Application of Associative Learning Paradigms to Clinically Relevant Individual Differences in Cognitive Processing

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Individual differences in cognitive processing have been implicated in a range of clinical problems, such as depression, anxiety, schizophrenia, sexual aggression, and disordered eating (e.g., Beck, 1976; Kelly, 1955; McFall, 1990). Clinical scientists have been slow, however, to capitalize on the wealth of theories, measurement strategies, and analytical approaches developed by quantitative cognitive scientists, even though these models and methods seem promising for the advancement of cognitive theories of psychopathology (Treat, McFall, Viken, Kruschke, Nosofsky, & Wang, 2007). Cognitive scientists also have been slow to evaluate the generalizability of their models and methods to the more complex circumstances characteristic of "real-world" processing. The limited exploration of the integrative area of quantitative clinical-cognitive science reflects, in part, two fundamental differences between cognitive and clinical science. First, quantitative cognitive scientists typically focus on the development and evaluation of formal mathematical models of the normative operation of component cognitive processes, such as attention, memory, and learning. Clinical scientists, in contrast, often study individual differences in abnormal processing. Second, quantitative cognitive scientists commonly study processing of simple, artificial stimuli that vary along readily identifiable dimensions, that are perceived similarly across persons, and with which persons frequently have limited experience. In contrast, clinical scientists more frequently study individual differences in processing of more complex, socially and emotionally relevant stimuli that vary along numerous dimensions, that may be perceived quite differently across persons, and with which persons often have prior experience. Thus, the application of cognitive science methods to clinical problems necessitates addressing the representation and assessment of individual differences, as well as far greater stimulus complexity.

This chapter provides an overview of our efforts to draw on contemporary cognitive science to examine clinically relevant individual differences in category learning with complex, socially relevant stimuli. Cognitive scientists long have recognized the fundamental importance of category learning as a core cognitive process (see Ashby & Maddox, 2005, or Kruschke, 2005a, for reviews). Clinical researchers tend to focus on static characterizations of cognitive processing, but examination of the way in which processing changes through time could be quite fruitful, whether the variation occurs naturally over different time scales, in response to feedback, or as a function of a theoretically relevant manipulation that is associated with exacerbation or amelioration of the clinical phenomenon. We focus in this chapter on learning as a function of feedback, because socially relevant learning processes presumably influence the development, maintenance, and modification of our interpersonal beliefs and behaviors. Moreover, the provision of trial-by-trial feedback in structured category-learning protocols ultimately may serve as a useful prevention or intervention strategy.

The approach that we adopt treats participants' perceptual organization of stimuli as a representational base for the operation of learning processes. Thus, characterization of individual differences in perceptual organization is central to our investigations of individual differences in category learning. We focus in particular on individual differences in the perceived salience of stimulus dimensions as an important determinant of individual differences in category learning with socially relevant stimuli. We document that participants show far better performance on category structures that are congruent with their underlying perceptual organization, and they struggle to learn category structures that are incongruent with the perceptual organization that they bring to the task.

The first section provides a detailed overview of our use of cognitive-science methods to characterize perceptual organization and category learning processes with complex stimuli. The second and third sections describe our use of these methods to characterize (a) individual differences in men's perceptual organization of and learning about women's affect (positive or negative) and physical appearance (physically exposed or not), with implications for our understanding of sexual aggression; and (b) individual differences in women's perceptual organization of and learning about other women's facial affect (happy or sad) and body size (heavy or light), with implications for our understanding of disordered eating.

Perceptual Organization and Category Learning

Perceptual Organization

Perceptual organization refers to the representation and organization of incoming stimuli in terms of their underlying psychological attributes. We most commonly assess perceptual organization using a similarity-ratings paradigm, in which participants judge the similarity of pairs of stimuli on a scale anchored by "very different" and "very similar." For example, participants might view numerous pairs of photographs of women who vary in terms of their affect (negative to positive) and physical exposure (covered to exposed). On a single similarity-ratings trial, the participant might evaluate the similarity of a physically exposed and happy woman to a physically unexposed and happy woman. Because these two photos differ only on degree of exposure, not on affect, a rating of "very different" would suggest that the participant perceives physical exposure to be more salient than affect, whereas a rating of "very similar" would suggest the opposite. Participants are told that there are no right-or-wrong answers and are encouraged to respond quickly with their first impression of the photo pair's similarity. Note that this task neither specifies the stimulus attributes of interest nor directs participants to attend to particular stimulus attributes, thus providing a relatively implicit assessment of participants' perceptual organizations.

A multidimensional scaling (MDS) analysis of participants' similarity ratings provides a spatial representation of the group-level perceptual organization or "psychological space," in which the perceived similarity between two stimuli is modeled as a decreasing function of the distance between the perceived values of two stimuli (Davison, 1992; Treat, McFall, Viken, Nosofsky, MacKay, & Kruschke, 2002). Thus, two stimuli that are judged to be very similar are scaled much closer in the psychological space than two stimuli that are judged to be very dissimilar. For example, the upper panel of Figure 1 displays the psychological space of 24 photo stimuli that present women varying along physical exposure and affect dimensions. Stimuli A and B, which depict physically exposed women expressing negative affect, are scaled close together, reflecting the participant's perception that they are very similar to one another. In contrast, this participant judged both stimuli to be very dissimilar to stimulus C, a physically unexposed woman expressing positive affect, who is scaled across the psychological space from stimuli A and B.

The metric used to compute the distance between stimuli reflects assumptions about the extent to which the stimulus dimensions are processed in a more separable or integral manner. The Euclidean metric is used when the stimulus dimensions are processed more holistically, or integrally, such as when evaluating color patches that vary in hue and saturation (Nosofsky & Palmeri, 1996; Shepard, 1964). The Euclidean distance between two stimuli is simply the length of a straight line between them. In contrast, the city-block metric is used when the stimulus dimensions are perceived more distinctively, or separably, such as when evaluating objects that vary in size and orientation. The city-block distance between two stimuli is the sum of the distances between them along each stimulus dimension.

In our experience, the better fitting metric for the more complex, ecologically valid stimulus sets of interest to clinical researchers often is Euclidean, rather than city-block, because the dimensions are difficult to isolate. The worse fit of the city-block metric suggests that the dimensions may be difficult to attend to selectively (Nosofsky & Palmeri, 1996), since the city-block metric entails independent analysis of the dimensions. In contrast, the appropriate metric for the simpler, artificial stimuli of interest to cognitive scientists typically is city-block, and it is much easier to attend selectively to separably processed dimensions. As we will see, the extent to which stimulus dimensions are processed separably versus integrally has significant implications for the operation of category learning processes with more complex stimuli.

In the weighted MDS model, individual differences in participants' similarity ratings are modeled as participant-specific weighting of the stimulus dimensions (Carroll & Chang, 1970). Conceptually, these "salience weights" stretch and shrink the dimensions of the group psychological space. The upper panel of Figure 1 presents the psychological space of a participant who is influenced much more by women's physical exposure than by their affect. The large salience weight for physical exposure serves to increase the distance between the more and less exposed women, which reflects this participant's perception that more and less exposed women are very dissimilar. In contrast, the small salience weight for affect shrinks the distance between the women displaying positive vs negative affect, consistent with the participant's judgment that women displaying positive and negative affect are not particularly dissimilar. The lower panel of Figure 1 depicts the psychological space of a participant who is influenced more by women's affect than by physical exposure. Thus, the physically exposed and unexposed women are scaled closer together than the women exhibiting positive and negative affect. A particularly nice feature of the weighted MDS model is its simultaneous representation of both group- and participant-specific aspects of perceptual organization: both the dimensions spanning the psychological space and the organization of the stimuli within each dimension are assumed to be shared by participants, whereas the relative salience of each dimension is allowed to vary across participants.

It is important to distinguish perceived dimensional salience from selective attention to dimensions. Perceived dimensional salience is relatively static and enduring, indicating the default allocation of attention to the dimensions within the context of a particular stimulus set. Selective attention, on the other hand, refers to relatively dynamic re-allocation of attention, whereby processing of dimensions might be amplified or attenuated selectively over a brief time span. For example, a person might display a perceptual organization in which affect is highly salient and exposure is relatively ignored. This relative salience would manifest itself in similarity ratings. The same person, however, might be able to re-allocate attention selectively if a different task demanded it (e.g., when learning an exposure-relevant category structure). Re-allocation of attention might prove to be difficult for these stimuli, however, because scaling studies suggest that the dimensions are integral.

We also have relied on a prototype classification task to provide estimates of the perceived salience of stimulus dimensions, since providing similarity ratings for all possible pair of stimuli (including prototypes) places a significant burden on participants (e.g., judging the similarity of all possible pairs of 24 stimuli takes approximately 30 minutes). In the classification task, participants first view two prototypical photo stimuli that vary along both theoretical dimensions of interest. For example, a “Type D woman” might express positive affect and be normatively heavy, whereas a "Type K woman" might express negative affect and be normatively light. Participants study the two prototypes for 10-15 seconds, then freely classify each of the remaining stimuli as an example of a Type D or a Type K woman, without corrective feedback. Because the prototypes vary along both theoretically relevant dimensions, participants can base their classifications on either or both dimensions. Here, too, the task provides a relatively implicit assessment of participants' perceptual organizations, as it neither specifies the stimulus attributes of interest nor directs participants to attend to particular stimulus attributes.

Multiple logistic-regression techniques are used to estimate individual differences in perceptual organization during the classification task. A participant's classification judgments are regressed onto normative data for the stimulus dimensions (e.g., a separate undergraduate sample's average judgments of the affect and body size of the women depicted in the photos). In other words, the normative data for affect and body size serve as two predictors of each participant's dichotomous classification decisions. 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 positive-affect prototype for every unit increase in the normative value of affect for the stimulus. Viken, Treat, Nosofsky, McFall, and Palmeri (2002) demonstrated a strong association between utilization coefficients (based on a prototype classification task) and the corresponding salience weights (based on a similarity ratings task) for body size and affect, with an average correlation of .75. Thus, we treat the utilization estimates from the prototype classification tasks as indicators of dimensional salience.

