When "3" is a Jerk and "E" is a King: Personifying Inanimate Objects in Synesthesia

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Abstract

■ We report a case study of an individual (TE) for whom inanimate objects, such as letters, numbers, simple shapes, and even furniture, are experienced as having rich and detailed personalities. TE reports that her object–personality pairings are stable over time, occur independent of her intentions, and have been there for as long as she can remember. In these respects, her experiences are indicative of synesthesia. Here we show that TE's object–personality pairings are very consistent across test–retest, even for novel objects. A qualitative analysis of TE's personality descriptions revealed that her personifications are extremely detailed and multidimensional, and that her personifications of familiar and novel objects differ in specific ways. We also found that TE's eye movements can be biased by the emotional associations she has with letters and numbers. These findings demonstrate that synesthesia can involve complex semantic personifications, which can influence visual attention. Finally, we propose a neural model of normal personification and the unusual personifications that accompany object–personality synesthesia. ■

INTRODUCTION

When shown the number "3," TE, a 17-year-old female high school student, reported the following:

> *Three is pure blue, the same color as E. Three is male; definitely male. Three is such a jerk! He only thinks of himself. He does not care about any other numbers or anything. All he wants is to better himself and he'll use any sneaky, underhanded means necessary. But he's also pretty young; he doesn't understand anything and he doesn't have very much power, as far as social status is concerned. So, he tries to hang out with Eight (who's also a bad number) just so that he can feel better about himself. But really, none of the numbers can stand him. He's a real jerk. He'll pretend as though he's your friend, but then he'll manipulate you and stab you in the back if he feels he can gain something from it. Then he'll never speak to you again. If Three had parents, even his parents would hate him. It's not as though what he does has some purpose or something behind it, he's just a really nasty number. He just wants things for himself. He doesn't care in what he does. If he had a voice, it wouldn't be high-pitched, but it wouldn't be deep. It'd be on the high side, a very annoying voice. He'd be short and very thin; very annoying.*

TE reports that she experiences detailed personalities like this for virtually all of the objects she encounters. This includes familiar objects such as letters, numbers, and the furniture in her room, as well as completely novel objects such as those shown in Figure 1. For instance, when shown the novel object depicted in the top left of Figure 1, she reported the following:

> *This would either be a preteen or a teenager. It's very curious about things but it doesn't have any friends. It sees things through something of a negative view, but not in the sense that it's a pessimist. It's not like it's depressed or anything, but everything's a little bleak. It just goes through its life. It's just experiencing things; it doesn't really think of past or future. It doesn't dwell on anything; it just kind of experiences it and goes on. It's an orangey-brown, more on the brown side.*

We first became aware of TE's object–personality pairings while studying her grapheme–color synesthesia, a condition in which letters and numbers elicit highly consistent and specific sensory experiences of color (Hubbard & Ramachandran, 2005; Mattingley, Rich, Yelland, & Bradshaw, 2001; Dixon, Smilek, Cudahy, & Merikle, 2000). TE's grapheme–color synesthesia is

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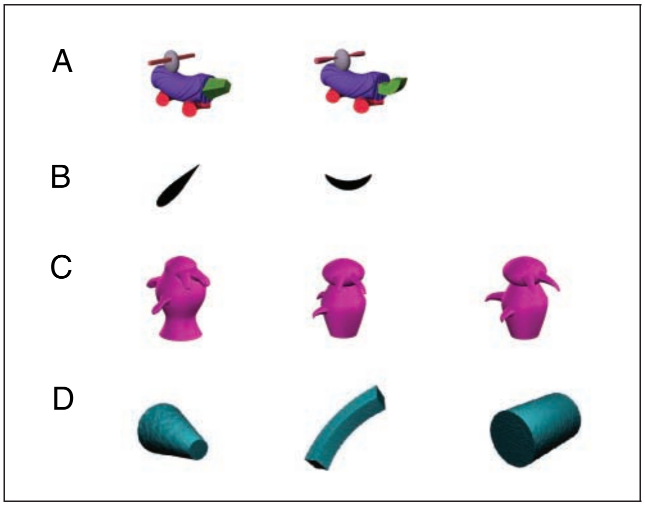

Figure 1. The novel objects used in the first and last sessions of the consistency test. The novel objects were taken from previous studies of object perception/categorization and included (A) fribbles (Tarr, 2000), (B) simple shapes (Dixon et al., 2002), (C) greebles (Gauthier & Tarr, 1997), and (D) geons (Beiderman, 1987).

evident in her description of "3" as being "pure blue, the same color as E." As she described her subjective experiences associated with each letter and number, it quickly became apparent that color was only a small part of her overall experience; surprisingly, her reports were dominated by intricate personifications of the graphemes. Even more remarkably, she reported experiencing these rich personifications with virtually all objects, including those encountered for the first time.

TE's descriptions of her object–personality associations included all the main hallmarks of synesthesia. Synesthetes typically report that their associations have been there for as long as they can remember (Sagiv, Simner, Collins, Butterworth, & Ward, 2006; Dixon et al., 2000), that the associations are consistent over time (Mattingley et al., 2001; Dixon et al., 2000; Baron-Cohen, Harrison, Goldstein, & Wyke, 1993; Cytowic, 1993), and that they are elicited without intention (Mattingley et al., 2001; Dixon et al., 2000; Wollen & Ruggiero, 1983). TE's reports echo these characteristics. For instance, the number "3" is, and always has been, a "male" and a "jerk." TE also reports that this high degree of consistency in her object–personality pairings holds even for objects she has seen only a few times. And, as is the case with other forms of synesthesia, TE cannot stop the personifications from coming to mind when she thinks of the number. In fact, she reports asking her father to remove certain objects from her room because she could not stop them from consistently eliciting extremely negative personalities. Because TE's object–personality pairings appear to show the main hallmarks of synesthesia, and because her personifications of numbers and letters seem to accompany her synesthetic experiences of color, we suggest that object–personality pairings are a form of synesthesia. Following standard nomenclature (Grossenbacher & Lovelace, 2001), we refer to TE's personifications as *object–personality synesthesia*.

