Arbitrary Category Labels Can Change Similarity Judgments of Human Faces

Frankie Lara (frankie.lara@jaguar.tamu.edu)
Amanda Hahn (achahn30@gmail.com)
Na-Yung Yu (nayungyu@gmail.com)
Takashi Yamauchi (takashi-yamauchi@tamu.edu)
Department of Psychology, Mail Stop 4235
Texas A&M University, College Station, TX 77843 USA

Abstract

In two experiments, participants were presented with a triad of morphed White and Hispanic faces paired with pseudoword labels. The meanings of these labels were manipulated to represent categorical information about the face. Labels were said to represent either the person's belief, the food s/he ate, the disease s/he had, or the person's last name. The results indicated that categorical information affects our judgments of faces. Information categories such as belief, food, and diseases were particularly strong in modifying the participants' similarity judgment of faces, whereas information characterized with last names of faces were least powerful. Previous research focuses on race face perception being affected primarily by racial indicators or racial information. Our results provide that how we perceptually analyze faces is not confined to obvious racial cues, but by non-racial semantic information as well, suggesting that category-relevant information by itself provides a strong basis for inductive generalization.

Keywords: Labeling; Similarity; Categorization

Introduction

In the perception of faces, there is a tendency to pay excessive attention to salient features such as race-specific (Eberhardt, Dasgupta, & Banaszynski, 2003; Levin, 2000; MacLin & Malpass, 2003). When we see racially ambiguous faces, we shift our attention to features that signal ethnicity such as hair-style or skin color and ignore other important information. This attention shift often results in undesired psychological effects such as cross-race face recognition deficit, i.e., faces that are categorized into "other race" are recognized less than the faces that are categorized into one's own race. (MacLin and Malpass, 2003) and erroneous impression formation (Kashima, 2000; Hamilton & Sherman, 1994; Macrae, Milne, & Bodenhausen, 1994).

Additional studies show that race-based categorization modifies perception of skin color and the width of faces and mouth (MacLin & Malpass, 2003). Research further suggests that holistic face-processing is more prevalent in same-race faces than in other-race faces (Michel, Rossion, Han, Chung, & Caldara, 2006b).

Social categorization based on in-group and out-group of an observer also yield a cross-race recognition deficit, implying that categorization itself can be a mediating factor changing face perception (Bernstein, Young, Hugenberg, 2007). As long as stimuli are grouped in a meaningful way, some modification in face perception is likely to occur. For example, incremental training or labeling of faces into arbitrary categories generates a categorical perception effect, in which faces taken across a category boundary are recognized better than faces taken within the category boundary (Kikutani, Roberson, & Hanley, 2008). Taken together, these studies demonstrate that not just racial information per se, but category information plays a substantial role in modifying perception of faces.

This explains why social categorization often accompanies faulty generalization and stereotyping. Categories are generative in nature. Categorical labeling not only accentuates features that are central to the category (e.g., prototypical features), but also help generate new features by means of explanations and justifications (Kunda, Miller, & Claire, 1990). When confronted with contradictory attributes (e.g., a rich African-American businessperson), people often make up a subtype of the category (e.g., black entrepreneur) and use it to preserve their initial stereotypical belief (Macrae, Stangor, & Hewstone, 1996). Combinations of contradictory concepts such as "Harvard-educated carpenter" create new features such as "being rebellious" or "anti-social," which were not part of each separate concept – "Harvard-educated" and "carpenter" (Kunda, Miller, & Claire, 1990). When a person is characterized categorically ("Linda is a feminist" as opposed to "Linda believes in and support feminism"), people not only think that the person possesses prototypical attributes of the category ("Linda majored in philosophy in college") but also some unrelated features are deemed likely ("Linda likes Chinese food") (Yamauchi, 2005, 2008, 2009). Categorization also helps reframe people's attention. When geometric stimuli are grouped by categories, perceptual sensitivity within the category is reduced while the differences between categories are enhanced (Tajfel & Wilkes, 1963; Yamauchi & Yu, 2008; Yamauchi et al., 2002). On this basis, we think that when labels help form categories, labeling can modify people's perceived facial similarities. The two experiments tested this idea.