Category Learning

Category learning in the present context refers to the placement of stimuli into categories with feedback about the accuracy of classification, although experimenter instruction as to the stimulus characteristics on which to base classifications remains absent. To date, we have relied on category structures defined by a single central boundary along a single dimension. For example, a participant might view photos of women who vary along physical exposure and affect dimensions, classify the woman depicted in each photo as a member of one of two categories with arbitrary labels (e.g., "Category F" and "Category J"), and then receive feedback on the accuracy of his classifications (e.g., "Correct! She is a member of Category J."). Note that both panels of Figure 1 include a category boundary indicated by a dashed line that is perpendicular to the physical exposure axis of the psychological space. In this case, the participant would be learning to classify physically exposed women as members of Category F and physically unexposed women as members of Category J. Participants are told that initially they will be guessing, as they have not been told the basis for the feedback. Participants also are informed that the basis for the feedback might change during the course of the task, and that they should attempt to learn the new category labels for the stimuli if this occurs. If a shift to an affect category structure occurred, then the participant might have to learn to classify women expressing positive affect as members of Category F and women expressing negative affect as members of Category J.

The formal process models of category learning upon which we rely assume that the underlying spatial representation of the stimuli (i.e., the perceptual organization) is the foundation for the category learning processes (e.g., Kruschke, 1992; Kruschke & Johansen, 1999; Nosofsky, 1992). These models predict that participants will learn a category structure based on a particular stimulus feature more quickly when stimuli in different categories are perceived to be very dissimilar and stimuli in the same category are perceived to be very similar. This prediction follows purely from generalization of learning from one exemplar to another in close proximity. In particular, when a category distinction aligns with a salient dimension, the distinction should be learned rapidly, because the stretching of a salient dimension increases the distance between stimuli in different categories. In our applications with complex and socially relevant stimuli, individual differences in category learning should be related to individual differences in the perceived salience of stimulus dimensions. Note that, in this analysis, dimensional salience always is a perceived, rather than an intrinsic, property of a stimulus dimension. Consider, for example, differences in the expected rate at which an exposure category structure is learned by the participants whose perceptual organizations are depicted in Figure 1. The participant for whom exposure is more salient than affect (in the upper panel) should acquire the exposure category structure rapidly, as the stimuli falling into the same category are perceived to be quite similar (i.e., they are close to one another in the psychological space), whereas the stimuli falling in different categories are perceived to be very dissimilar. In contrast, the participant for whom affect is more salient than exposure (in the lower panel) should learn the exposure category structure much more slowly, as the structure is far less congruent with his perceptual organization.

In both of the studies described in this chapter, we examine whether category-learning performance is congruent with participants' perceptual organizations. We also fit Kruschke and Johansen's (1999) connectionist model of category learning, RASHNL, which implements three mechanisms that may underlie participants' responses. The first mechanism sets the initial relative perceived salience of the psychological dimensions of physical exposure and facial affect. For example, participants who initially perceive affect to be more salient than exposure should be at a distinct advantage over their counterparts when learning the affect category structure, because of the greater perceived similarity of the stimuli within the same category and the greater perceived dissimilarity of the stimuli in different categories. The second mechanism is shifting of attention toward relevant dimensions and away from irrelevant dimensions. This attentional shifting allows participants to learn category structures by modifying their perceptual organization to be more consistent with the demands of the category structure. In other words, participants who initially perceive exposure to be more salient than affect could learn the affect category structure by increasing their attention to affect and decreasing their attention to exposure, thus modifying their perceptual organization to make it more similar to that of an initially affect-oriented participant. This shift in dimensional attention would minimize intra-category distances and maximize inter-category distances, and it could happen quite rapidly. The third mechanism is gradual strengthening of associations between regions of the psychological space and correct category responses. The association-learning mechanism produces incremental improvement in performance for specific exemplars and their nearby neighbors, whereas attention shifting affects the relative distribution of all exemplars simultaneously.

Distinguishing these mechanisms in category learning could be beneficial for our understanding of cognitive processing of these complex, socially relevant stimuli. As discussed above, the initial perceived salience of the psychological dimensions (i.e., the first mechanism mentioned above) is already a well-established predictor of category learning with simple, artificial stimuli. Consideration of category learning about more complex stimuli with which participants have prior experience allows us to investigate the potential influence of systematic individual differences in perceived dimensional salience on category learning as well. Extensive evidence within cognitive science also supports a role for attention shifting (the second mechanism) as a primary strategy when learning category structures with artificial stimuli that are composed of separable dimensions (e.g., Kruschke, 1993, 1996). Nosofsky and Palmeri (1996) demonstrated that attention shifting played a far less central role, however, when learning structures with artificial stimuli composed of integral dimensions (e.g., color patches that vary in hue and saturation). Thus, category learning studies have demonstrated that artificial stimuli that are best scaled by Euclidean metrics in similarity rating are best modeled with little attention shifting in category learning. Because the dimensions of the more ecologically valid stimuli of interest to clinical researchers frequently will be processed integrally, rather than separably, this may diminish the role of attention shifting in category learning with these stimuli. Moreover, a relative inability to shift attention rapidly might enhance the importance of individual differences in perceived dimensional salience for applied category learning. In this case, gradual changes in the associations between regions of the psychological space and the correct category label (the third mechanism) may become more central to the acquisition of applied category structures, particularly those that are incongruent with a person's initial allocation of attention across dimensions. Thus, the relative importance of the three learning mechanisms instantiated in RASHNL may differ meaningfully as a function of the nature of the stimuli of primary interest to cognitive and clinical scientists.

Individual Differences in Men's Perceptions of and Learning about Women

Background

Social information-processing models of sexually coercive or aggressive behavior between acquaintances specify a critical role for the way in which men process information about women (e.g., Farris, Treat, Viken, & McFall, 2008; Johnston & Ward, 1996; McFall, 1990; Segal & Stermac, 1990). More specifically, theorists suggest that men at greater risk of exhibiting sexual aggression toward acquaintances attend relatively less to information about women's affect or sexual interest and relatively more to women's physical sexual attributes (e.g., physical exposure, sensuality, provocativeness, and sexual attractiveness). In 2001, we conducted a study to evaluate this hypothesized link between men's risk status and their relative attention to affect and physical exposure dimensions of full-body photos of women in newsstand magazines (Treat, McFall, Viken, & Kruschke, 2001). This study provided an opportunity to examine individual differences in participants' performance when learning category structures that were based on either women's affect or physical exposure. This allowed us to evaluate whether individual differences in perceptual organization facilitated or inhibited performance on the category-learning tasks, depending on the congruence of the participant's perceptual organization with the category structure to be learned. We also fit Kruschke and Johansen's (1999) RASHNL model to the category learning data, so that we could evaluate the role of the three mechanisms described above. We hoped that attention shifting would play a central role in young men's category learning about women's affective and appearance-based cues, because a participant's ability to shift attention between these cues in an artificial category-learning task might indicate that his relative attention to such dimensions in "real-world" social environments would be malleable, as well.

<u>Methods</u>

Stimuli were 26 color slides of Caucasian women who appeared either in newsstand magazines or mass-marketing catalogs. A separate sample of undergraduate males rated these stimuli along 10-point scales for several relevant dimensions, including affect and exposure. The average ratings along the affect and exposure dimensions for each stimulus served as "normative ratings" for the stimuli. Only 14 of the 26 stimuli were used in the similarity-ratings task, given the prohibitively large number of all possible pairs that would need to be rated if we had included all 26 stimuli in this task. All 26 stimuli were used in the category-learning tasks. The normative ratings for affect and exposure were used to classify the stimuli as having high or low values on the exposure and affect dimensions for purposes of providing feedback in the two category-learning tasks.

Seventy-one undergraduate males first completed a similarity-ratings task, in which they judged the similarity of all possible pairs of 14 photos of women on a 10-point scale ranging from 0 = very different to 9 = very similar. After finishing an implicit classification task that is not relevant to the current discussion, participants then completed two category-learning tasks. They viewed individual photos of 26 women, judged whether each woman did or did not have an unspecified characteristic, and received trial-by-trial feedback on the accuracy of their classifications. The feedback was based on the woman's normative affect in one task and on the woman's level of physical exposure in the other task. Four blocks of trials were completed for each category structure.

Finally, participants responded to the Heterosocial Perception Survey (McDonel & McFall, 1991), which indexed a participant's perception of the justifiability of a man continuing to make sexual advances in the face of increasing resistance by a female acquaintance. Participants whose justifiability ratings declined less rapidly as the woman's negativity increases were presumed to be at higher risk of exhibiting sexually aggressive behavior toward acquaintances. This Rape Justifiability Score was computed for all participants, with higher values indicating a greater propensity toward sexual aggression.

Results

Weighted multidimensional scaling techniques were used to quantify individual differences in the relative perceived salience of the physical-exposure and facial-affect dimensions. A two-dimensional configuration was imposed, with the stimulus coordinates constrained to be equal to the normative ratings for exposure and affect, and salience weights for the two dimensions were estimated for each participant. Average salience weights for physical exposure and affect indicated that physical exposure was perceived to be far more salient than affect in this particular stimulus set. A single index of the relative salience of exposure versus affect was constructed from the two salience weights (MacCallum, 1977). Marked variability in relative salience scores was observed, as expected. Participants whose relative salience score fell in the upper and lower terciles were classified as exposure-oriented (n = 24) and affect-oriented (n = 24), respectively. As expected, exposure-oriented participants showed significantly higher Rape Justifiability Scores than affect-oriented participants. Exposure-oriented participants' perception of the justifiability of unwanted sexual advances depended less on the degree of negative reaction from the hypothetical woman than it did for affect-oriented participants. Thus, those participants who perceived affect to be relatively more salient on the similarity-ratings tasks demonstrated greater sensitivity to the negativity of a woman's affect in the justifiability rating task.

Proportion correct was computed for each of the four blocks of both the exposure and affect category-learning tasks. Preliminary analyses indicated that the order in which the two category structures was completed did not influence the findings, so it was not included in subsequent analyses. A repeated-measures analysis with a robust estimator was applied to the data with Group (exposure-oriented or affect-oriented), Task (exposure or affect), and Block as factors. A significant Task effect emerged, Wald $\chi^2_{(1)}$= 27.39, $p < .001$, with average performance on the exposure-relevant structure (M = .90) far exceeding performance on the affect-relevant structure (M = .81). The predicted Group x Task interaction also emerged, Wald $\chi^2_{(1)}$= 4.01, $p < .05$; both affect-oriented and exposure-oriented participants showed better performance across blocks when learning the category structure that was more congruent with their perceptual organization. These effects are illustrated in Figure 2. In sum, both average perceived salience and individual differences in perceived salience predicted performance on the exposure and affect category-learning tasks.

