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Brief article

Familiarity effects on categorization levels of faces and objects

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ABSTRACT

It is well established that faces, in contrast to objects, are categorized as fast or faster at the individual level (e.g., Bill Clinton) than at the basic-level (e.g., human face). This subordinate-shift from basic-level categorization has been considered an outcome of visual expertise with processing faces. However, in the present study we found that, similar to familiar faces, categorization of individually-known familiar towers is also faster at the individual level than at the basic-level in naïve participants. In addition, category-verification of familiar stimuli, at basic and superordinate levels, was slower and less accurate compared to unfamiliar stimuli. Thus, the existence of detailed semantic information, regardless of expertise, can induce a shift in the default level of object categorization from basic to individual level. Moreover, the individually-specific knowledge is not only more easily-retrieved from memory but it might also interfere with accessing more general category information.

1. Introduction

Objects can be recognized at various levels of abstraction, yet most observers tend to classify them by default at a level that have termed as *basic* (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). It is assumed that most human knowledge about objects is organized at this level, as it allows efficient balance between the specificity and distinctiveness of object properties (Murphy & Brownell, 1985); on the one hand, categorization at the basic-level is more specific than at a superordinate-level (for example, *dog* [basic] includes more details than *pet* [superordinate]). On the other hand, for most people, basic-level categories are more distinctive than subordinate categories when contrasted with other categories (*dog* vs. *cat* [basic] compared to *Beagle* vs. *Terrier* [subordinate]).

However, exceptions to the rule stating that the basic-level is the level at which objects are first recognized, were observed over the years. For example, atypical members of a category are named at a subordinate-level and not at a basic-level (*penguin* and not *bird;* Jolicoeur, Gluck, & Kosslyn, 1984; Murphy & Brownell, 1985). In addition, expertise, of both real-world and laboratory-trained experts, has been shown to induce a subordinate-shift in which objects are identified at a subordinate level rather than at the basic-level (Gauthier & Tarr, 1997; Johnson & Mervis, 1997; Scott, Tanaka, Sheinberg, & Curran, 2006; Tanaka & Taylor, 1991).

One specific case of expertise is face perception, a domain in which all humans are normally experts. In a well-known study Tanaka (2001) has shown that adults identify faces at a subordinate level (*Bill Clinton*) as fast as at the basic-level (*human face*). In contrast, for objects the basic-level categorization was preferred over subordinate-level categorization and participants categorized dogs slower at the subordinate-level (*Labrador*) than at the basic-level (*dogs*).

Importantly, in that latter study the subordinate level of faces and objects was not equated. While for objects the subordinate level was comprised of biological sub-species, for faces the subordinate-level consisted of a unique identity, representing a single object in the world. Addressing this discrepancy Tanaka mentioned that identification of

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a face at an individual level places greater perceptual constraints on the recognition system. Hence, the subordinate-shift that occurred for faces despite these perceptual demands demonstrates that expertise can modify the default level at which objects are first recognized. However, even without being an expert, individually-known objects and faces can be easily identified because of their frequent exposure to the perceiver. For example, even if someone is not a dog expert in the sense that she cannot easily distinguish between Beagles and Poodles she might still be able to easily identify her own Labrador among others. Thus, a down-shift from the default basic-level to the individual-level may characterize not only faces or objects of expertise but also objects that are familiar at the individual level.

In the present study participants performed a category-verification task in which they judged whether pictures of famous faces and famous towers matched a specific category-level. Assuming that a down-shift from basic-level categorization does exist for familiar stimuli we expected to find that identification at the individual level is as fast as categorization at the basic-level for both faces and towers.

A second related issue examined in this study was whether the activation of specific features characterizing individually-known items, affects basic-level and superordinate-level categorization. On the one hand familiarity might facilitate perception and, therefore, categorization at all levels (e.g., Gibson, 1991; Goldstone & Kersten, 2003). On the other hand, allocating attention to the individual level might inhibit "higher-level" categorization (as often found in priming effects, Neely, 1991). To this end, we compared basic and superordinate categorization for familiar and unfamiliar items.