TE's descriptions of her personifications of objects appear to go substantially beyond the sorts of personifications experienced by most individuals. The available evidence suggests that individuals associate human qualities such as gender (Davis, 1961), emotion (Collier, 1996), and agency (Heider & Simmel, 1944) with very simple shapes and object motions. However, most individuals do not experience the sort of vivid and detailed personifications expressed by TE. TE's descriptions also differ from previous descriptions of individuals who personify letters and numbers, which have been sometimes reported in the synesthesia literature (e.g., Cytowic, 2002; Calkins, 1893); although TE's object–personality experiences involve inducers such as letters and numbers, her personifications go beyond these simple sequences and extend to almost all objects she encounters.

Given the uniqueness of TE's subjective experiences, we first sought to empirically test the reality of TE's object–personality associations by evaluating the consistency of her associations and by analyzing the personality attributes she associates with familiar (i.e., letters and numbers) and novel (i.e., simple shapes) objects. We then sought to evaluate whether the object–personality pairings influence her overt viewing of objects to evaluate whether these meaningful personifications can influence overt attention. The experimental test of consistency and the analysis of TE's object–personality associations were conducted in Experiment 1, whereas the behavioral impact of her object–personality pairings was evaluated in Experiment 2.

EXPERIMENT 1

The purpose of Experiment 1 was to experimentally evaluate whether TE's object–personality experiences are consistently elicited each time she views an object or whether her descriptions are fleeting stories that change from moment to moment. If TE's object–personality experiences are consistently elicited by objects, then her descriptions should show high consistency across test–retest, as is the case with other forms of synesthesia (Mattingley et al., 2001; Dixon et al., 2000; Baron-Cohen et al., 1993; Cytowic, 1993). In addition, given her report that she experiences stable personifications for objects she has seen only a few times, TE should have highly consistent experiences even for novel objects. Furthermore, if TE's personifications of objects are truly similar to experiencing the personality of another individual, her personifications of novel objects should be qualitatively different from her personifications of familiar objects. Specifically, novel objects should have fewer interpersonal characteristics because she would not have had the opportunity to interact with the objects or see them interact with other objects. In contrast, the number of noninterpersonal attributes should be equivalent for novel and familiar objects.

To test these predictions, we had TE verbally describe the personalities she associates with familiar (i.e., letters and numbers) and novel (see Figure 1) objects. The verbal reports collected in this initial session were recorded and transcribed for a later test of consistency. The consistency of TE's object–personality pairings was evaluated in a test session that occurred 12 weeks after the initial session. We included an intervening session during which participants described personalities for another set of objects to interfere with any memory strategies that she may have used to remember the descriptions she gave in the initial session. For a conservative evaluation of her consistency, TE's test performance was compared to that of six control participants who completed the test only 2 weeks after the initial session. Finally, a qualitative analysis of TE's personifications was conducted on the basis of the descriptions she provided in the initial session.

Methods

Participants

A 17-year-old woman with object–personality synesthesia (TE) participated in three 1-hour sessions in exchange for $20.00 per session. Six nonsynesthetic students from the University of Waterloo served as controls for the consistency portion of the study. These controls participated in the same three sessions as did TE and received $8.00 per session. TE was paid more for her participation than were the controls to offset travel expenses.

Materials

The study included two types of displays: object displays and test displays. The *object displays* contained a single, centrally presented, familiar or unfamiliar object. The familiar objects included the letters A to Z and the numbers 0 to 9. The novel objects, some of which are shown in Figure 1, included fribbles (Tarr, 2000), simple shapes (Dixon, Desmarais, Gojmerac, Schweizer, & Bub, 2002), greebles (Gauthier & Tarr, 1997), and geons (Beiderman, 1987). Each of these objects measured 7 cm (7°) horizontally and 9 cm (9°) vertically, and were viewed from a distance of approximately 57 cm. The numbers and letters were displayed in black and the novel objects were displayed in the colors shown in Figure 1. All objects were presented in the center of the display, against a white background.

The *test displays* contained an object together with a list of four personality descriptions. The object was presented at the center of the top of the display, measuring 3 cm (3°) horizontally and 4 cm (4°) vertically, and was again viewed from a distance of approximately 57 cm. Four personality descriptions were listed below the object and were numbered 1 through 4. Each description was presented in 14-point Times New Roman font.

The displays were presented on a ViewSonic 670f monitor, driven by a 2.99-GHz Pentium 4 processor running E-Prime software (Psychology Software Tools, www.pstnet.com). A digital voice recorder (Apacer Multi-Function Digi Cam SV600) was used to record participants' verbal responses, which were later transcribed.

Procedure

The study consisted of three sessions (initial, intervening, and test). In an *initial session*, participants were presented with 32 object displays, each of which contained either a letter, number, or a novel object. Twenty-two displays contained a familiar object chosen from a set of 16 letters (C, D, E, F, G, H, I, M, N, Q, R, S, U, V, W, or X) or 6 numbers (0, 1, 2, 3, 6, or 8), and 10 displays contained one of the novel objects shown in Figure 1. Participants were shown the object displays and asked to verbally describe the personalities they associate with those objects. Responses were recorded digitally and later transcribed for use in the test session. Participants were given an unlimited amount of time to describe each object. Once a participant indicated that they had completed their description of the personality of the object, the experimenter pressed a button on the keyboard to advance to the next display. Before beginning the first session, the control participants were told about TE's experiences, given a sample of her personality descriptions, and asked to mimic her experiences.