We fit RASHNL (Kruschke & Johansen, 1999) to the proportion-correct values of the exposure- and affect-oriented groups on each block in the learning task, using a stepwise search algorithm to minimize the root-mean-squared-deviation between the observed and predicted proportion-correct values. The Euclidean metric was used to compute inter-stimulus distances, as preliminary model fits indicated that participants perceived the stimulus dimensions integrally, rather than separably. As expected, the RASHNL model fit best with group-specific estimates of initial perceived salience, such that exposure-oriented participants had a larger exposure/affect salience ratio than affect-oriented participants. These model results are consistent with the findings described above; however, fitting a process model to the data also provided group-specific estimates of the perceived salience of the stimulus dimension during category learning.

Unexpectedly, the RASHNL model suggested that re-allocating attention toward relevant dimensions and away from irrelevant dimensions did not contribute to participants' learning. The best fitting attention-shift rate was zero, and the best-fitting association learning rates did not differ for exposure- and affect-oriented groups. In summary, fits by the RASHNL model revealed that the exposure-oriented and affect-oriented groups differed only in the relative perceived salience of the dimensions. The groups learned at the same rate, and did not learn to attend selectively to the dimensions.

Conclusions

As expected, young men's perceptions of young women's physical-exposure and affective information showed strong relationships with men's performance on exposure and affect category structures. Overall performance was better on the exposure than the affect category structure, consistent with the far greater average salience of exposure than affect in weighted multidimensional scaling analyses. Participants also learned a category structure much more rapidly when it was congruent with their underlying perceptual organization. That is, exposure-oriented participants performed better on the exposure category structure than affect-oriented participants, whereas affect-oriented participants performed better on the affect category structure than exposure-oriented participants.

Fitting RASHNL to the category-learning data indicated that adaptive shifting of attention toward relevant stimulus dimensions and away from irrelevant stimulus dimensions did not play a role in participants' learning, as the best-fitting value for the attention shifting parameter was zero. Rather, participants gradually learned to associate regions of the psychological space with the correct category label. The lack of attentional shifting presumably reflects the integral, rather than separable, nature of the stimulus dimensions in the current application. Holistic processing of stimulus dimensions implies that it is difficult to shift attention toward or away from specific dimensions (Nosofsky & Palmeri, 1996). It would be useful in everyday life, however, if people were able to attend selectively to these dimensions, such as when a person needs to shift attention away from a potential sexual partner's physical exposure and toward the partner's affective expressions of sexual interest. Thus, it would be profitable for future research to investigate the conditions under which the distribution of attention across dimensions exhibits greater flexibility and malleability, even when the stimulus dimensions are perceived integrally.

Overall, these findings suggest that the well-established normative link between dimensional salience and category learning with simple, artificial stimuli (e.g., Kruschke, 1992; Kruschke & Johansen, 1999) indeed generalizes to the association between individual differences in perceptual organization and learning with more complex, socially and emotionally relevant stimuli, although the processes underlying learning may differ. Numerous theories suggest that the etiology or course of clinical phenomena is influenced by features of participants' perceptual organizations, such as attention to stimulus dimensions (e.g., Beck, 1976; Kelly, 1955; McFall, 1990). The present study provides further support for this link by demonstrating that young men who perceived women's physical characteristics to be more salient than their affect also perceived continued sexual advances in the face of a woman's increasing resistance to be more justified, relative to participants who perceived women's affect to be more salient. Clinical researchers have tended to focus far more on the role that attentional processes play in psychopathology, but the present work highlights the potential utility of translating the models and methods of associative learning to clinically relevant investigations as well. Performance on category learning paradigms with more complex stimuli may provide a window into the operation of "real-world" social learning processes that presumably underlie socially relevant attitudes and behaviors.

Individual Differences in Women's Perceptions of Women

Background

Clinical researchers increasingly have focused on the role of cognitive factors, such as distorted processing of shape- and weight-related information, in the etiology and maintenance of eating-disorder symptoms and in the development of cognitive-behavioral treatments for these symptoms (e.g., Cooper 2005; Fairburn, Cooper, & Shafran, 2003; Lee & Shafran, 2004). Vitousek and colleagues, for example, proposed that increased attention to and memory for shape-, weight-, and eating-related information influence the development and maintenance of eating-disorder symptoms (e.g., Vitousek, 1996; Vitousek & Hollon, 1990). Decreased attention to and memory for affective information also might play a significant role. Many women with eating disorders display marked deficits in interpersonal problem solving and emotion regulation, and they indicate that negative mood and social interactions are common triggers for eating-disordered behaviors (e.g., Lingswiler, Crowther, & Stephens, 2006; McFall, Eason, Edmondson, & Treat, 1999; Smyth, Wonderlich, Heron, Sliwinski, Crosby, Mitchell, & Engel, 2007). Such difficulties may reflect, in part, impoverished processing of affective information. In prior work, we have demonstrated that young women who report clinically significant disordered eating patterns ("High-Symptom women") show altered processing of other women's weight- and affect-related information, as presented in full body photos (Viken et al., 2002; Treat et al., in press). High-Symptom women, relative to Medium- and Low-Symptom women, showed greater attention to body size and less attention to affect in both similarity-ratings and prototype-classification tasks. High-Symptom women also showed better memory for body size and worse memory for affect, relative to the remaining participants, in a recognition-memory task. Thus, the operation of other higher-order component cognitive processes, such as category learning, also merits investigation.

The present work examines young women's perceptions of full-body photos of other women. The women depicted in the photos varied in affect (negative to positive) and in body size (lighter to heavier). We assessed the perceived salience of the photo dimensions, and then we examined how perceived salience influenced learning in a multi-phase category learning task. The phases of the category learning task were based loosely on learning experiences that young women might encounter in the real world. Our society inundates young women with social environments in which thinness is glamorized and increased body size is a strong negative predictor of a variety of indicators of success. Moreover, women who struggle with disordered eating self-expose themselves to television shows and magazines that promote a thin ideal at greater rates than their peers (e.g., Botta, 2003; Stice, Schupak-Neuberg, Shaw, & Stein, 1994; Tiggemann, 2003). Thus, women's immediate social environments provide highly influential "feedback" on the relevance of body size to happiness. Only gradually and later might affect emerge as a better indicator of happiness. In particular, if a young woman later undergoes therapy for an eating disorder, the therapy might include, implicitly or explicitly, attempts to re-orient attention away from body size. In summary, a young women initially might experience real-world "training" that body size is relevant, with affect being only a later-learned cue. Finally, the young woman might experience some sort of training to re-orient attention away from the initially learned cue.

Participants were assigned randomly to one of four learning conditions, each of which contained multiple phases of training. Table 1 presents the conditions and learning phases. Because we wanted to counterbalance which dimension initially was relevant, some participants learned an initial category structure for which body size was relevant (the "Body Size Initial" condition). Other participants learned an initial structure for which affect was relevant (the

"Affect Initial" condition). The "Body Size Initial" structure is shown in Figure 3. Each panel of Figure 3 shows the two-dimensional stimulus space, with affect plotted horizontally and body size plotted vertically.

In the Initial Phase of learning in the Body-Size Initial condition, photos of lighter women displaying neutral affect were to be classified into category F, and photos of heavier women displaying neutral affect were to be classified into category J. Only stimuli drawn from these two regions of the stimulus space were shown in the Initial Phase of the category-learning task. Participants received feedback on their classifications, but they were not told the basis for the feedback. Thus, body size was relevant to the category label in the Initial Phase for participants in the Body-Size Initial condition, whereas variability in affect was highly restricted and irrelevant to the category label. We expected that performance in the Initial Phase would be highly congruent with participants' perceptual organizations (e.g., participants who perceived body size to be more salient than affect would show far better initial performance in the Body-Size Initial condition).

In the second Redundant Phase of learning for those in the Body-Size Initial condition, affect became a redundant relevant cue, in that body size and affect both perfectly predicted the category label. For example, you can see in the second panel of Figure 3 (under "Redundant") that participants could make correct classifications based on either the woman's affect or body size. Only stimuli drawn from the two regions of the stimulus space indicated by the letters "F" and "J" were shown in one of two versions of the Redundant Phase. Participants again received feedback on their classifications but were not told the basis for the feedback. We anticipated that the newly relevant dimension (i.e., affect) would not be learned as well, because the previously learned dimension (i.e., body size) already had proven to be a perfectly predictive cue for the category label. In other words, we anticipated that learning about the redundant relevant cue of affect would be “blocked” in the Body-Size Initial condition (e.g., Kamin, 1969; Denton & Kruschke, 2006). In contrast, participants in the Body-Size Control condition would not be expected to show blocking, because they did not experience the Initial Phase of learning.

The third Redundant Phase in the category-learning task presented photos from all four corners of the stimulus space, so we could assess utilization of the two dimensions. This Transfer Phase presented photos from the four regions of the stimulus space labeled with “?” in Figure 3 and recorded participants’ classifications. Critically, participants did not receive corrective feedback during the transfer trials. Suppose that a participant had experienced the Redundant phase in which she learned to classify lighter, unhappy women into Category F and heavier, happy women into Category J. If she were relying purely on body size when making these judgments, then we would expect her to place all lighter women in category F and all heavier women in Category J, regardless of their affect. Alternatively, if she were using only affect as a basis for her judgments in the Redundant phase, then she would place all unhappy women in Category F and all happy women in Category J, regardless of their body size. Thus, the pattern of classifications in the Transfer Phase was diagnostic of a participant’s utilization of body-size and affect information. We anticipated that participants in the Body-Size Initial condition would transfer much more strongly to body size than to affect, because of the blocking of affect. Participants in the Body-Size Control condition, in contrast, were expected to show less transfer to body size, because affect would not have been blocked for them.

The final Shift Phase in the category-learning task made relevant the dimension that was irrelevant in the Initial Phase. Thus, for participants in the Body-Size Initial condition, women displaying positive affect were to be classified into Category F, whereas women displaying negative affect were to be classified into Category J. You can see that one way to perform well on this task is to ignore the initial dimension of body size and make classification decisions based on affect. Photos of women from the four regions of the stimulus space labeled in the Shift panel in Figure 3 were presented, and participants received corrective feedback. This final phase was intended to encourage a shift of attention to the initially irrelevant dimension. We expected that participants in the Body-Size Initial condition would show worse performance in the Shift Phase, relative to those in the Body-Size Control condition, because participants in the former condition would be attempting to learn a category structure based on a blocked cue.

Overall, we anticipated that the blocking manipulation in the Redundant Phase would result in suppressed learning about the blocked cue for participants in the experimental conditions (i.e., the Affect Initial and Body-size Initial conditions), as assessed in the Transfer and Shift phases. Notably, this prediction presupposes that the current design is analogous to the classic blocking design, in which the blocked cue does not appear at all in the initial phase. In the current design, in contrast, the blocked cue appears in the initial phase with a middling value (i.e., either neutral affect or moderate body size).