2. Method

2.1. Participants

Twenty-eight undergraduate students (18 females, 5 left-handed) of the Hebrew University participated in the study. Their age ranged between 21 and 39 years (mean = 25) and all reported normal or corrected-to-normal visual acuity. They signed an informed consent according to the institutional review board of the Hebrew University, and received either course credit or payment for their participation. None of the participants reported any formal or informal knowledge in architecture.

2.2. Materials

The picture stimuli consisted of eight color photographs of famous towers (e.g., Leaning Tower of Pisa) and eight photographs of famous faces (e.g., Condoleezza Rice). The stimuli were selected on the basis of familiarity ratings collected in a pilot study which included several types of famous landmarks (e.g., bridges, monuments, cathedrals). The category of towers was selected since it included enough items with high familiarity ratings. The two categories were equated for familiarity. During debriefing it was verified with the current participants that all familiar stimuli were individually-known.

Eight additional non-famous towers and unfamiliar faces were added to these categories. We attempted to match the unfamiliar and familiar stimuli to each other as close as possible. In addition, 16 monkey faces and 16 bridges were also included to serve as contrast categories to the target categories at the basic-level category verification.

Pictures were rescaled to a size of $5.33 \times 6.84°$ (8×12 cm) and equated for luminance and contrast (Fig. 1). Stimulus presentations and data recordings were controlled by E-Prime software (Psychological Software Tools, 2000).

2.3. Procedure

In each trial participants were presented with a category label, at either the superordinate (living/non-living), basic (tower/bridge, human/monkey) or individual level (e.g., Hugh Grant or Eiffel Tower), followed by a picture. They were requested to respond as quickly and accurately as possible whether the picture and the category name matched. Each trial began with a 500 ms fixation mark presented at the center of the screen, replaced by a category name for 2000 ms. At the offset of the category name a pic-

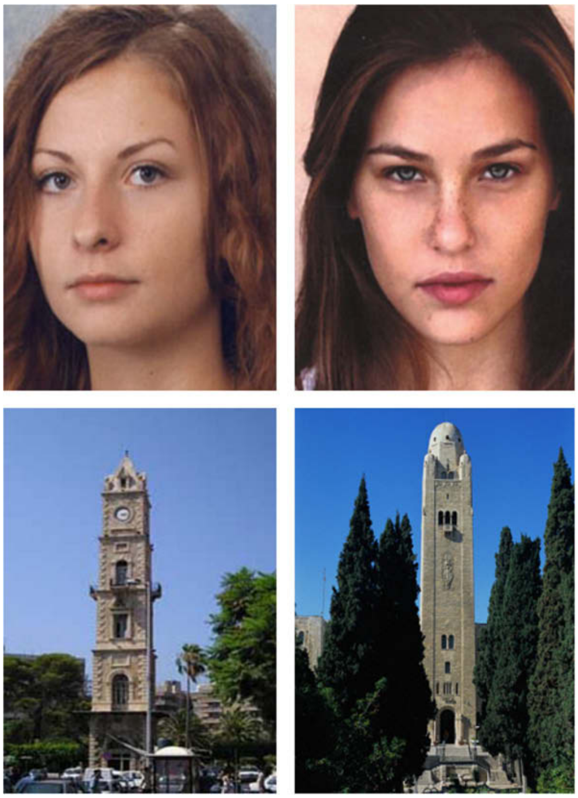

Fig. 1. Example of unfamiliar (left) and familiar (right) faces and towers (the familiar stimuli are Bar Refaeli (Israeli model) and YMCA tower (Jerusalem)).