In order to disrupt memory for the object–personality pairings collected in the first session, we included an *intervening session*, during which participants provided personality descriptions for an additional set of objects. In this session, participants were presented with another 22 object displays containing 10 letters (A, B, J, K, L, O, P, T, Y, Z), 4 numbers (4, 5, 7, 9), and 8 different novel objects. Providing these additional descriptions should retroactively interfere with participants' memory for the associations provided in the initial session.

The consistency of object–personality pairings collected in the initial session was evaluated in a final *test session*. On each of the 32 trials of the test session, participants were first shown an object display from the initial session and were instructed to press a key on the keyboard when they were ready to see the test display. The subsequent test display contained the same object and four alternative personality descriptions. The personality descriptions were unique for each participant and were one or two sentence excerpts from descriptions given by the participant in the initial session. Of the four excerpts presented below the object in each

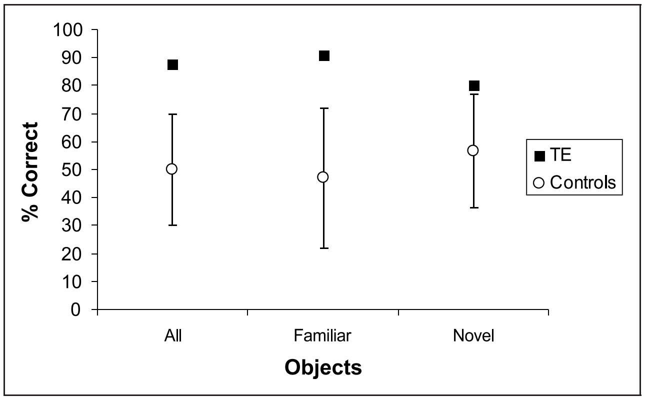

Figure 2. Percent correct scores on the four-alternative forced-choice consistency test for TE and the average of the control participants (n = 6). The figure shows the proportion correct scores for all 32 objects (left), only the 22 familiar objects (center), and only the 10 novel objects (right). The confidence bars indicate 1.96 standard deviations from the mean of the controls.

display, only one excerpt was taken from the participant's initial personality description of the object; the remaining three were randomly selected from other objects. Participants were instructed to read each statement and press the number on the keyboard corresponding to the description that best matched the object presented; upon response, the next trial was initiated.

All three sessions (initial, intervening, and test) were conducted on separate days. For TE, the intervening and test sessions were conducted 1 and 12 weeks following the initial session, respectively. To maximize the performance of the control participants, we reduced the interval between the sessions with the intervening and test sessions occurring 1 and 2 weeks after the initial session, respectively.

Results and Discussion

Consistency

The first step toward verifying the reality of TE's experiences was to determine whether her object–personality pairings were invariant (i.e., consistent) over test–retest. If TE's personifications are genuinely perceived each time she views an object, then she should be very consistent in the personifications she attributes to specific objects across test–retest, even at a relatively long interval (i.e., 12 weeks). Furthermore, she should even be highly consistent in her descriptions for objects she has seen only once before.

Figure 2 shows the results of the consistency test. As can be seen in the figure, TE was highly consistent in her object–personality pairings for both familiar and novel objects. Overall, TE correctly identified 88% of the descriptions she reported in the initial session; an accuracy 3.7 standard deviations greater than the mean accuracy of the control participants (50%). TE's performance on the consistency test was also examined separately for familiar and novel objects. TE's accuracy for familiar objects (91%) was 3.4 standard deviations greater than the mean accuracy of the controls (47%). Interestingly, TE's accuracy for novel objects (80%) was also 2.3 standard deviations greater than the mean of the controls (57%). These results indicate that TE's object–personality associations are consistent over time and that TE even generates stable "first impressions" of completely novel objects.

Qualitative Analysis

Having established that TE's object–personality pairings are consistent over time, we examined her object–personality descriptions in more detail. If TE's experiences are similar to the way individuals experience the personalities of others, TE's personifications of familiar objects should be qualitatively different than her personifications of novel objects. Specifically, personifications of novel objects should have fewer interpersonal characteristics than personifications of familiar objects. Similar to first encountering an individual in a one-on-one situation, a single exposure of an object likely would not afford the opportunity to experience how the object relates to others. In contrast, the number of noninterpersonal attributes should be equivalent for novel and familiar objects.

The qualitative analysis was conducted by two coders who worked together to generate a complete list of characteristics from TE's personality descriptions for the objects presented in the initial session. This compilation revealed that TE's personifications were remarkably detailed and varied; TE used 190 unique characteristics to describe the personalities.

These characteristics fell into four categories (see Table 1). A number of characteristics described the *physical* attributes of the personifications, such as having facial hair or being male or female. Others involved *personal* attributes not defined by interactions with

Table 1. Examples of the Characteristics in Each Category

Category	*Example Characteristics*
Physical	male, female, late 40s, child, early 30s, thick brown beard, heavyset, thin, tall, dark hair
Personal	mischievous, laid-back, brilliant, insightful, serious, carefree, organized, pessimistic, curious
Relational	friendly, gets taken advantage of, thinks he's better than others, popular, cares about others, would listen to others
Social role	grandfather-type, grandmother, younger brother, like an elder sister, motherly figure, fatherly, type of teacher, king, god, leader

Table 2. Total Number of Unique Characteristics within Each of Four Categories as Judged by Two Independent Coders

	Total Number of Characteristics	
Category	*Coder 1*	*Coder 2*
Physical	30	30
Personal	60	63
Relational	77	73
Social role	23	24

others, such as ‘‘melancholy’’ or ‘‘intelligent.’’ There were also social dimensions to her descriptions, with some characteristics conveying *relational* attributes, such as being ‘‘popular’’ and ‘‘friendly,’’ and others describing a person’s *social role* or position, such as being ‘‘a father figure’’ or ‘‘a leader.’’ The coders independently categorized the characteristics into these four categories. Table 2 shows the number of characteristics attributed to each of these categories by the two coders. The coders agreed on the categorization of 86.8% of the characteristics.