According to RASHNL, either attentional or associative learning mechanisms could underlie the predicted blocking effects. More specifically, among participants experiencing the Initial Phase of training, decreased transfer to the blocked cue and suppressed shift learning about the blocked cue could reflect (a) *only* generalization from the items learned in the Initial Phase, or (b) generalization *and* a shift of attention toward the initially relevant unblocked cue and away from the initially irrelevant blocked cue. The predicted main effects of blocking are qualitatively similar regardless of whether or not attention shifting plays a role, and one of the key benefits of quantitative modeling is parametric estimation of the magnitude of attention shifting. We hoped to demonstrate that attention shifting played a role in learning but recognized that integral processing of the stimulus dimensions might preclude this possibility.

Perceptual organization also was predicted to exert a strong influence on initial learning, transfer performance, and later learning, whereby performance was superior on category structures that were congruent with the participants' perceptual organization. Thus, we expected that the blocking manipulation would not eliminate the influence of perceptual organization on later transfer and learning.

Finally, we explored the interaction between perceptual organization and the blocking manipulation. Research on blocking in human category learning with simple artificial stimuli demonstrates that it is harder to block a more salient cue (Denton & Kruschke, 2006). To the extent that the classic blocking design and the current design operate analogously, we hoped to demonstrate that the blocking effect would be weaker when the to-be-blocked dimension was more salient. This prediction also hinged on separable processing of the stimulus dimensions, which presumably would be necessary to support learning via attention-shifting mechanisms.

On the other hand, it might be the case that the stimulus dimensions were processed holistically, such that learning was driven only by associative mechanisms. In this case, the current design (involving middling values on the "blocked" dimension) and classic designs are not analogous. Predictions in this case could be derived accurately only from model simulations, but qualitatively we would expect that if the initially *ir*relevant dimension were *salient*, then learning of the initial categories would be relatively difficult, and transfer would be less consistent with the initially relevant dimension, compared to when the initially irrelevant dimension was not salient. The magnitude of the difference between experimental and control groups could not be predicted in advance, but could be assayed via best-fitting parameter values in the RASHNL model.

No clinical information was obtained from participants in this study, as a prohibitively large number of participants would be necessary to examine the extent to which disordered eating status moderates the hypothesized effects. We know from our earlier work that variation in women's perceptual organization of body-size and affect information is a reliable correlate of disordered eating patterns, however. Thus, a strong connection between individual differences in perceptual organization and category learning performance would highlight the potential utility of examining the clinical relevance of individual differences in young women's learning about body-size and affect categories structures in future research.

Methods

Participants. 244 undergraduate females received partial course credit for their participation in the study. Mean age was 19.47 (SD=1.82), and 83.1% of participants self-identified their ethnicity as White/Caucasian.

Photo stimuli. Stimuli were pictures of 58 paid female models recruited from the university population. Each model was photographed in a white t-shirt and black stretch pants in front of a neutral background. Body size varied naturally, and each model was instructed to display both sad and happy expressions. A sample of 60 undergraduate women provided normative ratings of the photos along affect (unhappy to happy) and body size (slender to plump) dimensions. Mean normative ratings were used to classify each woman as light, moderate, or heavy along the body-size dimension. Women whose body size was judged to be in the lower third across all three facial expressions were classified as "light" (n = 15), and women whose body size was rated in the middle or upper third were classified as "moderate" (n = 12) or “heavy” (n = 18), respectively. Body-size classifications for the 13 remaining unique women varied across their facial expressions. The woman in each photo was classified as exhibiting “negative,” “neutral,” or “positive” affect if the mean normative rating of her affect fell in the bottom, middle, or upper third, respectively, of all mean affect ratings.

Prototype-classification tasks. Participants performed two classification tasks, which were presented in a counterbalanced order across participants. At the beginning of the first task, participants studied two prototypical photos that varied along both affect and body-size dimensions (e.g., a “Type D woman” received normative ratings toward the extreme “heavy” end of the body-size dimension and toward the extreme “happy” end of the facial-affect dimension, whereas a “Type K woman” received normative ratings indicating that she was viewed as “light” and “unhappy”). After participants inspected the two prototypes, they classified each of 20 remaining photo stimuli as examples of one of the two types of women. Next, participants completed the same task with two new prototypes (e.g., a happy-light, “Type V” woman, and a sad-heavy, “Type N” woman).

The paucity of photo stimuli precluded the use of different stimuli in the prototype-classification and phased-learning tasks. Therefore, the stimuli used in the classification task were the same as those viewed by participants in the Redundant, Transfer, and Shift Phases of the phased-learning task. This constraint necessitated construction of four versions of the classification task, depending on whether affect and body size correlated positively or negatively in the Redundant Phase for participants in the first two and the last two groups in the phased-learning task. The prototypes viewed in the prototype-classification tasks were the same across all four versions of the tasks, however, and the prototypes were not used in the learning task, given their markedly greater familiarity.

Phased-learning task. In all but the Transfer Phase of the category-learning task, participants classified individual photos as members of Category F or Category J and received accurate trial-by-trial feedback on their classifications. Participants were assigned randomly to one of four learning conditions, which are displayed in Table 1. A schematic depiction of the learning phases for participants in one of the four learning conditions, the Body-Size Initial condition, also is provided in Figure 3. Stimulus presentation order was randomized separately for each participant within each block.

Eight unique stimuli were presented in each of ten blocks in the Initial Phase of learning. Four of the stimuli received mean normative ratings in the upper third of the distribution of mean ratings for affect or body size for all 174 potential stimuli, respectively, whereas the remaining four stimuli received mean ratings in the lower third. The mean ratings for the eight stimuli along the dimension which was not the basis for the category structure fell in the middle third of the distribution of normative ratings. For example, the eight stimuli viewed in the Initial Phase of the Body-Size Initial condition received mean normative ratings in the middle third of the distribution of affect ratings, as depicted in Figure 3. None of the photos presented in the Initial Phase had been seen previously by participants.

Participants completed eight blocks of eight trials apiece in the Redundant Phase of learning. The shift to the Redundant Phase for participants in the Affect Initial and Body-Size Initial conditions was unannounced. In the Body-Size Initial and Body-Size Control conditions, four stimuli received mean normative ratings in the upper third of the ratings distribution for body size, and four stimuli received mean ratings in the lower third of the body-size-ratings distribution. Mean affect ratings for these two groups of stimuli fell in either the upper or lower third of the affect ratings distribution. As depicted in Figure 3, affect and body-size correlated positively for half of the participants in each condition (i.e., only happy-heavy and sad-light women were presented) and negatively for the remaining participants (i.e., only happy-light and sad-heavy women were presented). Analogously, in the Affect Initial and Affect Control conditions, four stimuli were judged normatively to be happy and four to be unhappy; average ratings for these stimuli along the body-size dimension fell in either the upper or lower third of the distribution of body-size ratings. Additionally, body-size and affect correlated positively for half of the participants and negatively for the other half. Structurally, the two control conditions were identical, although the stimuli used in the two conditions varied. All women presented in the Redundant Phase differed from those presented in the Initial Phase.

All participants classified 16 stimuli twice and received no feedback in the Transfer Phase, as shown in the lower left corner of Figure 3 for the Body-Size Initial condition. According to normative-ratings distributions, four stimuli were happy-heavy, four were happy-light, four were sad-heavy, and four were sad-light. Half of the stimuli had been viewed in the Redundant Phase.

In the final Shift Phase of learning, participants in the Body-Size Initial and Body-Size Control conditions completed seven blocks of a body-size category structure, which is shown in the lower right corner of Figure 3. Four of the stimuli presented on each block were judged to be happy, and four were judged to be unhappy; the body size of two of the former stimuli and two of the latter stimuli was classified as heavy, and the remaining stimuli were classified as light. Conversely, participants in the other two conditions learned a body-size category structure, in which four stimuli were light, four stimuli were heavy, and the affect classifications for these stimuli were orthogonal to the body-size classifications. All women presented in the Shift Phase had not been seen in earlier learning phases, although they had been viewed in the prototype classification tasks.

Procedure. Participants first read and signed the consent form and then were seated in front of a computer in a subject-running booth. Participants entered their age and ethnicity and then completed the two prototype-classification tasks and the phased-learning task, as described above. Finally, participants were debriefed and thanked for their participation. The experiment lasted approximately 55 minutes.

Data preparation

Prototype-classification data. Logistic-regression techniques were used to estimate individual differences in perceptual organization during the classification task. The following logistic function was fit to each participant's classification judgments for each of the two classification tasks:

$$\text{P("Type K" or "Type V" | AFF and BS values)} = \frac{1}{1+\exp(-[(a_k * AFF)+(b_k * BS)+c])},$$

where $k = 1$ or 2, depending on the task, and AFF and BS refer to standardized normative scale values for the stimuli along affect and body-size dimensions. The absolute value of the ratio of a_k to b_k indicated the relative perceived salience of affect and body size. As b_k approached zero, values of this ratio became extreme and unstable. Thus, the arctangent of the ratio was taken. This value has a simple geometric interpretation in the stimulus space as the best fitting angle of a line that separates the two category responses. The final measure of relative salience of affect and body size, i.e., their perceptual organization score, was the average of these transformed ratios for the two tasks:

$$\text{Perceptual Organization score} = \frac{\arctan\left(\left|\frac{a_1}{b_1}\right|\right) + \arctan\left(\left|\frac{a_2}{b_2}\right|\right)}{2}$$

Values for this measure ranged from 0.00 radians (or 0 degrees), when the participant relied exclusively on body size in making her classification judgments, to 1.57 radians (or 90 degrees), when the participant utilized only affect when classifying the stimuli.

Participants were classified as affect oriented if their relative salience score exceeded 1.22 radians (or 70 degrees), as body-size oriented if their score was less than .349 radians (or 20 degrees), or as both oriented if their score lay between these two extremes. Over twice as many participants were classified as affect oriented (N=107, 44.2%) rather than as body-size oriented (N=53, 21.9%), and one-third of the participants were classified as both oriented (N=82, 33.9%). A chi-square test supported the independence of perceptual organization classification and learning group, $\chi^2(6)=4.337$, $p > .50$, indicating that the three classes of perceptual organizations were distributed uniformly across the four learning groups.

Transfer data. Analogous logistic-regression techniques were used to quantify each participant's relative utilization of affect and body size on the transfer trials in the phased-learning task. The formula shown above was fit to each participant's classifications of all 32 stimuli, the arctangent of the absolute value of the ratio of a to b was calculated, and the arctangent was transformed into degrees. The resulting values ranged between 0, which indicated perfect transfer to body size, and 90, which indicated perfect transfer to affect. Finally, these values were reflected for participants in the Body-Size Initial and Body-Size Control groups, so that values of 90 indicated perfect transfer to the initial cue and 0 indicated perfect transfer to the shift cue.