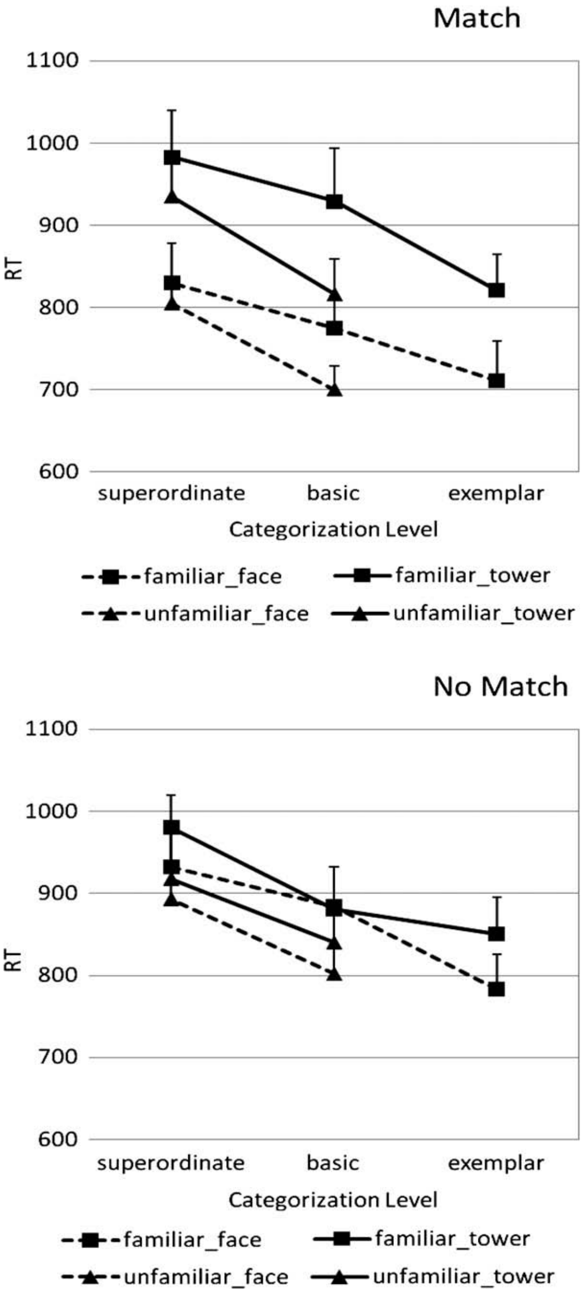

Fig. 2. Response latency for match (top) and no match (bottom) familiar and unfamiliar faces and towers as a function of categorization level. Error bars represent standard errors.

ture was presented at fixation and remained exposed until response. Using the index and middle fingers of their dominant hand participants pressed the "1" on a keypad if the name and picture matched and the "2" if they did not. The match condition was presented in half of the trials while the other trials were mismatched.

Each participant completed 288 trials, comprising 128 superordinate-level verification trials (4 categories × 16 trials in each category × 2 matching conditions), 128 basic-level verification trials, and 32 individual-level verification trials (2 categories × 8 trials × 2 matching conditions). Thus, each of the eight famous faces and towers was presented six times, while the unfamiliar stimuli in each of the four categories were presented four times. The levels of categorization were mixed and the 288 trials were presented in random order. Breaks were introduced every 48 trials. Prior to the experiment participants performed twenty practice trials with feedback.

3. Results

Due to the small number of trials in each condition, outlier RTs were not excluded; rather their relative bias was reduced using a log-transformation for each data point. After averaging, the means of the log-transformation measures were transformed back to the original scale of measurement – simple RTs. Mean response latency and accuracy are presented for the familiar and unfamiliar faces and towers at the different category levels in Fig. 2 for both match (top) and non-match responses (bottom; Table 1). By necessity, two separate analyses of variance (ANOVAs) were performed to address the study's two goals. The first did not include unfamiliar stimuli (which have only two levels of categorization). The second did not include the individual-level of familiar stimuli.