To test the prediction that there should be fewer relational and social role characteristics associated with novel objects than familiar objects, we compared the number of attributes reported in each category for each of the novel and familiar objects. Table 3 shows the average number of attributes per object as a function of descriptor category and object familiarity generated by each coder. The judgments of the two coders, regarding the number of characteristics per object in each category, were very similar (r = .874) and the coders obtained the same overall pattern of results. Inspection of Table 3 reveals that the personalities associated with familiar and novel objects did not differ in terms of their average number of physical or personal characteristics (statistics included in the table). In contrast, the personifications of familiar and novel objects differed significantly with respect to relational and social role characteristics (statistics included in the table).

There are several possible explanations for this finding. One possibility is that the relational and social aspects of the personalities TE experiences for objects develop with the passage of time. Another possibility is that the social aspects of the personalities emerge through repeated and concurrent exposure to the objects. Finally, there is the possibility that TE associates more relational and social role characteristics with the familiar objects that were used (letters and numbers) than the novel objects that were used (novel shapes) because the familiar objects consisted of ordinal sequences, whereas the novel objects did not. Discussions with TE support the second of these three possibilities. A follow-up interview with TE confirmed that, for her, the relational and social characteristics emerge only after she has seen the objects together (‘‘interacting’’) several times. In this regard, her personifications of familiar and novel objects match the way most people experience personalities of familiar and unfamiliar individuals. As such, these findings further confirm the reality of TE’s object–personality synesthesia.

EXPERIMENT 2

One aspect of TE’s experiences not clearly captured in her personality descriptions is her strong emotional

Table 3. Mean Number of Characteristics per Object in Each Category for Familiar and Novel Objects Together with the Difference between Means for Each Coder

Category	*Familiar Objects*	*Novel Objects*	*Difference*	*t*	*p*
Coder 1					
Physical	2.18 (1.44)	1.90 (1.37)	0.28	0.522	.61
Personal	4.14 (2.08)	3.70 (1.64)	0.44	0.585	.56
Relational	6.27 (2.14)	2.50 (1.78)	3.77	4.849	**<.01**
Social role	1.32 (1.13)	0.40 (0.52)	0.92	2.441	**<.05**
Coder 2					
Physical	1.95 (1.43)	2.20 (1.48)	−0.25	0.446	.66
Personal	4.46 (2.32)	4.30 (1.25)	0.34	0.428	.67
Relational	5.14 (1.98)	2.40 (2.37)	2.74	3.408	**<.01**
Social role	1.32 (1.29)	0.40 (0.52)	0.92	2.163	**<.05**

Standard deviations of means are shown in parentheses. Differences between familiar and novel objects, calculated as familiar mean − novel mean, were evaluated using an independent sample t test (df = 30). The corresponding t values and p values are also shown in the table.

reaction to the personalities elicited by objects. As noted above, she has even had her parents remove objects from her room because they elicited extremely negative personalities. Such strong emotions are even associated with the personifications of letters, numbers, and very simple shapes. For TE, the graphemes ''3'' and ''S'' elicit personalities she strongly dislikes, whereas ''2'' and ''M'' elicit personalities she finds very pleasant.

TE's report that her personifications of innocuous objects (e.g., letters and numbers) can elicit strong emotional reactions suggests the possibility that her synesthesia might have a strong impact on her overt behavior. Indeed, investigations of how nonsynesthetic individuals respond to emotional stimuli (e.g., emotional faces, snakes) suggest that emotion can have a substantial influence on the deployment of visual attention (e.g., Eastwood, Smilek, & Merikle, 2001, 2003; Fox, Russo, Bowles, & Dutton, 2001; Ohman, Ludqvist, & Esteves, 2001). For instance, Fox et al. (2001) have shown that faces expressing negative emotion hold attention longer than faces expressing positive emotion. Although there remains considerable controversy regarding whether emotional valence influences attention (Hunt, Cooper, Hunger, & Kingstone, in press; Purcell, Stewart, & Skov, 1996), there is sufficient evidence to raise the possibility that TE's emotional associations with simple graphemes might influence her overt viewing of those objects. Such a finding would be important because it would (1) demonstrate that object–personality synesthesia can influence overt behavior and (2) further support the conclusion generated from some studies of nonsynesthetes that the emotional valence of objects can influence visual attention.

The purpose of Experiment 2 was to evaluate whether TE's emotional reactions to her personifications of objects influence her overt viewing of those objects. TE and a group of control participants viewed displays containing an equal number of graphemes that, for TE, elicited positive and negative personalities. The participants were required simply to freely view the displays until they felt that they had viewed all of the objects. We decided to use a free viewing task rather than a structured visual search task because we wanted to observe how TE's personifications influenced her naturalistic viewing behavior without constraining her by specific task demands (e.g., searching for a prespecified target).[1] We monitored eye movements during free viewing to evaluate whether the valence of the personalities influenced overt viewing patterns.

Methods

Participants

A 17-year-old woman with object–personality synesthesia (TE) participated in a 1-hour session in exchange for $20.00. Six nonsynesthetic students from the University of Waterloo served as controls; each were compensated $8.00 for their participation. TE was paid more for her participation than were the controls to offset travel expenses. All participants had normal or corrected-to-normal vision.

