman). Again, participants classified each of 22 stimuli as either Type X or Type Y and then repeated these classifications with the same stimuli presented in a new, random order.

Self-Report Measures

After the second classification task, participants rated on 100-point scales how important each of seven attributes had been to their judgments in the earlier similarity ratings task (1 = not important, 100 = very important). One attribute was body size; the anchors for this attribute were *overweight* and *underweight.* A second attribute was facial affect; the anchors for this attribute were *happy* and *unhappy.* The other five attributes were included to disguise our focus on these two attributes. Participants were told that their ratings, across the seven attributes, did not need to sum to 100. Finally, participants completed the EAT measure of eating disorder symptoms and the BDI measure of depressive symptoms.

Results

Similarity Ratings Task

Because we were using WMDS to test specific hypotheses about perceptual differences in a highly structured stimulus set, we imposed the dimensional structure of the stimuli based on the average normative ratings of body size and affect. The two-dimensional array of normative ratings for the 24 stimuli is depicted in the top panel of Figure 1. The input data were the similarity ratings made by each subject for each of the 276 unique pairs of stimuli. Only attention weights for body size and affect were estimated in the analysis. Each participant received a separate attention weight for affect and for body size, indicating the importance of each dimension to the participant's similarity ratings.

Attention weights reflect both the direction and the magnitude of perceptual influences. A large attention weight can reflect either high relative or high absolute attention to a particular dimension. A purer indicator of relative attention is the *flattened subject weight* (FSW), which is calculated by normalizing attention weights first within participants, and then across participants (Young & Lewyckyj, 1996). In the case of our two dimensional space, the normalization or "flattening" procedure transforms the affect and body-size attention weights into a single index of relative attention, in which positive values indicate greater attention to affect and negative values indicate greater attention to body size.

The overall multiple correlation squared for the WMDS solution was .54, indicating that 54% of the variance in participants' scaled similarity judgments could be accounted for by the norm-based distances among the stimuli in the two-dimensional (body size and affect) space, combined with individual attention weights for each participant for the two dimensions.[1] The explained variance was approximately equally due to the affect (52%) and body-size (48%) dimensions. Compared with the control group, the bulimic group showed significantly lower attention weights for affect, $t(36) = 2.47$, $p = .02$, Cohen's $d = .75$, and significantly higher attention weights for body size, $t(36) = -2.18$, $p = .04$, $d = .67$. The greater attention to body size, relative to affect, in the bulimic group was reflected in significantly lower participant flattened weights, ($M = -.39$), $t(36) = 2.35$, $p = .02$, $d = .72$, when compared with the control ($M = 0.35$) group. Figure 2 shows the group differences in affect and body-size attention weights.

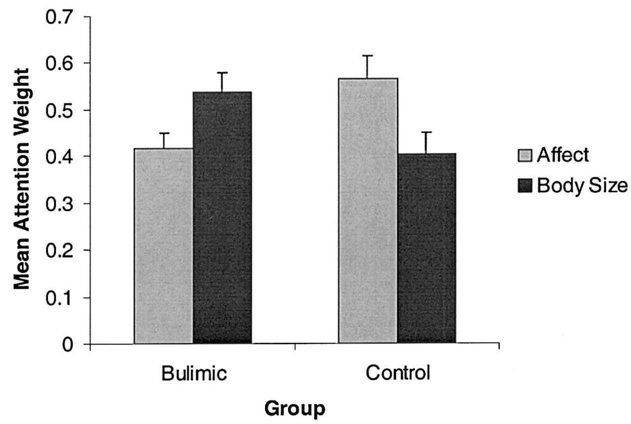

Figure 2. Average affect attention weights and body-size attention weights ($\pm SE$) for the bulimic and control groups.

Prototype Classification Tasks

To evaluate individual differences in performance on the prototype classification tasks, we computed utilization coefficients (Macho, 1997) for affect and body size. In separate multiple regression analyses for each participant on each of the two classification tasks, the participant's average classification judgments for each stimulus were regressed on the standardized affect and body-size norms for the stimuli. Each stimulus was classified twice, so the probability of any given participant classifying a stimulus with Prototype A was 0, .5, or 1.0. The slope estimates from these analyses reflect the change in the probability of classifying a stimulus into a particular category that can be predicted by the normative stimulus values for affect or body size. For instance, each participant's slope (or utilization coefficient) for affect reflects the expected increase in the probability of classifying a stimulus with the high-affect prototype for every unit increase in the normative value of affect for the stimulus. A coefficient of .30, for example, would mean that the probability that a stimulus will be classified with the high-affect stimulus (this probability ranges from 0 to 1.0) would increase by an absolute .30 with each unit increase in the standardized norms for affect. Note that we used the individual regression coefficients as descriptive summaries of each participant's classifications, not as inferential statistics. These individual values then were entered into the group level inferential analyses using participants as cases.