Learning data. Average percent-correct was calculated for each participant for both the Initial and Shift Phases of learning. In the latter case, percent correct was calculated across only the first three blocks, as effects on the first three blocks were expected to be more revealing than when accuracies converged to ceiling levels in the later blocks. The pattern of results described below was similar when analogous analyses were conducted on average performance across all blocks, rather than the first three blocks, but the effects were smaller in magnitude.

Additionally, individual participants' performance was examined on the last two blocks of the Redundant Phase, to determine whether their performance surpassed what would be expected on the basis of chance alone. The worst observed performance was 81.25% (i.e., correct response on 13 of 16 trials; $n = 3$). This would be expected less than 1.05% of the time, if the participant responded randomly, assuming a binomial distribution ($n = 16$ and $p = .5$). Thus, all participants' data were retained for further analysis.

Resampling approach to statistical analyses

Resampling methods of statistical inference derive sampling distributions empirically, rather than theoretically, by sampling with replacement repeatedly from the observed sample and calculating the relevant test statistic on each resample (Good, 2006). The resulting distribution of test statistics serves as the empirically derived sampling distribution, and critical values can be obtained by reading off the relevant value in this distribution at the percentile of interest. In contrast, parametric statistical approaches specify the sampling distribution and relevant critical values by making stringent theoretical assumptions about the moments of the population distribution. Resampling approaches to statistical inference are preferred when the assumptions of parametric statistical approaches are violated severely. In the present case, a resampling approach was adopted for two primary reasons: one, most distributions were either bimodal or so severely skewed that they could not be transformed to normality without discretization and resulting loss of information; and two, variances tended to differ dramatically across the cells of the analyses.

In each resampling-based comparison of J group means based on a total of N scores, 50,000 resamples with replacement of size N were obtained from the concatenated distribution of all J groups' observed data, and these resampled data were distributed into J groups with the appropriate sample sizes n_j. To create the relevant sampling distributions to evaluate main effect and interaction questions, the relevant F statistics were calculated for each resample. Appropriate percentiles from this distribution then served as critical values against which the F statistics based on the sample data could be compared, and the p-value indicated the proportion of the bootstrapped sampling distribution that exceeded the observed test statistic. Pair-wise mean comparisons then were conducted for significant omnibus tests, using analogous procedures to obtain two-tailed, bootstrapped p-values for t statistics. All computations were executed using Resampling Stats in MATLAB (Kaplan, 1999).

Results

Does the congruence of perceptual organization with the category structure influence performance in the Initial Phase of learning? Performance in the Initial Phase of learning was expected to vary as a function of the congruence of participants' perceptual organization classifications with the category structure. To increase the power of our analyses, participants in the Affect Initial and Body-Size Initial Groups were classified as exhibiting either high, medium, or low congruence with the category structure, depending on their perceptual organization classification. Thus, affect-oriented participants in the Affect Initial Group and body-size-oriented participants in the Body-Size Initial Group were classified as "high congruence", whereas body-size-oriented participants in the Affect Initial Group and affect-oriented participants in the Body-Size Initial Group were classified as "low congruence." The remaining both-oriented participants in both groups were classified as "medium congruence." Figure 4 depicts average performance in the Initial Learning Phase as a function of the congruence of participant perceptual organization with the initial category structure.

The resampling-based omnibus evaluation of whether at least two of the group means differed was significant, $F = 15.29$, $p < .001$. All follow-up evaluations of pair-wise differences between means were significant: high vs medium, $t = -3.03$, $p < .01$; high vs low, $t = -5.12$, $p < .001$; medium vs low, $t = -2.95$, $p < .01$. Thus, participants performed markedly better in the Initial Phase when learning a category structure that was congruent with their perceptual organization classification and struggled markedly when learning an incongruent category structure.

Do the blocking manipulation and the congruence of perceptual organization with the initial category structure influence performance in the Transfer Phase? Performance in the Transfer Phase was expected to vary as a function of both the blocking manipulation and the congruence of participants' perceptual organization classifications with the initial category structure. As in the previous analysis, participants in the Affect Initial and Body-Size Initial Groups were classified as exhibiting either high, medium, or low congruence with the initial category structure on the basis of their perceptual organization classification. Additionally, participants in both the Affect Initial and Body-Size Initial Groups were classified as members of the experimental group for the blocking manipulation, and the remaining participants were classified as members of the control group. Figure 5 depicts average performance in the Transfer Phase as a function of the congruence of participant perceptual organization with the initial category structure and the blocking manipulation. Larger values indicate greater transfer to the initial cue, with values of 90 indicating perfect transfer to the initial cue and values of 0 indicating perfect transfer to the shift cue.

The main effect of the blocking manipulation was significant, $F = 57.19$, $p < .001$, and the difference between the experimental and control means – the overall "blocking effect" – was substantial at 25.3 degrees. As expected, the experimental group was much more likely to transfer to the initial cue, presumably because either participants shifted attention toward the initial cue and away from the blocked cue or because participants generalized from the initial-phase items. In contrast, the control group was more likely to show transfer patterns that were purely congruent with their perceptual organization.

The main effect of the congruence of participants' perceptual organization classifications with the initial category structure also was significant, $F = 77.43$, $p < .001$. Follow-up evaluations indicated that all pair-wise differences were significant: high vs medium, $t = 5.79$, $p < .001$; high vs low, $t = 12.30$, $p < .001$; medium vs low, $t = 5.01$, $p < .001$. In other words, regardless of the blocking manipulation, participants transferred more strongly to the cue that was congruent with their perceptual organization.

A significant interaction between the blocking manipulation and the congruence of participants' perceptual organization classifications with the initial category structure emerged, $F = 10.07$, $p < .001$. Follow-up comparisons of the blocking effect for each level of the congruence factor indicated a significant blocking effect for the low-congruence group, $t = 5.68$, $p < .001$, and the medium-congruence group, $t = 4.04$, $p < .001$, and a non-significant trend for the high-congruence group, $t = .60$, $p < .10$. For example, you can see in Figure 5 that there was little effect of the blocking manipulation when the initial category structure was highly congruent with the perceptual organization classification; in both cases, participants transferred overwhelmingly to the dimension underlying the initial category structure. In contrast, when the initial category structure was less congruent with the perceptual organization classification, the effect of the blocking manipulation on participants' transfer patterns was substantial (i.e., the experimental group showed much stronger transfer to the dimension underlying the initial category structure than the control group)

Overall, therefore, the blocking effect was of similar strength for the medium- and low-congruence groups and significantly stronger than for the high-congruence group, which showed a non-significant blocking effect. Based on analogy to previous research with blocked, separably processed cues that had no middling value in the Initial Phase (Denton & Kruschke, 2006), we had anticipated that the low-congruence group would show the weakest blocking effect, because the to-be-blocked cue was highly salient, whereas the high-congruence group would have shown the strongest blocking effect, secondary to the weak perceived salience of the to-be-blocked cue. The results seem to indicate instead that the Initial-Phase items had a strong influence in the Transfer Phase, producing, in the Low-Congruence group, marked generalization to the initial category structure, thereby inflating the difference between experimental and control groups. In the high-congruence condition, on the other hand, the influence of perceptual organization on initial learning was so substantial that it would have been almost impossible for experimental participants in the high-congruence group to shift more strongly to the initial cue than control participants, as transfer was at a functional ceiling among control participants, thereby deflating the difference between experimental and control groups.

<u>Do the blocking manipulation and the congruence of perceptual organization with the initial category structure influence performance in the Shift Phase of learning?</u> Performance in

the Shift Learning Phase was expected to vary as a function of both the blocking manipulation and the congruence of participants' perceptual organization classifications with the initial category structure. As in the previous analyses, participants in the Affect Initial and Body-Size Initial Groups were classified as exhibiting either high, medium, or low congruence with the initial category structure, depending on their perceptual organization classification. We anticipated that low-congruence participants would perform substantially better in the shift phase than high-congruence participants, because participants with low congruence between their perceptual organization and the initially relevant cue had high congruence with the shift-phase relevant cue. Participants also were classified as members of the experimental or control groups for the blocking manipulation, as in the previous analyses. Figure 6 depicts average performance in the Shift Learning Phase as a function of the congruence of participant perceptual organization with the initial category structure and the blocking manipulation. Analyses were conducted on average performance in the first three blocks only; performance was near ceiling for many participants in later blocks, and early learning performance was expected to be more diagnostic of the effects of interest.

The main effect of the blocking manipulation was significant, $F = 14.31$, $p < .001$, indicating that later learning about the blocked cue was attenuated for the experimental group relative to the control group. This main effect echoes previous findings that learning about a blocked cue is retarded relative to learning about non-blocked control cues (Kruschke & Blair, 2000; Kruschke, 2005b). The main effect of the congruence of participants' perceptual organization classifications with the initial category structure also was significant, $F = 61.62$, $p < .001$. Follow-up evaluations indicated that all pair-wise differences were significant: low vs medium, $t = 4.14$, $p < .001$, low vs high, $t = 11.97$, $p < .001$, medium vs high, $t = 6.37$, $p < .001$.

In other words, regardless of the blocking manipulation, participants learned more rapidly a category structure that was congruent with their initial perceptual organization.

A significant interaction between the blocking manipulation and the congruence of participants' perceptual organization classifications with the initial category structure emerged, $F = 4.50$, $p < .05$. Follow-up comparisons of the blocking effect for each level of the congruence factor indicated a significant blocking effect for the low-congruence group, $t = -3.66$, $p < .001$, and the medium-congruence group, $t = -3.85$, $p < .01$, and a non-significant effect for the high-congruence group, $t = .47$, n.s. Inspection of Figure 6 facilitates understanding of this interaction. Participants in the low-congruence group by definition perceived the shift cue to be much more salient than the initial cue. These participants showed a strong blocking effect, such that those in the control group learned quickly about the shift cue (which was not blocked), whereas those in the experimental group learned far more slowly about the shift cue (which was blocked). Participants in the medium-congruence group showed a similar pattern. But participants in the high-congruence group – who perceived the shift cue to be far less salient than the initial cue – showed no evidence of blocking. This pattern of findings was inconsistent with the analogy to previous research involving blocked cues (with no initially middling values and attentionally separable dimensions; Denton & Kruschke, 2005). This prior work suggested that it would be harder to block a more salient shift cue, such that participants in the high-congruence group would have shown the strongest blocking effect. Instead, the results are consistent with the hypothesis that the Initial-Phase items have continuing influence throughout subsequent phases and attention is not shifted easily from the enduring perceived salience of these holistically processed dimensions.