Materials

The displays used in the free viewing study consisted of 12 graphemes, 6 of which were letters and 6 of which were numbers. Additionally, the objects on each display were selected equally from those rated by TE as having a personality she likes (*positive*: M, Q, U, X, Z, 2, 4, 6, 0) or dislikes (*negative*: C, D, F, G, S, 3, 7, 8, 9); these positive and negative personalities were represented equally among the letters and numbers. Displays were viewed from a distance of approximately 81 cm. Each display was constructed by dividing the screen into an imaginary 6×6 grid and randomly assigning each object to one of the resulting 36 locations. Typeface was varied across trials to reduce the repetitiveness of the displays. All objects were presented in 36-point font size, although they measured 0.5 cm (0.3°) to 2.1 cm (1.3°) horizontally and 1.0 cm (0.6°) to 1.8 cm (1.1°) vertically depending on the object and the typeface in which it was presented. Each object was centered within its corresponding cell, which measured approximately 6.9 cm (4.2°) horizontally and 5.2 cm (3.2°) vertically. An object was considered fixated when the pixel coordinates of the averaged fixation location landed inside its cell.

An SR Research EyeLink II eye tracking system was used to display the stimuli and collect response time and eye movement data. The EyeLink II head band contains three cameras for simultaneous tracking of both eyes and of head position for head-motion compensation. Pupils and corneal reflections were tracked on the most accurate eye for each participant. The system was calibrated using a random nine-dot pattern, and the average error in the computation of gaze position was less than 0.5° visual angle for each participant. The system's default settings for acceleration and velocity thresholds were used for saccade detection. A drift correction, performed after each rest period, took place once every 12 trials.

Two display screens were used. The stimulus displays were presented to the participants on a Dell P1230 22-inch flat screen color monitor with a medium short phosphor persistence; the monitor resolution was set at 1024×768. The displays were also presented to the experimenter on a second monitor so that real-time feedback could be given about gaze position. This allowed the experimenter to evaluate system accuracy and to initiate a recalibration if necessary.

Procedure

Participants were instructed to view each stimulus display until they believed they had seen everything on the

Table 4. Descriptive Statistics Associated with the Overall Viewing Times in the Free Viewing Study for TE and Control Participants

Participant	*Minimum*	*Maximum*	*Mean*	*SD*
Control 1	3875	8571	5360	800
Control 2	3819	8699	5691	876
Control 3	3822	10045	5899	1244
Control 4	1758	14635	4003	1356
Control 5	2370	15594	6101	2638
Control 6	3214	24823	8774	3506
TE	2304	31375	8487	4717

The controls are numbered and ordered by ascending standard deviations (*SD*) to show that TE has the highest overall standard deviation.

display, and that they could view the displays for as long as they wished. Participants were further instructed to press a button when they were finished viewing a display and ready to proceed to the next display. In order to ensure a similar mean viewing time to that of TE, control participants were also instructed to attempt to view the stimulus displays for at least 8 sec, on average, but to do so without counting the time in their heads.

The experiment was split into two blocks: a practice block of 12 trials and an experimental block of 180 trials. To afford direct comparison with TE's performance, the control participants viewed the same displays as were presented to TE, in the same randomized order. A trial began with a fixation marker presented in the center of the screen. The fixation marker remained on the screen for 2000 msec before being replaced by the stimulus display, which remained until a button press was made. Following every set of 12 trials, participants had a brief rest period.

Results and Discussion

Following the experiment, TE mentioned that, for her, viewing displays of random arrangements of numbers and letters was like viewing people at a dinner party! Furthermore, some displays were especially interesting because graphemes whose personalities would normally not go together had been placed in close proximity to each other. In contrast, other displays seemed less interesting because the arrangements of the graphemes were more inline with their personalities. Given these subjective reports, we analyzed the overall viewing times of the displays to evaluate whether some displays were viewed substantially longer than others, and whether the variability in TE's viewing times across displays was greater than that of the control participants.

The overall characteristics of the viewing times (minimum, maximum, mean, and standard deviation) for TE and the six controls are shown in Table 4. The table shows that TE had the greatest variability (i.e., standard deviation) in viewing times across displays. Indeed, TE's variability was 2.73 standard deviations greater than the mean variability of the control participants. TE's viewing times for each trial are shown in Figure 3, along with the viewing times of the control with the most representative viewing variability (i.e., closest to the mean variability). The figure confirms that TE viewed some displays substantially longer than others and is consistent with her report that some of the displays contained more interesting arrangements of personalities than others.

Having analyzed the overall viewing times of the displays, we next analyzed the eye movement data. Figure 4A shows the *mean number of fixations* TE (left) and the most closely matched control (right) devoted to the objects in each display that TE had previously designated as positive or negative. As can be seen in the figure, in a given display, TE fixated negative objects less often than positive objects, $t(179) = 2.80, p < .01$. In contrast to TE, the controls showed no significant differences in the number of fixations on positive (mean = 7.894) and negative (mean = 7.916) objects, all t values < 1.55, all p values > .12. In fact, TE's difference in the number of fixations on positive and negative objects was 4.78 standard deviations greater than the mean difference of the control participants. These findings are consistent with TE's report that she dislikes looking at objects that elicit negative personalities.

Monitoring eye movements also allowed us to measure the *mean fixation duration* on positive and negative objects in each display. In computing the mean fixation duration, we removed any fixation durations greater than 3 standard deviations from the mean fixation duration in each condition on each trial. This removed 6.1% of the total number of fixations for TE and an average of 4.1% for controls. The mean durations of TE's fixations on positive and negative objects are

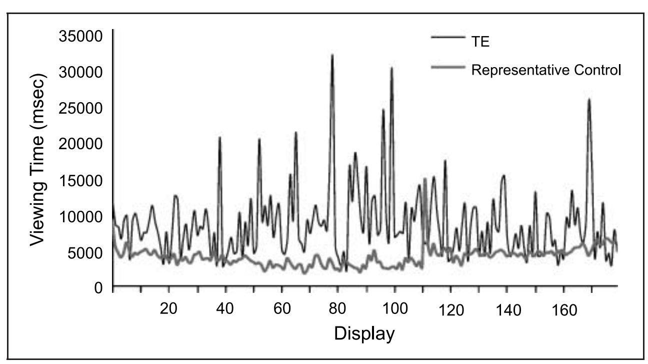

Figure 3. The viewing times associated with each trial in the free viewing task for TE and the most representative control participant.