Utilization coefficients for affect and body size were evaluated in two separate Group × Task (Task 1 or Task 2) analyses of variance (ANOVAs). The ANOVA for affect utilization found a significant effect for group, $F(1, 36) = 8.72$, $p < .01$, $\eta = .44$, indicating that the control group used information about affect in making classifications significantly more than the bulimic group. There also was a significant effect of task, $F(1, 36) = 28.25$, $p < .001$, $\eta = .66$, indicating that both groups used affect information more in the second task. Analysis of utilization coefficients for body size revealed a significant effect of group, $F(1, 36) = 4.44$, $p < .05$, $\eta = .33$, indicating that the bulimic group used significantly more information about body size in classifying the stimuli than the control group did. Figure 3 shows the group differences on utilization of affect and body-size information in classification.

Formal Modeling of Classification

Weighted prototype classification model (Nosofsky, 1987). Although the model can be defined in one large equation, it is easier to understand as three related components. In this model, as in the

[1] The multiple correlation squared for an unconstrained (exploratory) WMDS model, which freely estimated both individual attention weights and stimulus coordinates for two dimensions, was .59. This represents a very modest increment in the variance explained relative to the constrained model (.54) given that the unconstrained model had 48 additional free parameters. This suggests that the constrained model was a reasonable approximation of the group perceptual space. The body-size norms correlated .96 with the stimulus coordinates for the first dimension of the unconstrained model, and the affect norms correlated .92 with the stimulus coordinates for the second dimension of the unconstrained model.

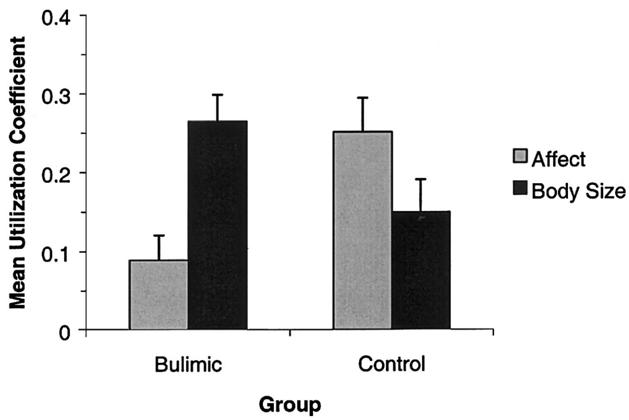

Figure 3. Average utilization coefficients for affect and body size (±*SE*) for the bulimic and control groups.

WMDS model, the distance between stimulus i and Prototype A, d_{iA}, is the weighted Euclidean distance between these two stimuli[2]:

$$d_{iA} = \left[\sum_{m=1}^{2} w_m (x_{im} - x_{Am})^2 \right]^{1/2} \quad (1)$$

In this equation, x_{im} is the position of stimulus *i* on Dimension m, x_{Am} is the position of Prototype A on Dimension m, w_m is a free parameter corresponding to the *salience* of dimension m (either affect or body size). The two dimensional saliences are constrained to sum to 1.0.

The weighted Euclidean distance from Equation 1, d_{iA}, is an important parameter in the second equation, where the perceived similarity of stimulus *i* to Prototype A, η_{iA}, is an exponentially decreasing function of the weighted Euclidean distance between these two stimuli. Thus, as the weighted distance d_{iA} increases, the perceived similarity *i* to A decreases. A new free parameter *c* indicates the overall *sensitivity,* or perceived dissimilarity, of the stimuli in general. As *c* increases, the overall perceived similarity of stimuli decreases (i.e., stimuli are perceived as more distinctive).

$$\eta_{iA} = e^{-cd_{iA}} \quad (2)$$

Finally, the perceived similarity of stimulus *i* to Prototype A, η_{iA}, which is a function of both the salience of individual dimensions (Equation 1) and overall sensitivity (Equation 2), is used to predict the category choices of the participants. The probability of classifying a particular stimulus *i* into the category represented by Prototype A, $P(A|i)$, is the weighted similarity of stimulus *i* to Prototype A, divided by the sum of the weighted similarities of stimulus *i* to Prototypes A and B:

$$P(A|i) = \frac{\beta_A \eta_{iA}}{\beta_A \eta_{iA} + (1 - \beta_A)\eta_{iB}} \quad (3)$$

In Equation 3, the similarities are weighted by a third free *response bias* parameter, β_A, which represents the relative use of the Type A classification response. β_A and β_B are constrained to sum to 1.0 (i.e., $\beta_B = 1 - \beta_A$), so β_A approximates .50 when no response bias is present.

Theoretical expectations. Note that the model distinguishes two aspects of sensitivity as considered in signal detection or utilization coefficient approaches. Salience refers to the relative influence of the different dimensions, whereas sensitivity refers to the overall discriminability of the stimuli across dimensions. We expected that body-size information would be more salient to the bulimic group than to the control group, whereas affect information would be more salient to the control group than the bulimic group. Therefore a group-specific salience parameter should be necessary to account for group differences in classification. Group-specific estimates of the response bias and sensitivity parameters should not be necessary.