Overview of the experiments

We employed a widely used triad task (Gelman & Markman, 1986; Sloutsky & Fisher, 2004; Yamauchi Markman, 2000; Yamauchi, Kohn, & Yu, 2007; Yamauchi & Yu, 2008; Yu et al., 2008, 2010; Waxman & Booth, 2001) in which we attached pseudoword labels (e.g., "Scrakies") to face pictures and examined how these labels

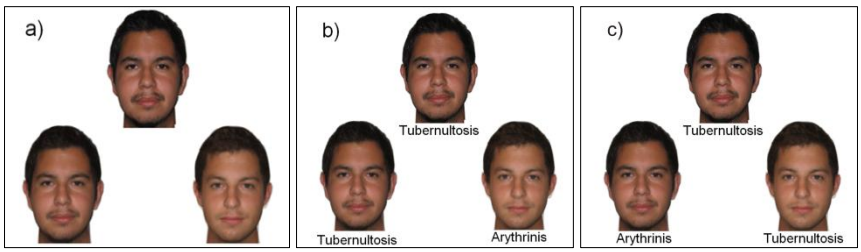

Figure 1: Otherwise identical, triads of faces shown (a) without labels, (b) with labels (different-label condition; Experiment 1), and (c) with labels (same-label condition; Experiment 2). Here, the dissimilar base picture appears on the right.

influenced participants' judgments of facial similarity when the same arbitrary labels represented different kinds of semantic information.

In our experiments, participants were shown a triad of human faces (Figure 1) and judged which face, bottom left or right, was more similar to the target face on the top. The target face (top face) was an original face that was either Hispanic or Caucasian. The bottom left and right faces were morphed faces. These faces were displayed either without a label (the control condition, Figure 1a) or with a label (the label condition, Figure 1b & 1c). Each label was an arbitrary pseudoword (such as "Scrakies"), but the meaning of the label was manipulated in the instructions that the participants read at the beginning of the experiment.

In the three experimental conditions, participants were told the arbitrary labels either represented the name of the food the person regularly eats (the food-label condition), the name of the disease that he has (the disease-label condition), or the name of belief that he follows (the belief-label condition). Note that these manipulations were introduced only in the instructions participants received and all participants received the same stimuli. These three conditions were contrasted to two control conditions, in which the labels were removed entirely from the stimulus frame (no-label condition, Figure 1a) or the arbitrary labels were characterized as the last name of the person (the last-name-label condition).

We measured the proportion of trials that participants chose the face that was physically dissimilar to the target image. For example, in Figure 1a, the left base image looks more similar to the target image when compared to the right base image. We measured the proportion of participants selecting the dissimilar face pictures (the right base image in Figure 1) when face pictures had no labels (Figure 1a), and when the target and dissimilar face pictures had different labels (Figure 1b – Experiment 1) or the same labels (Figure 1c – Experiment 2).

We predicted category information would affect similarity judgments while indexical labels would not to the same degree. We commonly classify people by their habit of eating (food-labels, e.g., vegetarians, ethnic-food lovers), the disease they have (disease-labels, e.g., people with high blood pressure, people with cancer, people with allergies) or the belief that people follow (belief-labels, e.g., Christians, positive thinkers). By categorizing people in this manner, we obtain a sense of similarity and unity among category members. In contrast, a last name is indexical; it refers to a specific person. Groups, such as families, can be formed by last names, but they do not give us a sense of coherence. A name points to a specific entity within a category and therefore should no influence judgments of similarity as strongly as categorical labels. Thus, our hypothesis that categorical labeling helps modify perception of facial similarity leads to the prediction that arbitrary labels change the perception of face similarity in the food-label, disease-label, and belief-label conditions, but not in the last-name label condition.