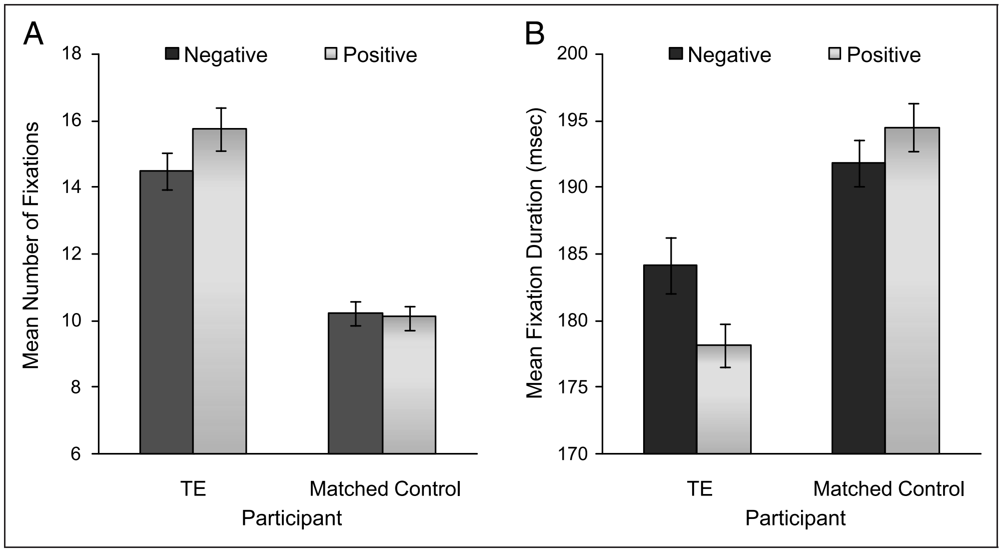

Figure 4. The mean number of fixations (A) and the average fixation duration (B) for TE and a matched control as a function of TE's emotional valence of the grapheme (positive and negative). The matched control is the individual whose scores most closely matched TE's scores, taking into account both mean number of fixations and mean fixation duration. The error bars indicate one standard error of the mean.

shown in Panel B (left) of Figure 4, together with the corresponding data from the most closely matched control (right). Figure 4B shows that, on average in a given trial, TE's fixation durations were longer for negative objects than positive objects, $t(179) = 2.19, p < .05$. In contrast to TE, the controls showed no significant differences in mean fixation duration on positive (mean = 229.6 msec) and negative (mean = 226.8 msec) objects, all t values < 1.25, all p values $> .22$. Strikingly, TE's difference in average fixation duration between positive and negative objects was 5.05 standard deviations greater than the mean difference of the control participants. These findings are consistent with the idea that it is more difficult for TE to disengage her attention from negative than positive items. As such, the findings further support the conclusion that TE's object–personality pairings can influence overt attention. Importantly, these findings are consistent with studies of normal individuals showing that it is more difficult to disengage attention from negative than positive stimuli (Fox et al., 2001).

GENERAL DISCUSSION

Our investigation of TE's object–personality synesthesia suggests the following conclusions: First, TE's object–personality experiences appear to be a genuine case of synesthesia. The results of our consistency test suggest that TE forms stable personalities for both familiar and novel objects. The findings imply that stable personalities can even be formed during a single encounter with an object. The qualitative analysis revealed that TE's personifications are very detailed and complex. The personifications of novel objects are similar in complexity to those of familiar objects, with the important exception that novel objects have fewer social attributes associated with them than do familiar objects. Second, our investigation revealed that TE's object–personality pairings can have a systematic impact on behavior. When viewing displays of graphemes that for TE were positive and negative, we found that TE's overall viewing times were extremely variable. According to her subjective reports, this is because she saw each display of graphemes as a group of individuals interacting (such as at a party), with some spatial organizations being more interesting to her than others. In addition, we found that TE was more likely to fixate on positive objects, but that she fixated on negative objects longer than positive objects.

Our findings extend previous research on synesthesia in two important ways. First, our study is the first to demonstrate that synesthesia can have a substantial impact on overt eye movements. Assuming overt eye movements reflect the allocation of visual attention (Findlay & Gilchrist, 2003), our findings are consistent with previous demonstrations that synesthetic experiences influence the allocation of spatial attention (Smilek, Dixon, & Merikle, 2003; Palmeri, Blake, Marois, Flanery, & Whetsell, 2002). Second, our findings build on previous reports of personification in synesthesia (e.g., Sagiv, 2005; Cytowic, 2002; Calkins, 1893) by demonstrating that personifications can be elicited not only by letters and numbers but by almost any visual object. Third, our study further supports a growing body of literature showing that synesthesia can involve complex nonsensory and highly detailed semantic characteristics. This finding fits well with recent demonstrations that synesthetic inducers can be highly conceptual in nature, including concepts such as grapheme meaning (Dixon, Smilek, Duffy, Zanna, & Merikle, 2006), numerosity (Hubbard, Piazza, Pinel, & Dehaene, 2005), and time (Smilek, Callejas, Dixon, & Merikle, in press; Seymour, 1980).