Model fits. The model was fit to the classification probabilities for each stimulus (probability of being classified with Prototype A or Prototype B) averaged across the individuals in each of the groups. These probabilities range continuously from 0 to 1.0. Log likelihood (LL) was maximized,[3] using multiple initial parameter estimates; root-mean-squared deviation of the predicted from the observed classification probabilities (RMSD) and squared correlation (r^2) also were calculated. A likelihood ratio chi-square (χ^2) test comparing the model with no group-specific parameters to each of the other models can be computed as twice the difference in log likelihoods for the models. Table 1 presents the results for four models for both classification tasks. The first model estimates three parameters and contains no group-specific parameters; this model accounted for 83.7% and 71.3% of the variability in the classification probabilities on the first and second classification tasks, respectively. The second, third, and fourth models estimate four parameters each, by providing group-specific estimates of the salience, response bias, and specificity parameters, respectively. Each of the four-parameter models can be compared with the more restrictive three-parameter model that is nested within them, to see if the addition of the group-specific parameter improves fit. Consistent with our expectations, the fit indices indicated that addition of the group-specific salience parameter resulted in a substantial improvement in fit for both Task 1, $\chi^2(1) = 54.02$, and Task 2, $\chi^2(1) = 121.70$, whereas the group-specific sensitivity parameter had a more modest effect, and the group-specific bias parameter had almost no effect.

Parameter estimates for the best-fitting, group-specific salience models, presented in Table 2, were consistent with our expectations. On both tasks, body size was more salient for the bulimic than the control group, and affect was less salient for the bulimic than for the control group. As saliences for body size and affect

[2] Models assuming a city-block distance metric also were fit to the data, but they fit less well than models assuming a Euclidean metric. This discrepancy in fit is consistent with our intuition that body size and affect are perceived in a more holistic, and less separable, fashion (Nosofsky & Palmeri, 1996; Shepard, 1964).

[3] Log likelihood was maximized, using the formula below (Nosofsky, 1989, p. 289), in which i refers to the stimulus (1–24), j is the prototype category (A, B, X, or Y), N_i is the frequency with which i is presented, f_{ij} refers to the observed frequency with which i is classified into Category j, and p_{ij} refers to the predicted probability with which i is classified into Category j.

$$LL = \sum_i \ln N_i! - \sum_i \sum_j \ln f_{ij} + \sum_i \sum_j f_{ij} \times \ln p_{ij} \quad (4)$$

Table 1
Model-Fitting Results for Prototype Classification Tasks

Measure	Group-specific parameter: None	w_{AFF}	β_A	c
Task 1				
r^2	.84	.91	.84	.84
RMSD	.12	.09	.12	.12
LL	−159.78	−132.77	−159.59	−156.91
χ^2		54.02*	.19	5.74*
Task 2				
r^2	.71	.88	.71	.74
RMSD	.16	.11	.16	.16
LL	−209.26	−148.41	−209.26	−203.18
χ^2		121.70*	0.0	12.16*

Note. Columns correspond to models with no group-specific parameter or with a single group-specific parameter reflecting salience for affect (w_{AFF}), bias for response A (β_A), or overall sensitivity (c). Fit indices: r^2 = explained variance; RMSD = root-mean-squared deviation of predicted from the observed classification probabilities; LL = log likelihood; χ^2 = likelihood ratio comparing the four-parameter models to the nested model with no group-specific parameter (df = 1).
* $p < .05$.

sum to 1.0 for each group, these comparisons are not independent, but the direction of the differences is as expected. Little evidence of response bias was present on either task.

Correlational Analysis of Linkage Between Perceptual Organization and Classification

Table 3 shows the correlations between the MDS and the classification indices. Individual differences in attention to affect and body size, derived from the similarity task, correlated strongly and significantly with individual differences in the use of affect and body size in making classification judgments.

Self-Reported Cognition

The self-reported importance of body-size to the similarity ratings was significantly higher in the Bulimic group (M = 76.67, SD = 29.51) than in the control group (M = 54.5, SD = 39.67), $t(36) = 1.936$, $p = .03$. The bulimic group also showed a nonsignificant tendency toward reporting that affect was less important (M = 58.33, SD = 33.3), when compared to the control group (M = 75.00, SD = 29.82).

Table 3
Correlations Between MDS-Derived Attention Weights and Utilization Coefficients for Classification Tasks

Attention weight	Task 1: UC_{AFF}	Task 1: UC_{BS}	Task 2: UC_{AFF}	Task 2: UC_{BS}
$WMDS_{AFF}$	.79	−.78	.83	−.46
$WMDS_{BS}$	−.70	.80	−.74	.58
$WMDS_{FSW}$	.78	−.83	.81	−.55

Note. All correlations are significant at $p < .01$. MDS = multidimensional scaling. UC_{AFF} = utilization coefficient for affect, and UC_{BS} = utilization coefficient for body size; both are estimated for each subject in the classification tasks. $WMDS_{AFF}$ = affect attention weight, $WMDS_{BS}$ = body-size attention weight, and $WMDS_{FSW}$ = flattened subject weight; all are estimated for each participant in the WMDS analysis.