Participants were faster to categorize the stimuli at the individual-level than at the basic-level, the latter being faster than the superordinate-level. Importantly, this effect was obtained for both faces and towers. An ANOVA performed for correct responses with Stimulus Type (faces, towers), Categorization Level (superordinate, basic, individual) and Response Condition (match, no-match) as within-subject factors confirmed this observation. The main effect of Categorization Level was significant, $F(1,26) = 11.35$, $p < .001$, $MSe = 31{,}228$, $\eta^2_p = .466$. Pairwise comparisons showed that across stimuli categorization was faster at the individual-level than at either basic [$t(27) = 3.44$, $p < .002$] or superordinate levels [$t(27) = 4.84$, $p < .001$], and faster at basic than superordinate levels

Table 1
Mean (and SD) accuracy for faces and towers as a function of familiarity, categorization level and type of response.

Categorization level	Familiar				Unfamiliar			
	Match		No Match		Match		No Match	
	Faces	Towers	Faces	Towers	Faces	Towers	Faces	Towers
Exemplar	0.98 (.043)	0.98 (.046)	0.98 (.062)	0.96 (.059)				
Basic	0.99 (.031)	0.97 (.079)	0.99 (.031)	0.96 (.059)	0.99 (.022)	0.96 (.065)	0.97 (.050)	0.97 (.065)
Superordinate	0.98 (.048)	0.91 (.092)	0.96 (.071)	0.98 (.060)	0.97 (.063)	0.91 (.104)	0.96 (.068)	0.98 (.059)

[$t(27) = 3.01$, $p < .006$]. Faces were categorized faster than towers, $F(1,27) = 13.82$, $p < .001$, $MSe = 50{,}047$, $\eta_p^2 = .338$, and match trials were faster than no-match trials, $F(1,27) = 8.40$, $p < .01$, $MSe = 21{,}290$, $\eta_p^2 = .237$. A significant Stimulus Type X Response Condition interaction [$F(1,27) = 5.03$, $p < .05$, $MSe = 39{,}189$, $\eta_p^2 = .157$] followed by separate ANOVAs indicated that the Stimulus Type effect was larger for match trials [$F(1,27) = 68.05$, $p < .001$, $MSe = 32{,}2749$, $\eta_p^2 = .716$] than no-match trials [$F(1,27) < 1$]. No other effects were significant.

Rather than relying only on the absence of interaction we also examined the Categorization Level effect for faces and towers separately. Indeed, the main effect of Categorization Level was significant for both types of stimuli (faces: $F(1,26) = 19.29$, $p < .001$, $MSe = 13{,}195$, $\eta_p^2 = .417$, towers: $F(1,26) = 7.12$, $p < .005$, $MSe = 37{,}515$, $\eta_p^2 = .207$). Pairwise comparisons showed that for both faces and towers stimuli categorization was faster at the individual-level than at either basic [faces: $t(27) = 3.66$, $p < .001$, towers: $t(27) = 2.24$, $p < .05$] or superordinate levels [faces: $t(27) = 7.183$, $p < .001$, towers: $t(27) = 2.86$, $p < .01$], and faster at basic than superordinate levels [faces: $t(27) = 2.13$, $p < .05$, towers: $t(27) = 2.04$, $p = .05$].

Although performance was highly accurate, ANOVA was also performed on accuracy data revealing a Categorization Level effect, $F(1,27) = 4.52$, $p < .05$, $MSE = .004$, $\eta_p^2 = .258$. Participants responded correctly on 95.6%, 97.9% and 97.6% of the trials for superordinate, basic and individual levels of categorization, respectively. Pairwise comparisons revealed significant differences between the superordinate and the two other levels ([$t(27) = 3.03$, $p < .005$] and [$t(27) = 2.06$, $p < .05$] for basic and exemplar, respectively).