Conclusions

This study evaluated three potential influences on women's learning about other women's affective or weight-related information: individual differences in the perceived salience of affect and body-size information, an experimental blocking manipulation, and the interaction between these two factors. We also used formal modeling techniques to evaluate whether shifts of attention toward relevant stimulus dimensions played a role in participants' learning.

As expected, congruence of individual differences in perceptual organization with the experienced category structure exerted a strong influence on performance throughout the phased-learning task, regardless of whether participants were in an experimental or control condition for the blocking manipulation. In the Initial Learning Phase, participants who experienced a category structure that was congruent with their perceptual organization showed percent-correct scores that were 13 percentage points higher than participants who experienced an incongruent category structure. In the Transfer Phase, participants showed much stronger transfer to a cue that was congruent with their perceptual organization (82.84 degrees) than to a cue that was incongruent with their perceptual organization (51.70 degrees). And in the Shift Learning Phase, participants learning a category structure that was congruent with their perceptual organization showed a 29-point advantage in percent correct, relative to participants learning an incongruent category structure. The greater overall perceived salience of affect than body size also influenced category learning. Average performance on the initial affect structure ($\underline{M}$ = .94, $\underline{SD}$ = .09) was significantly better than average performance on the body-size structure ($\underline{M}$ = .87, $\underline{SD}$ = .13), $\underline{t}(119) = 3.52$, $p < .01$. Performance on the later affect structure ($\underline{M}$ = .80, $\underline{SD}$ = .20) also was superior to that on the later body-size structure ($\underline{M}$ = .66, $\underline{SD}$ = .20), $\underline{t}(240) = 5.72$, $p < .001$. Thus, both average perceptual organization across participants (i.e., the greater perceived salience of affect than body size overall) and individual differences in perceptual organization influenced category learning, providing further evidence of the generalizability of the normative perceptual organization-learning relationship that previously has been observed with simple, artificial stimuli.

The blocking manipulation produced a notable reduction in transfer to and later learning about a blocked cue. Whereas control participants on average showed moderate transfer to the dimension underlying the initial category structure (43.99 degrees), experimental participants showed much stronger transfer to the (unblocked) dimension underlying the initial structure (68.49 degrees). Experimental participants also showed attenuated shift learning of the blocked cue relative to control participants (70 versus 78 percent correct).

The blocking effect on transfer and learning could reflect either shifting of attention away from the blocked cue or a re-mapping of the associations between regions of the psychological space and the category labels in the Initial Learning Phase. We fit RASHNL to the choice data from the four groups simultaneously to evaluate whether attention shifting played a role in learning. The best fitting parameters showed an attentional shift rate of *zero*. This lack of attentional learning is consistent with the stimulus dimensions being integral, not separable, as was suggested by the fact that the best fitting similarity-scaling metric was Euclidean, not city-block. The modeling suggests conclusions here that echo those made for men's perceptions of women in the previous section of the chapter. Women's learning about other women's affect and body size is influenced strongly by the observer's perceived salience of the dimensions. It is difficult to shift attention rapidly between these dimensions, even when performance on a category learning task would be facilitated by doing so.

The congruence of perceptual organization with the initial category structure interacted with the blocking manipulation. In general, when the initial category structure was congruent with the perceptual organization that a participant brought to the task, then performance on the shift category structure was very poor indeed. When, initially, participants experienced a category structure that was incongruent with their perceptual organization, they showed an average of 83% correct. When participants only later were exposed to a category structure that was incongruent with their perceptual organization – <u>after</u> having experienced a category structure that either was congruent or could be perceived as congruent (the Redundant Relevant Cues phase of learning, in the case of control participants) – they showed an average of 59% correct (or 68% correct, if all blocks in the shift learning phase are considered). This disparity in performance as a function of learning history and perceptual organization congruence is quite worrisome, given the simplicity of the category structures being presented (e.g., heavy vs light or happy vs sad). Thus, it will be of particular interest in future work to evaluate whether women who report disordered eating patterns are particularly likely to struggle when trying to learn an affect category structure at all, and especially after experiencing a body-size category structure. If so, then the blocking paradigm might serve as a useful analogue for a real-life circumstance in which the social environment's reinforcement of young women's preoccupation with body-size information as a royal road to happiness makes it extremely difficult to learn about alternative predictors of success.

Closing Comments

Category-learning processes play a central role in everyday life, and cognitive scientists have worked for decades to develop valid models and paradigms for the investigation of normative learning processes with simple, artificial stimuli. The work described in this chapter highlights the generalizability of these models and methods to the study of clinically relevant individual differences in category-learning processes with far more complex, socially and emotionally relevant information. Accounting for individual differences in category learning with complex stimuli necessitates an increased focus on individual differences in the perceived salience of stimulus dimensions. The present work documents the substantial influence of across-individual variability in perceived dimensional salience on category learning, such that participants learn category structures that are more congruent with their underlying perceptual organizations far more quickly than category structures that are less congruent. This faster learning of salience-congruent structures persists even after learning a salience-incongruent structure, most likely because the socially relevant stimuli have integral dimensions that prevent shifts of attention between dimensions. This observed link between individual differences in perceived salience and individual differences in category learning extends the well-established link between normative perceived salience and category learning.

The dimensions of the complex, socially relevant stimuli of interest to some clinical researchers also may be processed in a more holistic fashion than the components of the artificial stimuli of primary interest to cognitive researchers, which typically are processed more separably. Prior research with artificial stimuli has demonstrated that attention-shifting mechanisms play a far less significant role in category learning with integral-dimension stimuli (Nosofsky & Palmeri, 1996) than separable-dimension stimuli. The research described herein extends this finding to applied research with far more complex stimuli. In both reported studies, formal fits of RASHNL (Kruschke & Johansen, 1999) to the category-learning data indicated that learning resulted not from shifting attention toward relevant stimulus dimensions and away from irrelevant dimensions (because the best-fitting attentional shift rate was zero), but rather from individual differences in the initial perceived salience of stimulus dimensions and the gradual strengthening of associations between regions of the stimulus space and category labels. The evident difficulties in dynamic re-allocation of attention for integral stimuli enhance the significance of individual differences in perceptual organization in applied social learning. They also highlight the importance of future research on the conditions associated with increased dimensional attention shifting, even when the stimulus dimensions are perceived more holistically, as the ability to shift attention rapidly could be quite adaptive in social perceptual learning.

More generally, the present work illustrates the utility of translating associative-learning paradigms to address applied questions about clinically and socially relevant processing of complex stimuli. These paradigms may offer useful analogues of "real world" social learning environments that presumably contribute to the development of attitudes and beliefs of interest to clinical researchers. Formal modeling techniques then could be used to elucidate the mechanisms underlying learning, which not only might enhance clinical scientists' understanding of the role of more dynamic aspects of processing in clinical phenomena, but also might contribute to the development of novel prevention or intervention strategies that directly target deficient or maladaptive cognitive processing. Current cognitively oriented treatments rely primarily on verbally mediated techniques that emphasize the identification and modification of specific distorted thoughts and beliefs (Treat et al., 2007), but cognitive therapy might be augmented usefully by drawing to a greater degree on the plethora of associative-learning paradigms to modify problematic processing patterns or to facilitate the acquisition of important category structures.

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Table 1

Design of Phased-Learning Task in Women's Learning Study.

	Learning Phase				
Condition/Group	Initial	Redundant	Transfer	Shift	N
Affect Initial	Affect	Affect + Body Size	Transfer	Body Size	63
Affect Control	--------	Affect + Body Size	Transfer	Body Size	59
Body-Size Initial	Body Size	Affect + Body Size	Transfer	Affect	58
Body-Size Control	--------	Affect + Body Size	Transfer	Affect	62

Figure Captions

Figure 1. Multidimensional spatial representation of perceptual organizations of participants who perceive exposure to be relatively more salient than affect (upper panel) and who perceive affect to be relatively more salient than exposure (lower panel). See text for further information.

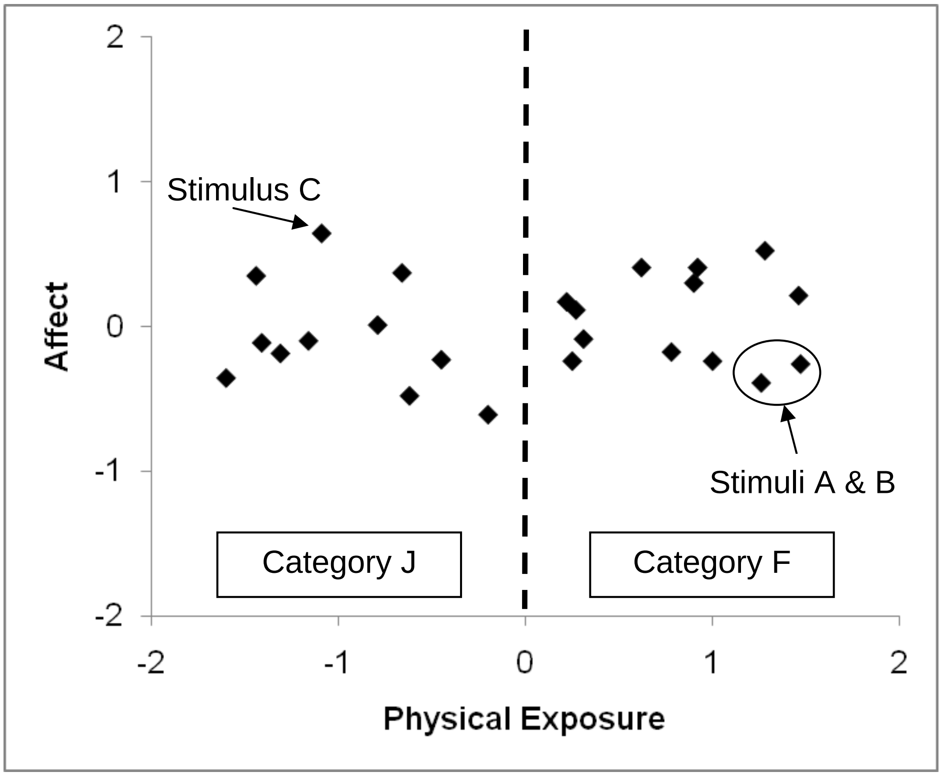
Figure 2. Perceptual organization and category structure (Task) influence performance on exposure and affect category-learning tasks in men's learning study. AO = Affect-Oriented. EO = Exposure-Oriented. Bars correspond to standard error of the means.