Relation to Anthropomorphism in Normal Cognition

Individuals often ascribe anthropomorphic characteristics to specific organizations of features and to simple shapes moving in a nonrandom manner (e.g., Scholl & Tremoulet, 2000; Collier, 1996; Davis, 1961; Heider & Simmel, 1944). For instance, when individuals of various cultures are shown stick figures with either a square or round head, they are much more likely to categorize the square-headed figure as ''male'' and the round-headed figure as ''female'' (Davis, 1961), and simple shapes also appear to be associated with specific emotions; a line is associated more often with the adjective ''bored,'' whereas a circle is associated more often with the adjective ''cheerful'' (Collier, 1996).

The fact that simple shapes can elicit specific anthropomorphic characteristics in nonsynesthetic individuals raises the possibility that TE's object–personality pairings might be driven primarily by the basic visual properties of the objects. A consideration of TE's personifications of letters and numbers suggests that, although her personifications may be influenced by visual features to some extent, the role that visual features play is not straightforward and certainly not the whole story. Consistent with a role of visual features, we found that certain pairs of graphemes that look visually similar also have similar personality characteristics. For instance, the number ''1'' and the letter ''I'' are both god-like, are both nice, and are not strongly male or female. Also, the letters ''M'' and ''W'' are both mature (40 and 60 years of age, respectively) females who are nice and very friendly. However, inconsistent with the view that TE's experiences are exclusively driven by visual features, we found a number of cases in which TE experienced similar personalities for letters that do not look anything alike. For instance, TE reports that ''zero ('0') and one ('1') are the gods of the numbers and they are the only two numbers that don't have a gender; they're genderless.'' Also inconsistent with a strong role of visual features—as well as the suggestion put forth by Davis (1961)—is the fact that the male-to-female ratio of the personalities is about the same for letters that have mostly line or angular features (E, F, H, I, M, N, R, V, W, X) and for letters that have mostly curved features (C, D, G, Q, S, U). The male-to-female ratio is 6 males to 3 females for letters with angular features (the letter I is genderless) and 5 males to 1 female for letters with curved features. Furthermore, our finding that novel objects have fewer relational and social role characteristics than familiar objects also argues against a strong role of features; rather, it suggests that TE's personifications depend, in part, on her experience with the objects.

It seems that the personalities of some letters and numbers may depend, in part, on their ordinal sequence rather than on particular features. For instance, TE reports that ''F hangs out with G, H, J and K, but mostly G'' and that ''F and G are best friends.'' And, when describing the letter ''R,'' TE notes that R ''hangs out with S'' and that R has ''been a big sister to T.'' Along the same lines, we believe that TE's emotional responses to the graphemes are likely not determined solely by the shape of the inducing stimuli but rather depend on a combination of object shape and the personality associations with the shape.

Although TE's object–personality associations seem to be very idiosyncratic, we suggest that the personifications experienced by TE are likely more extreme versions of the sorts of anthropomorphisms that most individuals make every day. However, for most individuals, anthropomorphism is constrained to specific shape configurations or patterns of motion that have some ethological relevance. In contrast, TE's personifications do not seem to be constrained to ethologically relevant shapes or motions, but rather are indiscriminately activated by almost every object. Whereas most individuals would not ascribe a personality to the number ''3,'' TE experiences a rich and detailed personification of the number, as if she had just encountered a human being.

Neural Underpinnings

We suggest that TE's object–personality synesthesia likely involves brain areas that are active in nonsynesthetic object perception and personification. Although there are very few neuroimaging studies of personification, the available evidence implicates a *personification network* that includes five critical areas: (1) the extrastriate cortex; (2) the fusiform gyrus; (3) the amygdala; (4) posterior parts of the temporo-parietal junction (angular gyrus); and (5) the medial frontal cortex. The most direct evidence for this network comes from a study contrasting brain activity associated with viewing randomly moving shapes and brain activity associated with viewing nonrandom movement that predisposes observers to anthropomorphize the movement (Castelli, Happe, Frith, & Frith, 2000). The study found increased activation in all of the areas of the aforementioned personification network, with the exception that areas directly adjacent to the amygdala were active rather than the amygdala itself.

There is further indirect support for each of the components of our proposed personification network. First, it is clear that the extrastriate cortex and the fusiform gyrus should be involved in the network as these areas are intimately involved in object perception and identification (e.g., Allison, McCarthy, Nobre, Puce, & Belger, 1994). Second, there is good reason to include the temporo-parietal junction on the basis of both patient and brain stimulation studies. For instance, patients with posterior parietal damage resulting in paroxysmal alien hand syndrome have been known to personify the affected arm (Leiguarda, Starkstein, Nogues, Berthier, & Arbelaiz, 1993). As well, stimulation of the temporoparietal junction has been associated with the experience of oneself (i.e., one's own persona) as being outside of the body (Blanke, Ortigue, Landis, & Seeck, 2002) and ''the feeling of presence'' (Arzy, Seeck, Ortigue, Spinelli, & Blanke, 2006). Third, medial frontal regions should be included in the personification network on the basis of patient and neuroimaging data. Specifically, damage to various frontal areas of the brain can lead to radical changes in personality, often characterized by deficits in social decision making (Damasio, Tranel, & Damasio, 1990; Stuss & Benson, 1986). Furthermore, functional imaging studies implicate the prefrontal and frontal areas in attributions of mental states to others (e.g., Shamay-Tsoory, Tomer, Berger, Goldsher, & Aharon-Peretz, 2005; Fletcher et al., 1995) and the understanding of the ''self'' (Keenan, Wheeler, Gallup, & Pascual-Leone, 2000). Finally, support for the inclusion of the amygdala in the network comes from numerous studies implicating the amygdala in emotional evaluations and reactions (e.g., Adolphs & Tranel, 1999; Adolphs, Tranel, & Damasio, 1998; LeDoux, 1992). And, unlike normal individuals, patients with damage to the amygdala fail to anthropomorphize nonrandom movements of simple shapes (Heberlein et al., 1998). Thus, taken together, the available evidence supports the inclusion of each of the proposed components in the personification network.