Focusing on familiarity effects we observed that the overall pattern of performance was similar across categories, with response latencies faster and more accurate at the basic- than at the superordinate-level for both familiar and unfamiliar stimuli. However, responses to unfamiliar stimuli were *faster* than familiar stimuli, regardless of stimulus type. This observation was supported by ANOVA performed on the RTs with Familiarity (familiar, unfamiliar), Response Condition, Stimulus Type and Categorization Level as within-subject factors. The main effect of Familiarity was significant, $F(1,27) = 12.58$, $p < .001$, $MSe = 28{,}344$, $\eta_p^2 = .318$, as well as the Categorization Level, $F(1,27) = 20.04$, $p < .001$, $MSe = 33{,}530$, $\eta_p^2 = .426$. Stimulus Type was also significant, with faster RTs for faces than for towers, $F(1,27) = 22.09$, $p < .0001$, $MSe = 37{,}706$, $\eta_p^2 = .450$. A Stimulus Type X Response Condition interaction [$F(1,23) = 7.04$, $p < .01$, $MSe = 43{,}269$, $\eta_p^2 = .207$], indicated that faces were categorized faster in matching trials ($F(1,23) = 44.81$, $p < .0001$, $MSe = 19{,}478$, $\eta_p^2 = .661$) but not in non-matching trials ($F(1,23) = 1.17$, $p > .18$). No other effects were significant.

Participants were more accurate when categorizing at the basic-level than at the superordinate-level ($F(1,27) = 10.74$, $p < .005$, $MSe = .005$, $\eta_p^2 = .285$). As in the latency data faces were categorized more accurately than towers, $F(1,27)=13.22$, $p<.001$, $MSe=.004$, $\eta_p^2 = .329$. This effect was qualified by a Stimulus Type X Response Condition interaction ($F(1,27) = 15.59$, $p < .001$, $MSe = .004$, $\eta_p^2 = .366$) resulting from higher accuracy for faces in match trials ($F(1,27) = 29.12$, $p < .001$, $MSe = .004$, $\eta_p^2 = .519$) but not in non-match trials ($F(1,27) < 1$).

4. Discussion

Finding a subordinate- or individual-level shift in category verification tasks is often considered evidence for visual expertise (e.g., Gauthier & Tarr, 1997; Tanaka, Curran, Porterfield, & Collins, 2006). Along these lines, Tanaka (2001) interpreted the down-shift found for face categorization to the obvious human expertise with faces. In the present study we revealed that a similar shift of default categorization from basic-level to the individual-level can be induced for non-face stimuli with which the observer is not expert, such as towers, if she can identify the stimuli at the individual-level. Although cases of subordinate-shift were shown to occur with non-face stimuli in previous studies (Scott et al., 2006; Tanaka & Taylor, 1991) the present results are novel in that (a) participants categorized towers at the individual-level faster than at the basic-level without going through an extended training period and without being experts with the basic-level (towers) category, and (b) while previous shifts from basic category level were previously demonstrated from the basic- to the subordinate-level, in the present study it was expanded to the individual-level as well.

Why did we observe a shift to the individual-level for non-face objects, similar to faces, while numerous studies have shown that objects are usually identified at their basic- and not at a subordinate-level? The present findings indicate that, in addition to expertise and typicality, individual familiarity is an additional determinant that may induce a down-shift in default level of categorization. The influence of this factor can be understood in terms of an "entry-point" hypothesis which argues that the recognition of an object first occurs at the level which corresponds best to the perceptual characteristics that are most salient in memory (Jolicoeur et al., 1984). Relative to unfamiliar objects, individually-known objects are represented in memory by a richer set of salient features, which facilitate their specific recognition. These representations still adheres to the principle dictated by Rosch et al. (1976) that objects are represented at a level that maximizes their specificity and distinctiveness. Consequently, when they are encountered in real-world they are identified at this level.

If the above interpretation is correct we should treat cautiously claims about expertise (for either objects or faces) being a trigger to shifts in the default level of categorization if these claims are based solely on findings showing that stimuli are recognized as fast at the individual- as at the basic-level. Identifying a familiar object at its individual-level could be based not on our perceptual expertise with the specific category to which it belongs, or on its discriminability from other stimuli presented in the same context (D'Lauro, Tanaka, & Curran, 2008), but on a myriad of other idiosyncratic individual features that are not usually used in expert categorizations (e.g., the inclination of a tower or the freckles on someone's face). With this reservation being said we do not deny the fact that there are other qualities that define perceptual expertise. For example, experts are able to transfer their perceptual skills to never-before-seen exemplars within their class of expertise (Scott, Tanaka, Sheinberg, & Curran, 2008; Tanaka, Curran, & Sheinberg, 2005; Tanaka & Pierce, in press). This constraint may provide a more stringent test of perceptual expertise than the downward shift requirement.