When items do not share category membership, differences are emphasized. On the contrary, when items are in the same category, differences are diluted (Sloutsky, 2003; Waxman & Markow, 1995). Therefore, in Experiment 1, when the dissimilar picture does not share a label with the target, the proportion of participants selecting the dissimilar base picture should be considerably smaller in the food-label, disease-label, and belief-label conditions than the no-label condition. In Experiment 2, the dissimilar base picture shares a label with the target, so the proportion of participants selecting the dissimilar base picture should be larger than the no-label condition. The proportion of participants selecting dissimilar face pictures as "similar" should be indistinguishable between the no-label and last-name-label conditions in both Experiments

Experiment 1

Method

Participants A total of 191 undergraduate students participated in this experiment for course credit. They were randomly assigned to one of five conditions: no-label (n=39), belief-label (n=39), food-label (n=35), disease-label (n=34), and last-name-label (n=34) conditions**.**

Materials Stimuli were triads of faces that either had no label or label attached to them (Figures 1a and 1b). The target was an original picture of either a Hispanic or Caucasian face, and the two base pictures were a morph of the original Hispanic and Caucasian face (Figure 2).

In total, we photographed five pairs of original Hispanic and Caucasian faces. All expressions are neutral and no faces contained any distinguishing features, e.g., none had moles or mustaches. These photographs were morphed into

five pairs of 20 images using Morph Man 4.0 (2003) software starting from the original Hispanic face and morphing towards the Caucasian face (Figure 2). Altogether there were 100 images (10 original faces and 90 morphed images) that had varying degrees of Hispanic and Caucasian facial features.

Figure 2. One real Hispanic face (far left) is morphed gradually with one real Caucasian face (far right). In the actual experiment, there were 18 morphed images between the two original faces.

From the 90 morphed images, base pictures were selected controlling for physical differences between stimuli. Specifically we developed three levels of physical difference- low, medium and high physical difference within conditions – based on the degree of merging two of the original face pairs. In the low physical difference condition there was a small amount of physical difference between the two base picture (Figure 3a); in the medium physical difference condition, the base pictures were moderately different (Figure 3b); and in the high physical difference condition, the base pictures were highly different (Figure 3c). Two sets of base pictures were randomly selected at each level of physical difference and were combined with two original pictures in each pair, yielding 12 triads for each pair (a total of 60 triads = 5 face pairs × 12 triads).

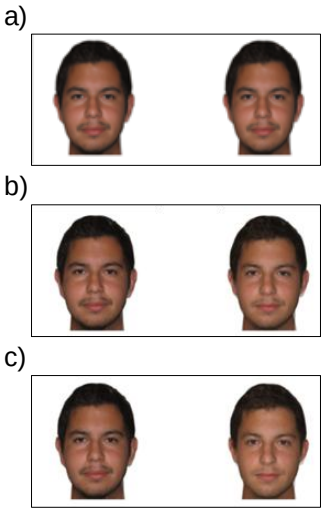

Figure 3: The three levels of physical difference— low (a), medium (b), and high (c) used in the similarity judgment task. In this example, the dissimilar picture is seen on the right.

Procedure Participants were shown 60 triads of pictures, one at a time, and judged which base picture within the triad was more similar to the target image by pressing either the right or left arrow key on the keyboard. The order of presenting the stimuli and the left-right location of placing the dissimilar base pictures were determined randomly. The experiment took approximately 15 minutes to complete.

Design The experiment had a 3 (Physical Difference; low, medium, and high; within-subjects factor) × 5 (Label Condition; belief-label, food-label, disease -label, last-name-label and no-label; between–subjects factor) mixed design. All participants in the five conditions (no-label, food-label, disease-label, belief-label, and last-name-label conditions) received the identical stimuli. The labels in each condition were physically the same, but the meaning attached to the labels was altered in the instructions.

Results

Figure 4 summarizes the results in Experiment 1. There was a significant main effect of label condition: F (4, 176) = 4.49, MSE = .03, p = .002, η^2 = .09. Individually, the belief-label (M = .10), food label (M = .09), and disease label (M = .11) demonstrated a significant effect when compared to the no label condition (M = .18): belief label vs. no label, t (76) = 3.76, SE = .02, p < .001, d = .85; food label vs. no label, t (72) = 5.66, SE = .02, p < .001, d = 1.32; and disease label vs. no label: t (71) = 4.13, SE = .02, p < .001, d = .97. The last name label condition (M = .13), however, showed no