Association Between Cognitive Task Performance and Self-Report Measures

Table 4 presents the correlations between the cognitive tasks and the self-report measures. Although the groups were formed on the basis of the BULIT screening, performance on the cognitive tasks had somewhat stronger associations with the Dietary Restriction subscale of the EAT. Associations with the Bulimia subscale of the EAT were similar to those obtained with the BULIT. Neither the Oral Control subscale of the EAT nor the BDI correlated significantly with any of the cognitive variables. BMI was not associated with any of the cognitive variables.

Discussion

Our results demonstrate that women who have been differentiated on the basis of self-reported symptoms of bulimia show strikingly different behavior on perceptual and decision-making measures drawn from cognitive science. As predicted by cognitive theories of eating disorders (Vitousek & Hollon, 1990; Williamson et al., 1999), the perceptions and classification decisions of high-symptom women were influenced by body size significantly more, and by affect significantly less, than were the perceptions and decisions of controls. Individual differences in attentional indices derived from the similarity ratings task correlated strongly with individual differences in decision-making indices on the categorization task. It appears that the Bulimic and Control groups structured their perceptions of other women and applied those perceptions to classification tasks in very different ways. The results

Table 2
Parameter Estimates for Best-Fitting Models of Performance on Classification Tasks

Task	w_{BS}: Bulimics	w_{BS}: Controls	w_{AFF}: Bulimics	w_{AFF}: Controls	β_A	β_B	c
1	.87	.65	.13	.35	.55	.45	.62
2	.94	.67	.06	.33	.51	.49	.69

Note. w_{BS} = salience of body size; w_{AFF} = salience of affect ($1 - w_{BS}$); β_A = response bias for response A; β_B = response bias for response B ($1 - \beta_A$); c = specificity.

Table 4
Correlations Between Indices on Cognitive Tasks and Eating and Depressive Symptoms

Index	Group	BULIT	EAT subscale: Bulimia	EAT subscale: Diet	EAT subscale: Oral	BDI	BMI
$WMDS_{BS}$	.34*	.29	.42**	.49**	−.06	.15	−.02
$WMDS_{AFF}$	−.38*	−.30	−.36*	−.49*	.10	−.08	−.14
$WMDS_{FSW}$	−.37*	−.30	−.40*	−.50*	.09	−.12	−.06
UC_{BS} (1)	.40*	.39*	.37*	.47**	−.02	.17	−.15
UC_{BS} (2)	.16	.09	.07	.25	−.09	.09	−.08
UC_{AFF} (1)	−.44**	−.36*	−.35*	−.52**	.29	−.14	−.13
UC_{AFF} (2)	−.42**	−.38*	−.33*	−.49**	.16	−.12	−.10

Note. BULIT = Bulimia Inventory; EAT = Eating Attitudes Test; BDI = Beck Depression Inventory; BMI = body mass index (kg/m^2). $WMDS_{BS}$ = body-size attention weight, $WMDS_{AFF}$ = affect attention weight, and $WMDS_{FSW}$ = flattened subject weight; all are estimated for each participant in the WMDS analysis. UC_{BS} = utilization coefficient for body size, and UC_{AFF} = utilization coefficient for affect; both are estimated for each participant in the classification tasks. (1) or (2) = Classification Task 1 or 2, respectively.
* $p < .05$. ** $p < .01$.

suggest that the high-symptom women applied a kind of cognitive "filter" to their social perceptions such that they were more attentive to body-size differences than to differences in affect. The differential perceptions, in turn, were associated with differences in decision making, as reflected in categorization performance.

The strong link between attention and classification processes, as indicated by the congruence of participants' performances on the similarity ratings and categorization tasks, is consistent with numerous theories proposing shared underlying processes for the two tasks (e.g., Nosofsky, 1992a). Typically, however, these theoretical and measurement models have been used to evaluate normative processing of simple artificial stimuli. This study demonstrates the generalizability of at least one of these models, Nosofsky's weighted prototype classification model, to evaluation of individual differences in attention and classification, using complex, socially relevant stimuli. The model explained the bulimic and control groups' different classification patterns well, with the addition of a single, group-specific parameter. As expected, group differences in classification were associated with group differences in dimensional salience, rather than differences in bias or overall stimulus distinctiveness. Use of this formal modeling strategy allowed us to test our theoretical expectations rigorously and to evaluate competing models (e.g., a model incorporating group-specific bias estimates). The rich theoretical links between attention or classification and processes of learning and memory suggest that future work should focus on those topics as well.

The observed perceptual differences are consistent with those obtained in performance tasks like the Stroop (Cooper & Fairburn, 1992a; Fairburn, Cooper, Cooper, McKenna, & Anastasiades, 1991). Because the Stroop task reflects distractive effects of rapidly changing attention, and the current tasks reflect more sustained attentional effects on perceptual organization, it appears that several processes related to attention may differ in bulimic and control women. The similarity and classification tasks that we have used are at the heart of contemporary research in cognitive science, and they are embedded in the theoretical framework that is guiding basic research on cognition (Ashby, 1992). Basic research provides a kind of roadmap by which results from paradigms like these can be expanded into theoretically linked studies of memory processes (Nosofsky, 1992a), connectionist learning models (Kruschke & Johansen, 1999; Nosofsky et al., 1992; Treat et al., 2001), serial versus parallel processing (Townsend, 1990), automatic versus controlled processing (Shiffrin, 1988), and the link between perception and decision making (Ashby & Gott, 1988).