A second interesting finding in the present study is that within each category unfamiliar stimuli were categorized *faster* than familiar stimuli at both the basic- and superordinate-level. It could, supposedly, be claimed that this result can be attributed to the specific characteristics of the familiar stimuli at the individual level, which made them harder to categorize at higher-levels, and/or with the fact that individually-known items have not been frequently associated with basic- or superordinate-level categories. Thus, for example, familiar towers may have been less "tower-like" than unfamiliar towers and/or more weakly associated with them being a tower per se. However, we believe that this claim is unlikely for two main reasons: (a) First, this interpretation might account for the familiarity latency differences in the match trials but it cannot explain the differences in the no-match trials. (b) Second, while this account may seem more plausible for the tower category it appears to be less plausible for the face category, where familiarity effects were also found. Why should familiar faces appear less face-like than unfamiliar faces?

A more conceivable interpretation is that the information which is first accessed during object identification is dynamically prioritized according to the current level at which a specific object is categorized. Thus, the same information can be accessed faster or slower depending on whether it is part of the semantic contents at the preferred level of categorization. Specifically, the perceptual knowledge, accessible at the subordinate-level for individually-known items, renders them more distinctive and accessible, interfering with basic-level categorization. Since unfamiliar items do not activate individual exemplar characteristics, the interference from the individual- to basic-level categorization does not exist. Indirect support for this view was provided by Tanaka and Taylor (1991), who found that, being asked to list as many features as possible characterizing an object, experts used more subordinate-level characteristics than novices whereas novices used more basic-level characteristics than experts. It is yet to be determined whether the additional time required to access information at more general, overarching, categories results from mechanisms of passive inhibition (as in the *two-stage process* model of Posner & Snyder, 1975), or due to active inhibition (as in the *center-surround inhibition* model of Carr & Dagenbach, 1990). The former process suggests that activation of semantic information accessible at other category levels is delayed due to allocation of attention to the category-level from which more distinct and specific information is elicited. According to the latter interpretation, the semantic information which can be obtained at more general levels is actively suppressed and therefore harder to access.

Although the present study is, to our knowledge, one of the first to address individual familiarity effects in categorization of objects other than faces (see also Miyakoshi, Nomura, & Ohira, 2007) our findings mirror an earlier report by Murphy and Brownell (1985) which was largely overlooked. In that study atypical category members were categorized *slower* at basic- and superordinate-levels than typical members. For example, a line drawing of a rubber raft was categorized slower as a boat than a line-drawn rowboat. Thus, typical and atypical members of the same basic category differ not only in the subordinate-level categorization, with atypical members categorized faster than typical members, but in other levels as well (see also Ganel & Goshen-Gottstein, 2002). These results stand, purportedly, in contrast to other evidence suggesting that prior conceptual knowledge facilitates perception (Goldstone, 2000). For example, O'Toole, Peterson, & Deffenbacher (1996) have shown that observers, who recognize faces of their own race more accurately than faces of other races (the "other-race effect"), were also more accurate in a sex discrimination task of faces from their own race.

In summary, the present study highlights two novel aspects in object categorization. First, it underscores the importance of individual familiarity, independent of expertise and typicality, as an influential factor in determining the level at which an object is categorized by default. Second, it emphasizes the dynamic aspects of the categorization level which depends on the extent of information available in semantic memory about the particular exemplar.

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References

Carr, T. H., & Dagenbach, D. (1990). Semantic priming and repetition priming from masked words: Evidence for a center-surround attentional mechanism in perceptual recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*, 341–350.

D'Lauro, C., Tanaka, J. W., & Curran, T. (2008). The preferred level of face categorization depends on discriminability. *Psychonomic Bulletin and Review, 15*, 623–629.