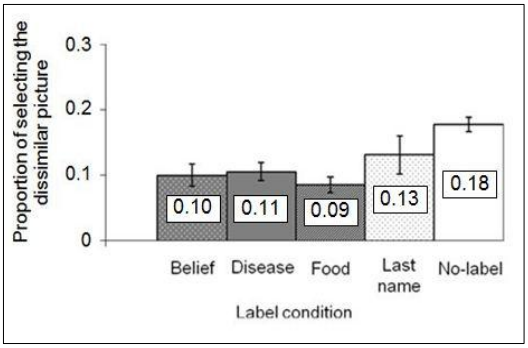

Figure 4. The proportion of participants selecting the dissimilar image of the base pair pictures according to label type in Experiment 1. The error bars represent two SE units calculated from each condition

significant difference when compared to the no label condition (M = .18), t (71) = 1.59., SE = .03, p > .10, d = .37.

Physical similarity played a role in judgments. Labels influenced similarity judgments of faces more in the low physical difference condition than the medium and high physical difference conditions. In the low physical difference condition, all labels produced a significant effect compared to the no-label condition, ts > 2.33, ps < .01, ds > .60. In the medium physical difference condition, the food label and disease labels produced significant effects when compared to the no label condition: ts > 2.33, ps < .01, while the belief and last name conditions did not, ts < 2.33, ps > .01. In the high physical difference condition, the disease condition was significantly different compared to the no label condition, t (65) = 3.16, SE = .06, p = .002, d = .77, while other conditions were not, ts < 2.33, ps >.01.

Discussion

Consistent with our hypothesis, labels attached to face pictures modified participants' judgments of similarity considerably. When the target and dissimilar face pictures had the different labels, the proportion of participants selecting the dissimilar face pictures decreased dramatically. The impact of the labels was particularly pronounced when these labels conveyed some categorical information, such as the types of food, disease, or belief that the people eat, have, or follow. When the labels represented the last names of the people, the effect of labels diminished considerably, supporting the view that the distortion of race perception occurs especially when labels are associated with categorical information.

Because such an effect was present primarily when labels conveyed categorical information, we suggest that the distortion of face perception is linked to the general mechanism of categorical perception. Experiment 2 tested this idea further.

Experiment 2

The results from Experiment 1 suggest that labels attached to face pictures can modify people's perception of similarity. In Experiment 1, all dissimilar face pictures carried the different labels as the target picture (Figure 1b); as a result, the difference between the two face pictures (target and dissimilar base pictures) was exaggerated considerably. If, as hypothesized, the categorical labels attached to the face pictures are indeed responsible for the modified perception faces, then the labels can also create the perception of "sameness." In other words, if the dissimilar face pictures carry the same label as the target picture then the dissimilar face pictures should be perceived as more *similar* to the target picture. This was tested in Experiment 2. The only difference between Experiment 1 and 2 was the assignment of the labels. In Experiment 2, the labels of the base pictures were simply swapped so that the dissimilar face pictures and the target picture had the same label (Figure 1c). In Experiment 2, when compared to the no-label condition, the proportion of participants selecting the dissimilar face pictures should increase considerably when the dissimilar face pictures and the target picture have the same label. This phenomenon should occur primarily in the belief-label, food-label and disease-label conditions, but not when in the last-name condition.

Method

Participants A total of 182 undergraduate students participated in this experiment for course credit. They were randomly assigned to one of five conditions: no-label (n=34), belief-label (n=40), food-label (n=38), disease-label (n=33), and last-name-label (n=37) conditions.

Materials and Procedure The materials and procedure used in Experiment 2 were identical to those described in Experiment 1.

Design The design of Experiment 2 was the same as Experiment 1 except that the target face in each slide shared the same label as its least similar base face (Figure 1c).

Results

Consistent with our hypothesis, our results show that category information, even though they were only indirectly related to race, can affect judgment of Hispanic and White faces.