Figure 3. Phased-learning schemata, for Body-Size Initial condition in women's learning study.

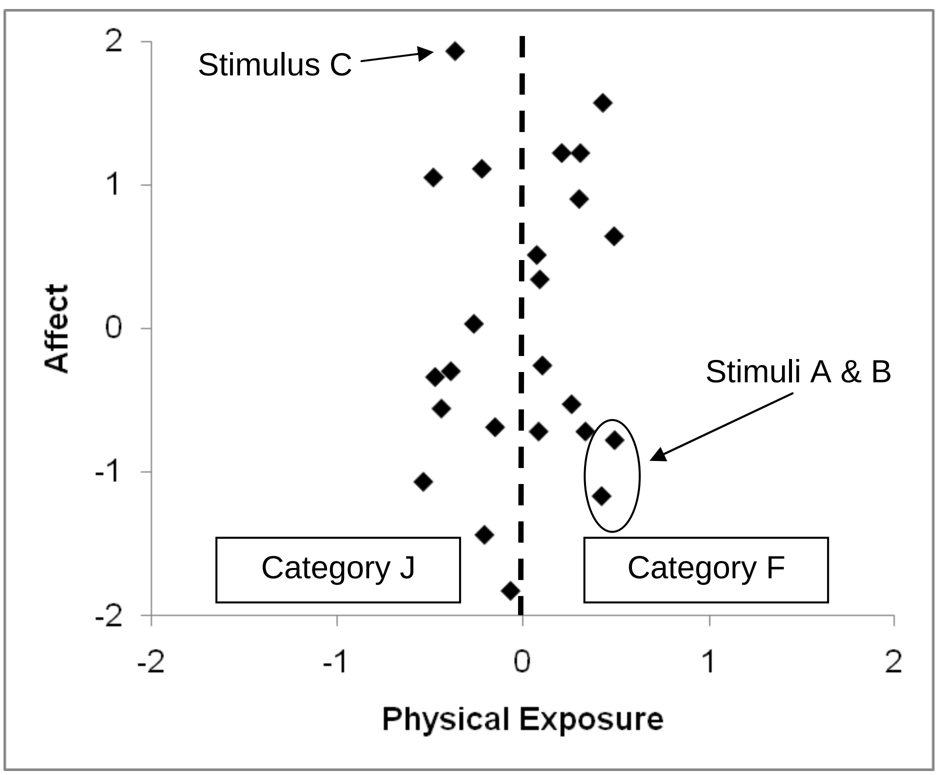
Figure 4. The congruence of perceptual organization with the initial category structure influences performance in the initial learning phase of the women's learning study. Bars correspond to bootstrapped standard error of the means.

Figure 5. The blocking manipulation and the congruence of perceptual organization with the initial category structure influence performance in the transfer phase of the women's learning study. Bars correspond to bootstrapped standard error of the means.

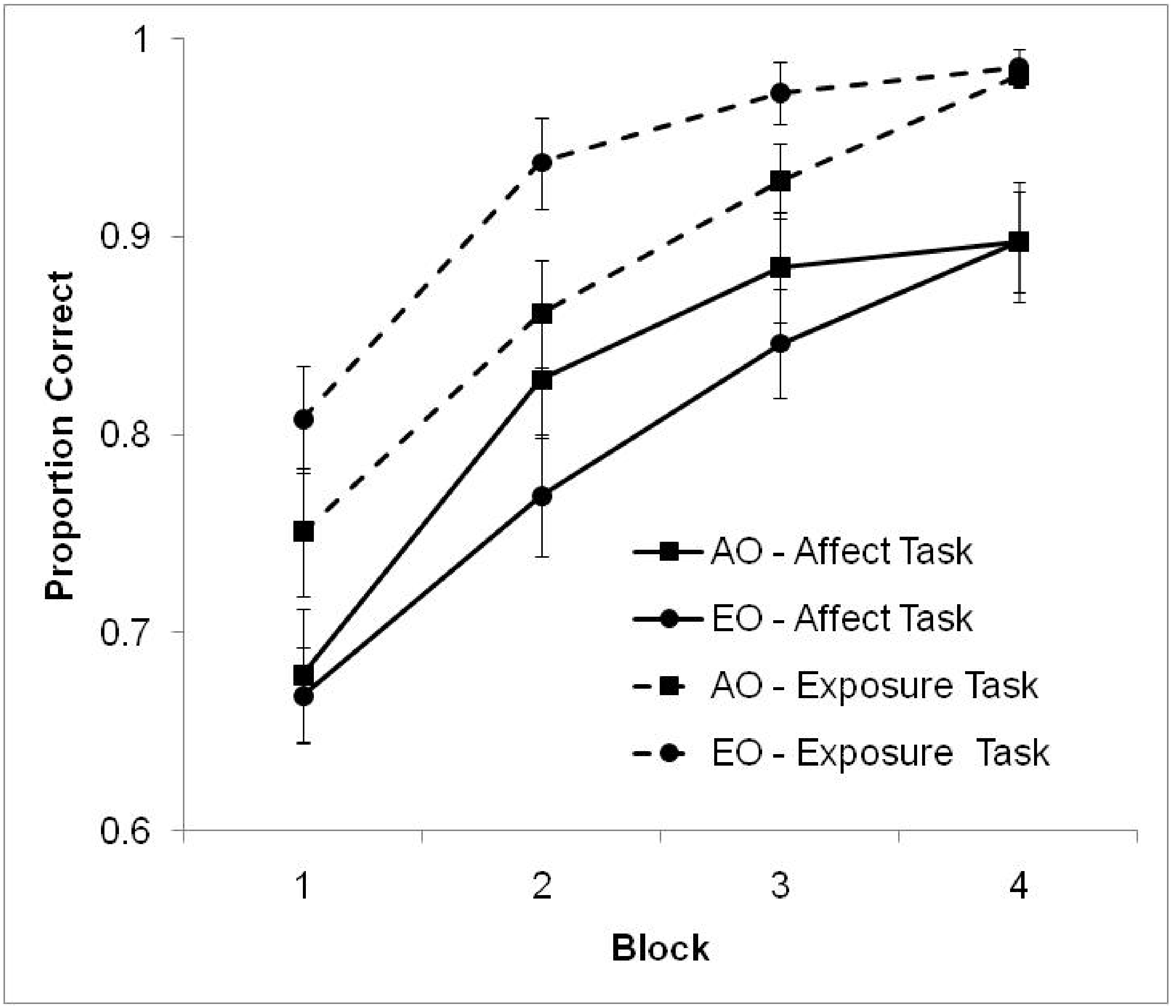
Figure 6. The blocking manipulation and the congruence of perceptual organization with the initial category structure influence performance on the first three blocks of the shift learning phase of the women's learning study. Bars correspond to bootstrapped standard error of the means.