Ganel, T., & Goshen-Gottstein, Y. (2002). The perceptual integrality of sex and identity of faces: Further evidence for the single-route hypothesis. *Journal of Experimental Psychology: Human Perception and Performance, 28*, 854–867.

Gauthier, I., & Tarr, M. J. (1997). Becoming a "Greeble" expert: Exploring mechanisms for face recognition. *Vision Research, 37*, 1673–1682.

Gibson, E. J. (1991). *An odyssey in learning and perception*. MIT Press.

Goldstone, R. L. (2000). Unitization during category learning. *Journal of Experimental Psychology: Human Perception and Performance, 26*, 86–112.

Goldstone, R. L., & Kersten, A. (2003). Concepts and categories. In A. F. Healy & R. W. Proctor (Eds.), *Comprehensive handbook of psychology, Volume 4: Experimental Psychology* (pp. 591–621). New York: Wiley.

Johnson, K., & Mervis, C. (1997). Effects of varying levels of expertise on the basic-level of categorization. *Journal of Experimental Psychology: General, 126*, 248–277.

Jolicoeur, P., Gluck, M. A., & Kosslyn, S. M. (1984). Pictures and names: Making the connection. *Cognitive Psychology, 16*, 243–275.

Miyakoshi, M., Nomura, M., & Ohira, H. (2007). An ERP study on self-relevant object recognition. *Brain & Cognition, 63*, 182–189.
Murphy, G. L., & Brownell, H. H. (1985). Category differentiation in object recognition: Typicality constraints on the basic category advantage. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 11*, 70–84.
Neely, J. H. (1991). Semantic priming effects in visual word recognition: A selective review of current findings and theories. In D. Besner & G. Humphreys (Eds.), *Basic processes in reading: Visual word recognition* (pp. 264–336). Hillsdale, NJ: Erlbaum.
O'Toole, A. J., Peterson, J., & Deffenbacher, K. A. (1996). An 'other-race effect' for categorizing faces by sex. *Perception, 25*, 669–676.
Posner, M. I., & Snyder, C. R. R. (1975). Attention and cognitive control. In R. L. Solso (Ed.), *Information processing and cognition: The Loyola symposium* (pp. 55–85). Hillsdale, NJ: Erlbaum.
Psychological Software Tools (2000). E-prime (Version 1.0b) [Computer software]. Pittsburgh, PA.
Rosch, E., Mervis, C., Gray, W., Johnson, D., & Boyes-Braem, P. (1976). Basic objects in natural categories. *Cognitive Psychology, 8*, 382–439.
Scott, L., Tanaka, J. W., Sheinberg, D., & Curran, T. (2006). A reevaluation of the electrophysiological correlates of expert object processing. *Journal of Cognitive Neuroscience, 18*, 1453–1465.
Scott, L. S., Tanaka, J. W., Sheinberg, D. L., & Curran, T. (2008). The role of category learning in the acquisition and retention of perceptual expertise: A behavioral and neurophysiological study. *Brain Research, 1210*, 204–215.
Tanaka, J. (2001). The entry point of face recognition: Evidence for face expertise. *Journal of Experimental Psychology: General, 130*, 534–543.
Tanaka, J. W., Curran, T., Porterfield, A. L., & Collins, D. (2006). Activation of pre-existing and acquired face representations: The N250 ERP as an index of face familiarity. *Journal of Cognitive Neuroscience, 18*, 1488–1497.
Tanaka, J. W., Curran, T., & Sheinberg, D. (2005). The training and transfer of real world perceptual expertise. *Psychological Science, 16*, 145–151.
Tanaka, J. W., & Pierce, L. J. (in press). The neural plasticity of other-race face recognition. *Cognitive, Affective and Behavioral Neuroscience*.
Tanaka, J., & Taylor, M. (1991). Object categories and expertise: Is the basic-level in the eye of the beholder? *Cognitive Psychology, 23*, 457–482.