Figure 5 summarizes the results of Experiment 2. There was a significant main effect of label condition: F (4, 177) = 4.50, MSE = .16, p = .002, η^2 = .09. Specifically, the belief-label condition (M = .36), the food-label condition (M = .33) and the disease-label condition (M = .32) demonstrated significant effects when compared to the no-label condition

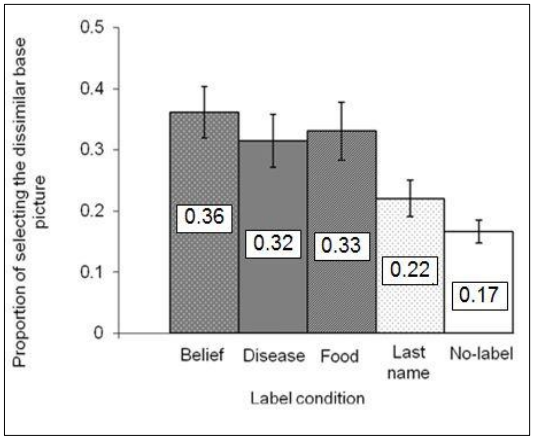

Figure 5. The proportion of participants selecting the dissimilar image of the base pair pictures according to label type in Experiment 2. The error bars represent two SE units calculated from each condition

(M = .17): belief-label vs. no-label, t (72) = 4.05, SE = .05, p < .001, d = .95; food-label vs. no-label, t (70) = 3.18, SE = .05, p < .005, d = .75; disease-label vs. no-label, t (65) = 3.11, SE = .05, p < .005, d = .76. The last name label (M = .22), however, showed no significance when compared to the no label condition (M = .17); t (69) = 1.84, SE = .03, p = .07, d = .44. There was no interaction effect between the label condition and the physical difference: F (8, 354) = .74, MSE = .01, p = .66, η^2 = .02.

The belief, food, and disease conditions all showed significance at each level of physical difference when compared to the no label condition: ts > 2.33, ps < .01, ds > .60. Just as in the between subject analysis, the last-name label produced null effects across all levels of physical difference: ts < 2.00, ps > .05.

Discussion

As in Experiment 1, labels attached to the face pictures in Experiment 2 modified participants' judgments of similarity considerably. Again, the impact of labels was particularly

pronounced when the labels conveyed certain categorical information such as the types of food, belief and disease that people eat, follow, and have. The effect of labels was reduced dramatically when the labels were associated with the names of people. In Experiment 2, the target and dissimilar face pictures had the same labels (Figure 1c). As a result, the proportion of participants selecting the dissimilar face pictures as similar to target pictures increased dramatically. These results indicate that the effect of the categorical labels is bi-directional. Categorical labels can create a sense of difference and a sense of proximity. These changes occurred primarily when labels were associated with the types of food, disease, and belief that people have (or eat) but not when labels were associated with the last names of the people.

Together, these experiments further support the view that the meaning attached to these labels, not labels themselves, modifies our perception of similarity both positively and negatively by enhancing the sense of similarity and difference depending on whether stimuli carry the same or different labels.

General Discussion

Our results indicate that categorical information influences the participants' judgments of similarity. In Experiment 1, participants chose the dissimilar face significantly *less often* when the target and dissimilar face pictures had different labels. In Experiment 2, participants chose the dissimilar faces *more often* when the target and dissimilar face pictures had the same labels. The impact of the labels was negligible when the labels were associated with the last names of people. These results suggest that categorical information given to these labels were indeed responsible for the modified perception of similarity. This modified perception likely arose from some general mechanism underlying the categorical perception effect (Goldstone, 1994, 1995; Livingston, Andrews, & Harnad, 1998; Newell & Bulthoff, 2002; Roberson, Davies, & Davidoff, 2000).

Previous research has focused on race-specific cues to distort racial perception (Eberhardt, Dasgupta, & Banaszynski, 2003). Other research deliberately uses racially related facial features to distort race perception (MacLin & Malpass, 2003). Our study, which uses both White and Hispanic faces, extends previous results by demonstrating that perceptions of race-oriented faces can be distorted by attributing information that is not directly related to racial cues. Meaningful categorical labels can create a sense of similarity and difference depending on whether two stimuli have the same or different labels. Some category information seems to have greater impact than others. For example, the belief labels and the food labels were relatively stronger than the disease and last-name labels. Although the reason behind these differences cannot be determined based on these experiments, we speculate that some categories of information held stronger weight because of their behavior and preference implications

Gil Diesendruck and Heidi haLevi (2006) point out that personality traits are the primary means by which categorical distinctions and inferences are made because these traits explain behavior and preferences (Yuill, 1992). Food-labels, disease-labels, and belief-labels explicitly refer to such behaviors and preferences, while last-name-labels do not suggest that two people will behave in the same manner.