If the methods of cognitive science offer an extraordinary opportunity for clinical assessment, the study of applied problems also offers benefits to cognitive science. Cognitive theories and methods frequently have been based on the processing of simple, abstract stimuli. Application to the complex and representative stimuli demanded by clinical research can demonstrate the generalizability of these theories and methods. Clinical research also directs attention to issues of individual differences, which often have been ignored in cognitive science to the detriment of the research (Ashby, Maddox, & Lee, 1994; Luce, 1997). The presence of marked individual differences places new demands on cognitive models, because the models must explain both normative performance and deviations from that norm. For this reason, samples rich in individual differences may provide a means of distinguishing among alternative cognitive models even when the fit of those models cannot be distinguished based on normative data alone (Neufeld, Carter, Vollick, Boksman, & Jetté, 2002). Thus, clinical research presents a novel opportunity for cognitive researchers to evaluate the generalizability and robustness of their methods and models.

Although our high-symptom women were chosen because they endorsed a broad set of bulimic symptoms on the BULIT, the correlations between the cognitive measures and the Dietary Restraint scale of the EAT (Table 4) were at least as high as those for the BULIT. This result suggests that the cognitive patterns that we observed may not be specific to bulimic symptoms. The correlations could be influenced by the fact that the EAT was completed on the day of the cognitive assessment; however, even within the EAT, the correlations with the Dietary Restraint subscale were as high as those with the Bulimia subscale. It does not appear that cognitive performance was associated primarily with *successful* dietary restraint in this sample; no significant correlations emerged between cognitive performance and BMI. It will be important in future research to study both dietary restriction and symptoms more specific to bulimia.

Given the substantial comorbidity between eating disorders and depression (Laessle, Kittl, Fichter, & Pirke, 1988; Schlesier-Carter, Hamilton, O'Neil, Lydiard, & Malcolm, 1989), it is useful to consider whether differences between the bulimic and control groups might be due to depressive symptoms. In the present sample BDI scores did not correlate significantly with any of the cognitive measures in Table 4, and controlling for BDI did not alter the correlations between the cognitive measures and the self-report of eating disorder symptoms. Others also have reported that the link between bulimic symptoms and cognitive differences is not explained by the association between depression and eating disorders (Formea & Burns, 1996; Schlesier-Carter et al., 1989).

One limitation of the current study is that it did not use a clinical sample of individuals with eating disorders, but instead compared high- and low-symptom groups based on a validated screening device. This limitation may not be crucial when studying eating disorders because most recent research suggests that clinical and subdiagnostic samples fall on a continuum based on an array of relevant variables (Guertin, 1999; Stice, Killen, Hayward, & Taylor, 1998). Research on cognitive tasks such as the Stroop also suggests a continuum of diagnosed, symptomatic nondiagnosed, and nonsymptomatic participants (Cooper & Fairburn, 1992a; Formea & Burns, 1996; Perpiñá, Hemsley, Treasure, & de Silva, 1993). However, it will be important in the future to apply the current assessments to a clinical sample seeking treatment.

The structured nature of the stimulus set was both a strength and a weakness. It was a strength because it allowed us to focus on attentional differences in the theoretically relevant dimensions of affect and body size, and on the way in which attentional differences in these dimensions carried over into the categorization task. It was a weakness because we don't know how well the results would generalize to stimuli with prominent variation along other dimensions. For instance, is the lower attention to affect that we observed among the bulimic group a general phenomenon, or is it merely a reflection of competition between body size and affect in the current stimulus set? Clearly, it will be important to evaluate individual differences in processing of information other than body size and affect. However, it has been our experience in piloting a number of stimulus sets for use with these methods that attempts to build too many dimensions of variation into a single stimulus set results in a poor signal-to-noise ratio.

In the future, it will be helpful to evaluate convergence between cognitive science strategies for assessing cognition in bulimia and more traditional self-report approaches. The present study did not use established self-report measures of cognition prior to the performance tasks. Participants did estimate the importance of body size and affect to their similarity ratings after completing the cognitive tasks. These estimates correlated about .65 with the MDS attention weights for the same dimension, and about .50 with the utilization coefficients for the same dimension, suggesting substantial convergence between performance measures and self-report. However, the general relevance of this convergence is unclear. Subjects made these self-reports immediately following hundreds of judgments in performance tasks designed to reveal individual differences in attention to body size and affect. It is not clear whether concurrently obtained reports about this focused experience have any implications for participant's retrospective self-report about cognitions outside the laboratory. In future studies, it will be important to use traditional self-report measures of cognition prior to cognitive performance tasks in order to obtain appropriate uncontaminated measures of convergence.