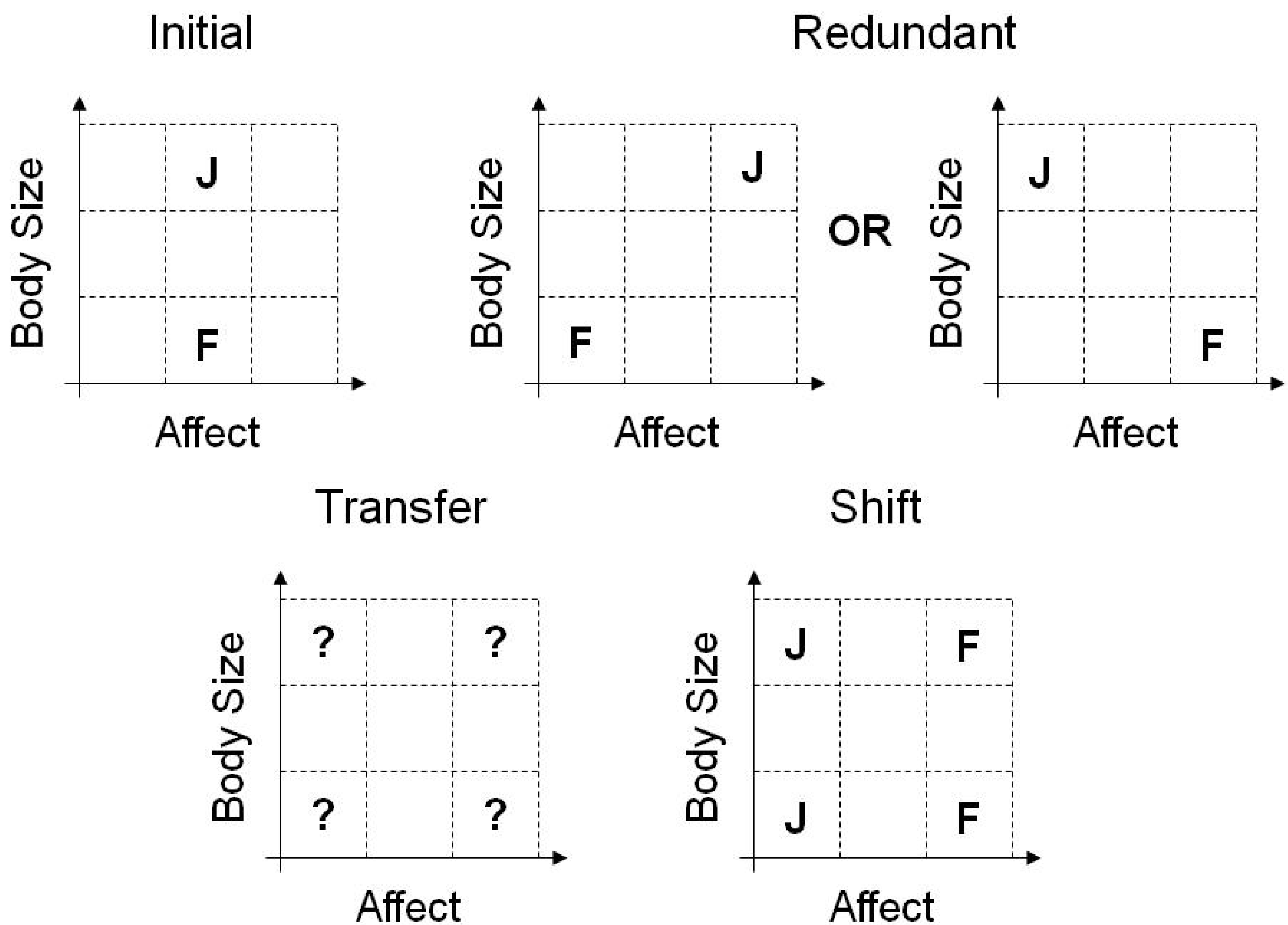


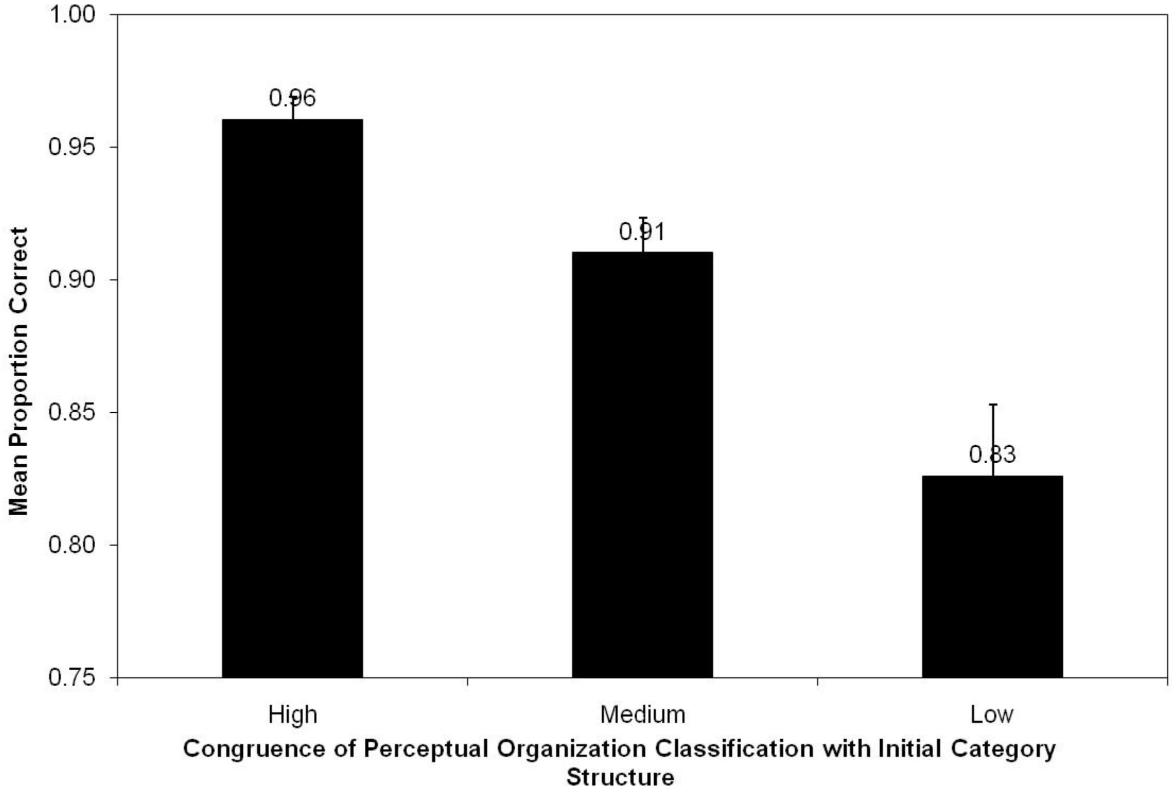
Stimulus C
Stimuli A & B
Category J
Category F
Affect
Physical Exposure
2
1
0
-1
-2

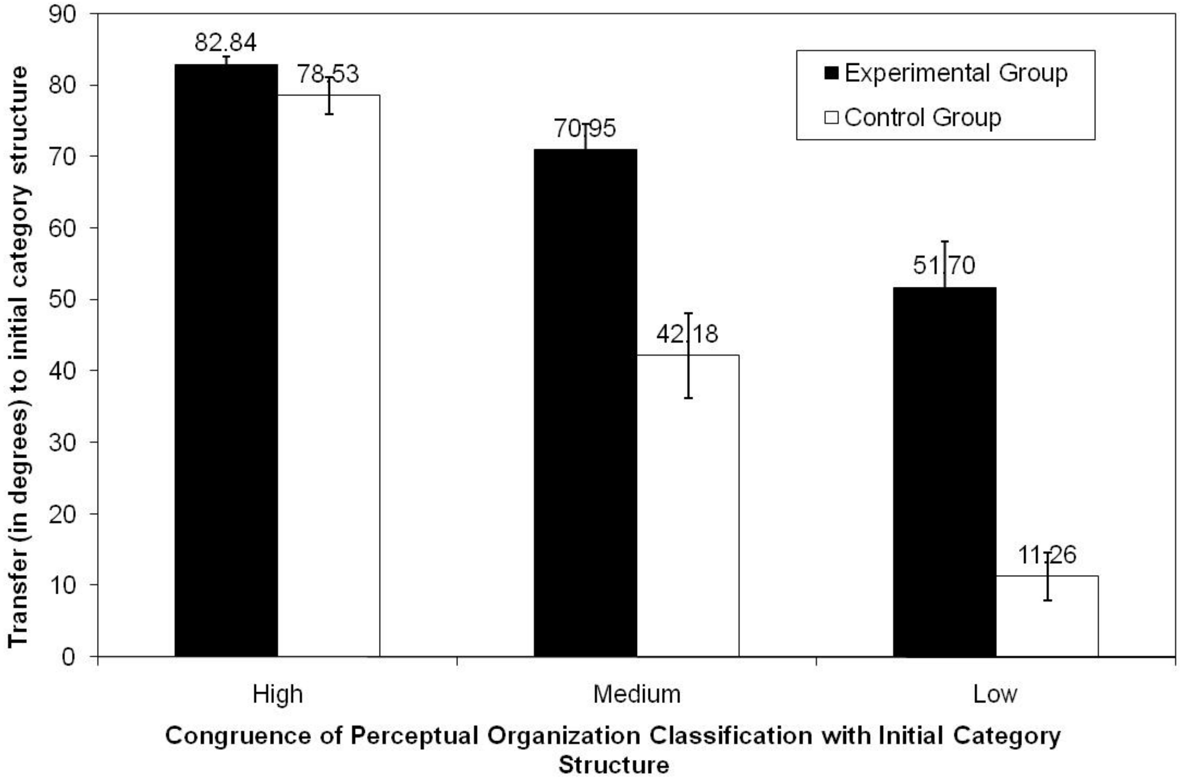


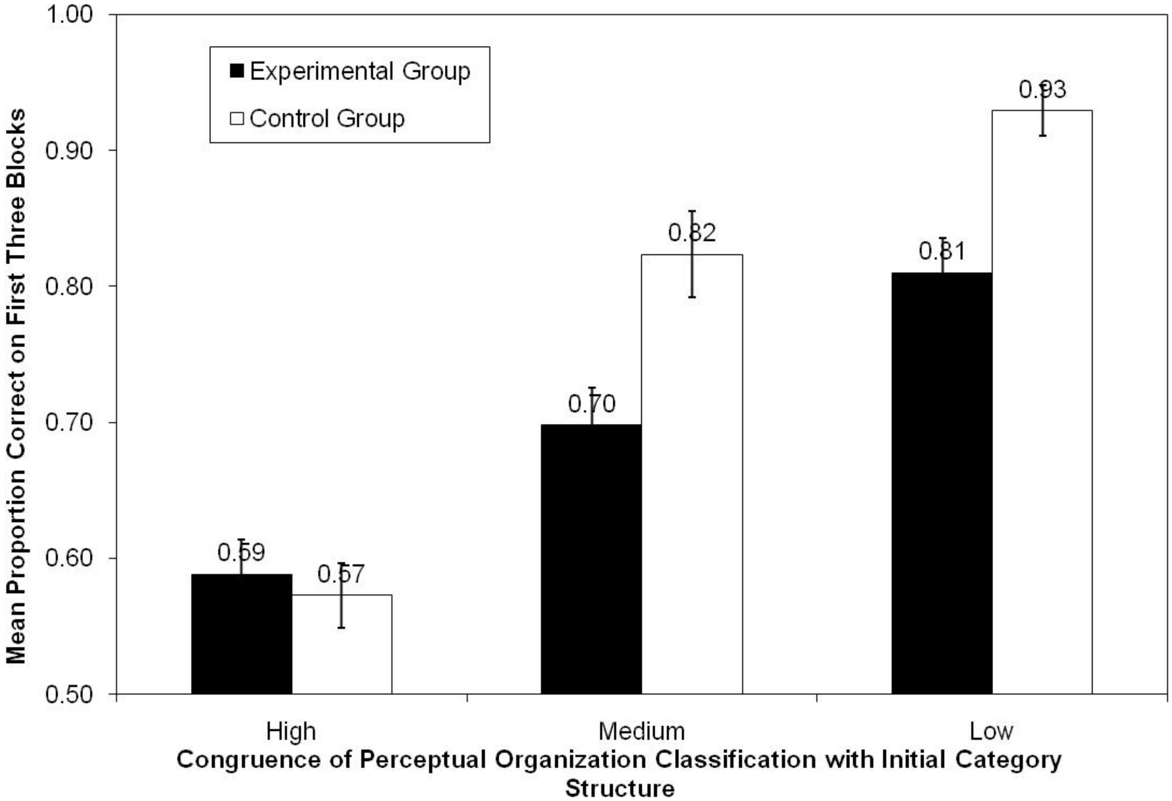
Stimulus C
Stimuli A & B
Category J
Category F
Affect
Physical Exposure
2
1
0
-1
-2


1
0.9
0.8
0.7
0.6
Proportion Correct
1
2
3
4
Block
AO - Affect Task
EO - Affect Task
AO - Exposure Task
EO - Exposure Task


Initial
Body Size
J
F
Affect
Redundant
Body Size
J
F
Affect
OR
Body Size
J
F
Affect
Transfer
Body Size
?
?
?
?
Affect
Shift
Body Size
J
F
J
F
Affect


1.00
0.95
0.90
0.85
0.80
0.75
Mean Proportion Correct
0.96
0.91
0.83
High
Medium
Low
Congruence of Perceptual Organization Classification with Initial Category Structure


90
80
70
60
50
40
30
20
10
0
82.84
78.53
70.95
42.18
51.70
11.26
Experimental Group
Control Group
Transfer (in degrees) to initial category structure
High
Medium
Low
Congruence of Perceptual Organization Classification with Initial Category Structure


Mean Proportion Correct on First Three Blocks
1.00
0.90
0.80
0.70
0.60
0.50
Experimental Group
Control Group
0.59
0.57
0.70
0.82
0.81
0.93
High
Medium
Low
Congruence of Perceptual Organization Classification with Initial Category Structure