This reaction to labels and assumptions based on these traits may be related to naïve theories that people form in everyday situations (Chao, Chen, Roisman, & Hong, 2007; Gelman, 2003). It is suggested that people tend to assume there is an essence underlying observed physical characteristics of people, animals, and things (Ahn, 2001; Chao et al., 2007; Gelman, 2003; Medin & Ortony, 1989; Murphy & Medin, 1985). Such essence can be biological characteristics (diseases or DNA, Medin & Atran, 2004), core beliefs (e.g., religion, Cairns, Jenworthy, Campbell & Hewstone, 2007), or behavioral habits (Gelman & Heyman, 1999). The results of our experiments demonstrated how easily people construct naïve theory and how powerful the influence of the naïve theory is. The simple label-meaning manipulation used on our experiments was powerful enough to alter their perception of people. Our results, combined with previous research, suggest categorical information is important when makes judgments about people.

References

Ahn, W. (2001). Dissociation between categorization and similarity judgment; differential effect of causal status on feature weights. In U. Hahn & M. Ramscar (Eds.), *Similarity and categorization* (pp. 87-107). New York: Oxford University Press.

Bernstein, M. J., Young, S. G., & Hugenberg, K. (2007). The Cross-Category Effect: Mere social categorization is sufficient to elicit an own-group bias in face recognition. *Psychological Science, 18*, 709-712.

Cairns, E., Jenworthy, J., Campbell, A., & Hewstone, M. (2007). The role of in-group identification, religious group membership and intergroup conflict in moderating in-group and out-group affect. *British Journal of Social Psychology*, 45(4), 701-716.

Chao, M. M., Chen, J., Roisman, G., & Hong, Y.-y. (2007). Essentializing race: Implications for bicultural individuals' cognition and physiological reactivity. *Psychological Science, 18*, 341-348.

Diesendruck, G., HaLevi, H., (2006). The Role of Language, Appearance, and Culture in Children's Social Category-Based Induction. *Child Development*, *77(3)*, 539-553.

Eberhardt, J., Dasgupta, N., & Banaszynski, T. L. (2003). Believing is seeing: The effects of racial labels and implicit beliefs on face perception. *Personality and Social Psychology Bulletin, 29*, 360–370.

Gelman, S. A. (2003). *The essential child: Origins of essentialism in everyday thought*. New York: Oxford University Press.

Gelman, S. A., & Heyman, G. D. (1999). Carrot-eaters and creature-believers: The effects of Lexicalization on children's inferences about social categories. *Psychological Science, 10*(6), 489-493.

Gelman, S. A., & Markman, E. M. (1986). Categories and induction in young children. *Cognition, 23*, 183-209.

Goldstone, R. L. (1994). Influences of categorization on perceptual discrimination. *Journal of Experimental Psychology: General, 123*(2), 178-200.

Goldstone, R. L. (1995). Effects of categorization on color perception. *Psychological Science, 6*(5), 298-304.

Hamilton, D. L., & Sherman, J. W. (1994). Stereotypes. In R. S. Wyer, Jr., & T. K. Srull (Eds.), Handbook of social cognition (2nd ed., Vol. 2, pp. 1-68). Hillsdale, NJ: Erlbaum.

Kashima, Y. (2000). Maintaining cultural stereotypes in the serial reproduction of narratives. *Personality and Social Psychology Bulletin*, 26, 594-604.

Kikutani, M., Roberson, D. & Hanley, J.R. (2008) What's in the name? Categorical Perception of unfamiliar faces can occur through labeling. *Psychonomic Bulletin & Review, 15*, 787-794

Kunda, Z., Miller, D. T., & Claire, T. (1990). Combining social concepts: The role of causal reasoning, *Cognitive Science, 14*, 551-557.

Levin, D.T. (2000). Race as a visual feature: Using visual search and perceptual discrimination tasks to understand face categories and the cross-race recognition deficit. *Journal of Experimental Psychology: General , 129* , 559-574.