Another important topic for future work would be the factors associated with stability and change in attentional and other cognitive processes. When participants are tested under consistent conditions, individual differences in cognitive processing may show considerable stability. In a sample of 30 undergraduate women (Viken, Treat, & Vazquez, 1996) using the same stimuli and MDS procedures as the current study, we found significant and substantial 1-week test–retest correlations for individual differences in affect attention weights (.81), body-shape attention weights (.75), and flattened subject weights (.79). However, it is also expected that cognitive processing will change in response to context, emotional arousal, or other factors. Future research might manipulate attentional processes, either acutely or as a result of more enduring treatment effects, and trace the effects of the manipulation on later cognitive processing. Manipulations that "dose" participants with a caloric, fatty, or taboo food or drink, or that expose participants to words or images designed to elicit body dissatisfaction, have been shown to influence thoughts of and preoccupation with body dissatisfaction (Cooper et al., 1993; Cooper & Fairburn, 1992b; McKenzie, Williamson, & Cubic, 1993; Thompson, Coovert, Pasman, & Robb, 1993). Presumably, these types of manipulations also would influence high- and low-symptom women's cognitive processing differentially, such that high-symptom women's attention to body-size information increases and their processing of other types of information decreases.

Overall, these results illustrate the potential utility of adapting theoretical and measurement models drawn from cognitive science to evaluate the role of cognition in clinical phenomena. Additionally, the present work provides preliminary support for the generalizability of cognitive science approaches to the study of clinically relevant individual differences in perceptions of complex, socially relevant stimuli, suggesting that a single model of cognitive processing can account for both normative and nonnormative processing and behavior.

References

Ashby, F. G. (1992). *Multidimensional models of perception and cognition.* Hillsdale, NJ: Erlbaum.

Ashby, F. G., & Gott, R. E. (1988). Decision rules in the perception and categorization of multidimensional stimuli. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 14,* 33–53.

Ashby, F. G., Maddox, W. T., & Lee, W. W. (1994). On the dangers of averaging across subjects when using multidimensional scaling or the similarity-choice model. *Psychological Science, 3,* 144–151.

Baker, J. D., Williamson, D. A., & Sylve, C. (1995). Body image disturbance, memory bias, and body dysphoria. *Behavior Therapy, 26,* 747–759.

Beck, A. T., Rush, A. J., Shaw, B. F., & Emery, G. (1979). *Cognitive therapy of depression.* New York: Guilford Press.

Black, C. M. D., Wilson, G. T., Labouvie, E., & Heffernan, K. (1997). Selective processing of eating disorder relevant stimuli: Does the Stroop test provide an objective measure of bulimia nervosa? *International Journal of Eating Disorders, 22,* 329–333.

Bonifazi, D. Z., & Crowther, J. H. (1996). In vivo cognitive assessment in bulimia nervosa and restrained eating. *Behavior Therapy, 27*(2), 139–158.

Carroll, J. D., & Chang, J. J. (1970). Analysis of individual differences in multidimensional scaling via an *n*-way generalization of "Eckart–Young" decomposition. *Psychometrica, 35,* 238–319.

Cohen, M. M., & Massaro, D. W. (1992). On the similarity of categorization models. In F. G. Ashby (Ed.), *Multidimensional models of perception and cognition* (pp. 395–447). Hillsdale, NJ: Erlbaum.

Cooper, M. J. (1997). Cognitive theory in anorexia nervosa and bulimia nervosa: A review. *Behavioral and Cognitive Psychotherapy, 25,* 113–145.

Cooper, M. J., Anastasiades, P., & Fairburn, C. G. (1992). Selective processing of eating-, shape-, and weight-related words in persons with bulimia nervosa. *Journal of Abnormal Psychology, 101,* 352–355.

Cooper, M. J., Clark, D. M., & Fairburn, C. G. (1993). An experimental study of the relationship between thoughts and eating behaviour in bulimia nervosa. *Behaviour Research and Therapy, 31,* 749–757.

Cooper, M. J., & Fairburn, C. G. (1992a). Selective processing of eating, weight and shape related words in patients with eating disorders and dieters. *British Journal of Clinical Psychology, 31,* 363–365.

Cooper, M. J., & Fairburn, C. G. (1992b). Thoughts about eating, weight and shape in anorexia nervosa and bulimia nervosa. *Behaviour Research and Therapy, 30,* 501–511.

Cooper, M. J., & Fairburn, C. G. (1994). Changes in selective information processing with three psychological treatments for bulimia nervosa. *British Journal of Clinical Psychology, 33,* 353–356.

Cooper, M. J., & Hunt, J. (1998). Core beliefs and underlying assumptions in bulimia nervosa and depression. *Behaviour Research and Therapy, 36,* 895–898.

Fairburn, C. G., Cooper, P. J., Cooper, M. J., McKenna, F. P., & Anastasiades, P. (1991). Selective information processing in bulimia nervosa. *International Journal of Eating Disorders, 10,* 415–422.