Given this abundant support for the existence of an object perception and personification network, an important question remains: How does processing in this network lead to object–personality synesthesia? We believe object–personality synesthesia arises when the personification network is strongly activated by objects that for normal individuals either do not activate, or weakly activate, this network. As in other forms of synesthesia, this is likely due to a greater number of neural connections in the network or reduced inhibition of normally occurring connections (see Ramachandran & Hubbard, 2001).

We should also comment on the brain areas that might be involved in the influence of TE's personifications on attention. The influence of TE's personifications on her eye movements likely emerges when processing in the personification network interacts with processing in areas of the brain responsible for directing covert attention and eye movements. There seems to be general agreement that covert and overt shifts of visual attention activate areas in the parietal and frontal regions of the brain and that these regions interact with extrastriate areas to enhance processing of attended information (see Corbetta, 1998 for a review). Our finding that it was more difficult for TE to disengage from negative items than positive items further implicates the parietal regions, which are known to be involved in disengaging attention from objects (Posner, Walker, Friedrich, & Rafal, 1984). We are particularly struck by the fact that the parietal and frontal regions associated with personification and the self are very close to the parietal and frontal regions involved in shifts of covert and overt attention. This suggests the possibility of a strong relationship between these networks, which would be extremely functional for a species needing to effectively direct attention in a social and relational context.

Personification of Ordinal Sequences

Following the submission of our manuscript, it was brought to our attention that there were two in-press articles describing several individuals who personify numbers, days of the week, and months of the year (Simner & Holenstein, in press; Simner & Hubbard, in press).[2] Simner and colleagues referred to these experiences as *Ordinal Linguistic Personification (OLP)* because, in these cases, the personifications were elicited only by sequential linguistic units. It is worth noting that there are several interesting similarities between OLP and object–personality synesthesia. Specifically, both types of experience occur without intention, involve highly specific experiences of personality, and are consistent over time (Simner & Holenstein, in press). Also, in both object–personality synesthesia and OLP, proximal items in a sequence of letters and numbers elicit very similar personalities or personalities that have close relationships (e.g., the letters F, G, and H are all friends).

However, there is also an important difference between object–personality synesthesia and OLP. Specifically, whereas personification in OLP is restricted only to ordinal sequences, object–personality synesthesia involves personification to almost all objects. This difference has led our group and Simner and colleagues (Simner & Holenstein, in press; Simner & Hubbard, in press) to propose slightly different neural conceptualizations of personification in synesthesia. Simner and colleagues highlight the role of the angular gyrus in OLP because the angular gyrus is known to be involved in processing ordinal sequences. In addition, Simner and Holenstein (in press) suggest that OLP may *not* arise from the same mental processes involved in personification experienced by nonsynesthetic individuals. In contrast, we include the angular gyrus as only one component of a more general personification network and we suggest that object–personality synesthesia is a more extreme (overgeneralized) form of the sorts of personifications experienced by nonsynesthetes.

The fact that TE and individuals with OLP have similar yet distinct subjective experiences is not surprising, given the considerable phenotypic heterogeneity documented in previous studies of synesthesia (see Dixon & Smilek, 2005; Hubbard, Arman, Ramachandran, & Boynton, 2005; Dixon et al., 2004). The phenotypic differences between object–personality synesthetes and individuals with OLP are interesting because they raise questions about whether and how these conditions might be related. One possibility is that these two forms of synesthesia are variations of the same underlying condition, with object–personality synesthesia being a stronger or more intense form of the condition. Another possibility is that personification of ordinal sequences (in OLP) is independent of personification of nonordinal objects (in object–personality synesthesia), but that these two types of experiences can co-occur. Although at present there are insufficient data to make any strong conclusions, we lean toward the first of the two possibilities. This is because we are particularly struck by (and excited about) the large *similarities* (rather than the subtle differences) between Simner and colleagues' reports of OLP and our independent assessment of TE's object–personality synesthesia.

Implications for Normal Cognition

Our proposal that object–personality synesthesia is an extreme manifestation of normal personification involving similar neural networks suggests that our findings should have important implications for studies of normal cognition. Indeed, we believe our studies have direct bearing on recent debates concerning the influence of meaningful information on the allocation of spatial attention. Some studies indicate the emotional valence of faces can influence the deployment of visual attention (Eastwood et al., 2001, 2003; Ohman et al., 2001; Hansen & Hansen, 1988) and that negative faces hold attention longer than positive faces (Fox et al., 2001). In contrast, other studies suggest that most influences of emotion on attention can be attributed to simple feature differences between positive and negative stimuli rather than emotional valence (e.g., Hunt et al., in press; Purcell et al., 1996). Our findings make an important contribution to this debate by showing emotional influences on attention in a very different context, namely, in the context of object–personality synesthesia. As such, our findings bolster the general conclusions that negative stimuli can hold attention longer than positive stimuli and that emotional valence can influence the allocation of attention. We believe that further study of individuals such as TE may provide valuable insights not only into the cognitive and brain mechanisms underlying synesthesia but also into the processes underlying normal cognition.

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Notes

1. One possible criticism of the free viewing task is that performance in the task may depend on a variety of strategies adopted by the observer. However, this criticism applies even to more structured tasks, such as visual search, because these tasks also allow for a myriad of possible strategies (e.g., Smilek, Enns, Eastwood, & Merikle, 2006).
2. We thank Edward M. Hubbard for bringing these articles to our attention.

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