Livingston, K. R., Andrews, J. K., & Harnad, S. (1998). Categorical perception effects induced by category learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 24*(3), 732-753.

MacLin, O. H., & Malpass, R. (2003). The ambiguous-race face illusion. *Perception, 32*, 249–252.

Macrae, C.N., Milne, A.B., 7 Bodenhausen, G.V. (1994). Stereotypes and enery-saving devices: A peek inside the cognitive toolbox. *Journal of Personality and Social Psychology, 66*, 37-47.

Macrae, C.N., Stangor, C. & Hewstone, M. (Eds.) (1996). Stereotypes and stereotyping. New York: Guilford.

Medin, D. L., & Atran, S. (2004). The native mind: Biological categorization and reasoning in development and across cultures. *Psychological Review, 111*(4), 960-983.

Medin, D., & Ortony, A. (1989). Psychological essentialism. In S. Vosniadou & A. Ortony (Eds.), *Similarity and Analogical Reasoning* (pp. 179 - 195). New York: Cambridge University Press.

Michel C., Rossion, H. J., Chung, C. H., & Caldara, R. (2006b). Holistic processing is finely tuned for faces of one's own race. *Psychological Science, 17*(7), 608-615.

Murphy, G. L., & Medin, D. L. (1985). The role of theories in conceptual coherence. *Psychological Review, 92*(3), 289-316.

Newell, F. N., & Bulthoff, H. H. (2002). Categorical Perception of familiar objects. *Cognition, 85*, 113-143.

Roberson, D., Davies, I., & Davidoff, J. (2000). Color categories are not universal: Replications and new evidence from a stone-age culture. *Journal of Experimental Psychology: General, 129*(3), 369-398.

Sloutsky, V. M. (2003). The role of similarity in the development of categorization. T*rends in Cognitive Sciences, 7*, 246-251.

Sloutsky, V. M., & Fisher, A. V. (2004). Induction and categorization in young children: A similarity-based model. *Journal of Experimental Psychology: General, 133*(2), 166-188.

Tajfel, H., & Wilkes, A. L. (1963). Classification and quantitative judgment. *British Journal of Psychology, 54*, 101-114.

Waxman, S. R., & Booth, A. E. (2001). Seeing pink elephants: Fourteen-month-olds' interpretations of novel nouns and adjectives. *Cognitive Psychology,* 43, 217-242.

Waxman, S. R., & Markow, D. B. (1995). Words as invitations to form categories: Evidence from 12- to 13-month-old infants. *Cognitive Psychology, 29*(3), 257-302.

Yamauchi, T. (2005). Labeling bias and categorical induction: Generative aspects of category information. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 31*, 538-553.

Yamauchi, T. (2008) Linking syntax and inductive reasoning: Categorical labeling and generic noun phrases. *Psychologia*.51, 1-13.

Yamauchi, T. (2009). Finding abstract commonalties of category members. *Journal of Experimental and Theoretical Artificial Intelligence*. 21 (3), 155-180.

Yamauchi, T., Kohn, N., & Yu, N. Y. (2007). Tracking mouse movement in feature inference: Category labels are different from feature labels. *Memory & Cognition, 5*(852-863).

Yamauchi, T., Love, B. C., & Markman, A. B. (2002). Learning nonlinearly separable categories by inference and classification. *Journal of Experimental Psychology: Learning, Memory & Cognition, 28*(3), 585-593.

Yamauchi, T., & Markman, A. B. (2000). Learning categories composed of varying instances: The effect of classification, inference, and structural alignment. *Memory & Cognition, 28*, 64-78.

Yamauchi, T., & Yu, N. Y. (2008). Category labels versus feature labels: Category labels polarize inferential predictions. *Memory & Cognition, 36*(3), 544-553.

Yu, N., Yamauchi, T., & Schumatcher, J. (2008). Rediscovering symbols: The role of category labels in similarity judgment. *Journal of Cognitive Science, 9*, 89-109.

Yu, N.. Yamauchi, T., Yang, H, Chen, Y. & Gutierrez-Osuna, R., (2010). Feature selection for inductive generalization. Cognitive Science, 34, 1574-1593.

Yuill, N. (1992). Children's conception of personality traits. *Human Development, 35*, 265 – 279.