Fairburn, C. G., Cooper, Z., & Cooper, P. J. (1986). The clinical features and maintenance of bulimia nervosa. In K. D. Brownell & J. P. Foreyt (Eds.), *Handbook of eating disorders: Physiology, psychology, and treatment of obesity, anorexia, and bulimia* (pp. 389–404). New York: Basic Books.

Formea, G. M., & Burns, G. L. (1996). Selective processing of food, weight, and body-shape words in nonpatient women with bulimia nervosa. *Journal of Psychopathology and Behavioral Assessment, 18,* 105–118.

Garner, D. M., & Bemis, K. M. (1982). A cognitive–behavioral approach to anorexia nervosa. *Cognitive Therapy and Research, 6,* 123–150.

Garner, D. M., Olmsted, M. P., Bohr, Y., & Garfinkel, P. E. (1982). The Eating Attitudes Test: Psychometric features and clinical correlates. *Psychological Medicine, 12,* 871–878.

Guertin, T. L. (1999). Eating behavior of bulimics, self-identified binge eaters, and non-eating-disordered individuals: What differentiates these populations? *Clinical Psychology Review, 19,* 1–23.

Hermans, D., Pieters, G., & Eelen, P. (1998). Implicit and explicit memory for shape, body weight, and food-related words in patients with anorexia nervosa and nondieting controls. *Journal of Abnormal Psychology, 107,* 193–202.

Jones, L. E. (1983). Multidimensional models of social perception, cognition, and behavior. *Applied Psychological Measurement, 7,* 451–472.

Kruschke, J. K. (1992). ALCOVE: An exemplar-based connectionist model of category learning. *Psychological Review, 99,* 22–44.

Kruschke, J. K., & Johansen, M. K. (1999). A model of probabilistic category learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25,* 1083–1119.

Laessle, R. G., Kittl, S., Fichter, M. M., & Pirke, K. M. (1988). Cognitive correlates of depression in patients with eating disorders. *International Journal of Eating Disorders, 7,* 681–686.

Lang, P. J. (1988). Fear, anxiety, and panic: Context, cognition, and visceral arousal. In S. Rachman & J. D. Maser (Eds.), *Panic: Psychological perspectives* (pp. 219–236). Hillsdale, NJ: Erlbaum.

Luce, R. D. (1997). Several unresolved conceptual problems of mathematical psychology. *Journal of Mathematical Psychology, 41,* 79–87.

Macho, S. (1997). Effect of relevance shifts in category acquisition: A test of neural networks. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23,* 30–53.

MacLeod, C. (1993). Cognition in clinical psychology: Measures, methods or models. *Behaviour Change, 10,* 169–195.

McFall, R. M., Treat, T. A., & Viken, R. J. (1997). Contributions of cognitive theory to new behavioral treatments. *Psychological Science, 8,* 174–176.

McFall, R. M., Treat, T. A., & Viken, R. J. (1998). Contemporary cognitive approaches to studying clinical problems. In D. K. Routh & R. J. DeRubeis (Eds.), *The science of clinical psychology: Accomplishments and future directions* (pp. 163–197). Washington, DC: American Psychological Association.

McKenzie, S. J., Williamson, D. A., & Cubic, B. A. (1993). Stable and reactive body image disturbances in bulimia nervosa. *Behavior Therapy, 24,* 195–207.

Mintz, L. B., & O'Halloran, M. S. (2000). The Eating Attitudes Test: Validation with *DSM–IV* eating disorder criteria. *Journal of Personality Assessment, 74,* 489–503.

Mizes, J. S., & Christiano, B. A. (1995). Assessment of cognitive variables relevant to cognitive behavioral perspectives on anorexia nervosa and bulimia nervosa. *Behaviour Research and Therapy, 33,* 95–105.

Neufeld, R. W. J., Carter, J. C., Vollick, D., Boksman, K., & Jetté, J. (2002). Application of stochastic modelling to the assessment of group and individual differences in cognitive functioning. *Psychological Assessment, 14,* 279–298.

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review, 84,* 231–259.

Nosofsky, R. M. (1986). Attention, similarity, and the identification–categorization relationship. *Journal of Experimental Psychology: General, 115,* 39–57.

Nosofsky, R. M. (1987). Attention and learning processes in the identification and categorization of integral stimuli. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13,* 87–108.

Nosofsky, R. M. (1989). Further tests of an exemplar-similarity approach to relating identification and categorization. *Perception & Psychophysics, 45,* 279–290.

Nosofsky, R. M. (1992a). Exemplar-based approach to relating categorization, identification, and recognition. In F. G. Ashby (Ed.), *Multidimensional models of perception and cognition* (pp. 363–393). Hillsdale, NJ: Erlbaum.

Nosofsky, R. M. (1992b). Similarity scaling and cognitive process models. *Annual Review of Psychology, 43,* 25–53.

Nosofsky, R. M., Kruschke, J. K., & McKinley, S. C. (1992). Combining exemplar-based category representations and connectionist learning rules. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18,* 211–233.

Nosofsky, R. M., & Palmeri, T. J. (1996). Learning to classify integral-dimension stimuli. *Psychonomic Bulletin & Review, 3,* 222–226.

Perpiñá, C., Hemsley, D., Treasure, J., & de Silva, P. (1993). Is the selective information processing of food and body words specific to patients with eating disorders? *International Journal of Eating Disorders, 14,* 359–366.

Rather, B. C., & Goldman, M. S. (1994). Drinking-related differences in the memory organization of alcohol expectancies. *Experimental and Clinical Psychopharmacology, 2,* 167–183.

Rudy, T. E., & Merluzzi, T. V. (1984). Recovering social–cognitive schemata: Descriptions and applications of multidimensional scaling for clinical research. *Advances in Cognitive–Behavioral Research and Therapy, 3,* 61–102.

Schlesier-Carter, B., Hamilton, S. A., O'Neil, P. M., Lydiard, R. B., & Malcolm, R. (1989). Depression and bulimia: The link between depression and bulimic cognitions. *Journal of Abnormal Psychology, 98,* 322–325.

Schotte, D. E., McNally, R. J., & Turner, M. L. (1990). A dichotic listening analysis of body weight concern in bulimia nervosa. *International Journal of Eating Disorders, 9,* 109–113.

Sebastian, S. B., Williamson, D. A., & Blouin, D. C. (1996). Memory bias for fatness stimuli in the eating disorders. *Cognitive Therapy and Research, 20,* 275–286.

Shepard, R. N. (1964). Attention and the metric structure of the stimulus space. *Journal of Mathematical Psychology, 1,* 54–87.

Shiffrin, R. M. (1988). Attention. In R. C. Atkinson, R. J. Herrnstein, G. Lindzey, & R. D. Luce (Eds.), *Steven's handbook of experimental psychology* (2nd ed., pp. 739–811). New York: Wiley.

Smith, M. C., & Thelen, M. H. (1984). Development and validation of a test for bulimia. *Journal of Consulting and Clinical Psychology, 52,* 863–872.

Stice, E., Killen, J. D., Hayward, C., & Taylor, C. B. (1998). Support for the continuity hypothesis of bulimic pathology. *Journal of Consulting and Clinical Psychology, 66,* 784–790.

Thompson, J. K., Coovert, D. L., Pasman, L. N., & Robb, J. (1993). Body image and food consumption: Three laboratory studies of perceptual perceived calorie content. *International Journal of Eating Disorders, 14,* 445–457.

Townsend, J. T. (1990). Serial vs. parallel processing: Sometimes they look like Tweedledum and Tweedledee but they can (and should) be distinguished. *Psychological Science, 1*(1), 46–54.

Treat, T. A., McFall, R. M., Viken, R. J., & Kruschke, J. K. (2001). Using cognitive science methods to assess the role of social information processing in sexually coercive behavior. *Psychological Assessment, 13,* 549–565.

Treat, T. A., McFall, R. M., Viken, R. J., Nosofsky, R. M., MacKay, D. B., & Kruschke, J. K. (2002). Assessing clinically relevant perceptual organization with multidimensional scaling techniques. *Psychological Assessment, 14,* 239–252.

Viken, R. J., Treat, T. A., & Vazquez, H. A. (1996). *The reliability of individual differences in women's perception of body size and affect.* Unpublished manuscript.

Vitousek, K. B. (1996). The current status of cognitive–behavioral models of anorexia nervosa and bulimia nervosa. In P. M. Salkovskis (Ed.), *Frontiers of cognitive therapy* (pp. 383–418). New York: Guilford Press.

Vitousek, K. B., & Hollon, S. D. (1990). The investigation of schematic content and processing in eating disorders. *Cognitive Therapy and Research, 14,* 191–214.

Welch, G., & Hall, A. (1989). The reliability and discriminant validity of three potential measures of bulimic behaviors. *Journal of Psychiatric Research, 23,* 125–133.

Williams, J. M. G., Mathews, A., & MacLeod, C. (1996). The emotional Stroop task and psychopathology. *Psychological Bulletin, 120,* 3–24.

Williams, J. M. G., Watts, F. N., MacLeod, C., & Mathews, A. (1997). *Cognitive psychology and emotional disorders* (2nd ed.). New York: Wiley.

Williamson, D. A., Muller, S. L., Reas, D. L., & Thaw, J. M. (1999). Cognitive bias in eating disorders: Implications for theory and treatment. *Behavior Modification, 23,* 556–577.

Wilson, T. D. (1994). The proper protocol: Validity and completeness of verbal reports. *Psychological Science, 5,* 249–252.

Young, F. W., & Lewyckyj, R. (1996). *ALSCAL user's guide* (5th ed.). Chapel Hill, NC: L. L. Thurstone Psychometric Laboratory, University of North Carolina.

Zotter, D. L., & Crowther, J. H. (1991). The role of cognitions in bulimia nervosa. *Cognitive Therapy and Research, 15,* 413–426.

Received June 21, 2001
Revision received May 13, 2002
Accepted May 15, 2002 ■