Research Article

First Impressions

Making Up Your Mind After a 100-Ms Exposure to a Face

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ABSTRACT—*People often draw trait inferences from the facial appearance of other people. We investigated the minimal conditions under which people make such inferences. In five experiments, each focusing on a specific trait judgment, we manipulated the exposure time of unfamiliar faces. Judgments made after a 100-ms exposure correlated highly with judgments made in the absence of time constraints, suggesting that this exposure time was sufficient for participants to form an impression. In fact, for all judgments—attractiveness, likeability, trustworthiness, competence, and aggressiveness—increased exposure time did not significantly increase the correlations. When exposure time increased from 100 to 500 ms, participants' judgments became more negative, response times for judgments decreased, and confidence in judgments increased. When exposure time increased from 500 to 1,000 ms, trait judgments and response times did not change significantly (with one exception), but confidence increased for some of the judgments; this result suggests that additional time may simply boost confidence in judgments. However, increased exposure time led to more differentiated person impressions.*

Lavater's (1772/1880) *Essays on Physiognomy*, which was written in 1772 and reprinted in more than 150 editions by 1940, described in minute detail how to relate facial features to personality traits (e.g., "the nearer the eyebrows are to the eyes, the more earnest, deep, and firm the character," p. 59). Although these ideas strike most people today as ludicrous and bring to mind phrenology, empirical evidence shows that the effects of facial appearance on social outcomes are pervasive. In almost every significant domain of life, attractive people get better outcomes than unattractive people (Hamermesh & Biddle, 1994; Zebrowitz, 1999). The effects of baby-faced appearance are as pervasive as are the effects of attractiveness (Montepare & Zebrowitz, 1998; Zebrowitz, 1999). For example, baby-faced individuals are less likely to receive severe judicial outcomes than mature-faced individuals (Zebrowitz & McDonald, 1991).

From the structure of the face, people form not only global impressions, but also specific trait impressions (Hassin & Trope, 2000). For example, we showed that inferences of competence, based solely on facial appearance, predicted the outcomes of U.S. congressional elections in 2000, 2002, and 2004 (Todorov, Mandisodza, Goren, & Hall, 2005). Although we measured impressions on a variety of traits, including attractiveness, trustworthiness, and likeability, the trait inference that predicted the election outcomes was competence. Competence was also rated as the most important attribute for a person running for a public office. This finding suggests that person attributes that are important for specific decisions are inferred from facial appearance and influence these decisions.

From both the standard-intuition and the rational-actor points of view, trait inferences from facial appearance should not influence important deliberate decisions. However, to the extent that these inferences occur rapidly and effortlessly, their effects on decisions may be subtle and not subjectively recognized. Using the terms of dual-process theories (Chaiken & Trope, 1999; Kahneman, 2003), we have argued that trait inferences from faces can be characterized as fast, intuitive, unreflective System 1 processes that contrast with slow, effortful, and deliberate System 2 processes (Todorov et al., 2005). We provided preliminary evidence for this proposal by showing that inferences of competence based on 1-s exposure to the faces of the winners and the runners-up for the Senate races sufficed to predict the election outcomes.

In this article, we report a series of studies in which we systematically manipulated the exposure time of faces to further explore the minimal conditions under which people make trait inferences from facial appearance. Research on visual processing has shown that high-level object representations can be constructed very rapidly from visual scenes (Grill-Spector & Kanwisher, 2005; Rousselet, Fabre-Thorpe, & Thorpe, 2002; Thorpe, Fize, & Marlot, 1996). It is possible that inferences about socially significant attributes are also rapidly extracted

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from facial appearance. We conducted five experiments, each focusing on a different judgment from facial appearance: attractiveness, likeability, competence, trustworthiness, and aggressiveness. Among the studied traits, attractiveness is the only one that is unambiguously related to facial appearance; that is, it is a property of facial appearance. In this respect, judgments of attractiveness provide a benchmark for judgments of character traits. Liking is a global affective response that may require minimal inferential activity (Zajonc, 1980). In contrast to attractiveness and liking, trustworthiness, competence, and aggressiveness are specific traits that have clear behavioral manifestations. These traits are also important for both social and economic interactions.

In all the experiments, faces unfamiliar to the participants were presented for 100 ms, 500 ms, or 1,000 ms. For each face, participants were asked to make a trait judgment and then to express their confidence in that judgment. We tested three hypotheses: (a) that a 100-ms exposure to a face is sufficient for making a trait judgment, (b) that additional exposure time increases confidence in trait judgments without necessarily changing the judgments, and (c) that additional exposure time allows for more differentiated trait impressions.

If trait inferences from faces can be characterized as System 1 inferences, minimal exposure time should be sufficient for trait inferences to occur. In order to obtain criterion judgments, we asked a large group of participants to make trait judgments of the faces in the absence of time constraints. If a 100-ms exposure to a face is sufficient for making a trait inference, then trait judgments made after 100-ms exposure should correlate with judgments made in the absence of time constraints. In contrast, if 100 ms is insufficient, these judgments should be uncorrelated, and only judgments made after longer exposures should correlate with judgments made in the absence of time constraints.

We were also interested in how additional exposure time affects trait judgments and confidence in these judgments. If people commit to a judgment early in time, additional time can serve only as a justification of this judgment. If this is the case, confidence should increase as a function of exposure time, but there should be no corresponding change in judgment. For example, if 500-ms exposure is sufficient for participants to form stable trait judgments, little change in judgments should be observed with additional exposure time. However, additional exposure time may boost confidence in judgments.

Even if trait impressions can be formed after minimal exposure time, additional time may allow for more differentiated impressions. For example, it is possible that after 100-ms exposure, people perform a coarse affective discrimination of faces, such that judgments of different traits are highly correlated. Additional time may allow for more fine-grained impressions based on specific trait attributions, in which case judgments of different traits would be less correlated. We tested these predictions using factor analysis.

METHOD

Participants

A total of 245 undergraduate students from Princeton University participated in the studies either for payment or for partial course credit. One hundred twenty-eight participated in a preliminary study in which we obtained measures of trait inferences from facial appearance in the absence of time constraints. One hundred seventeen participated in the five main experiments; 20 were asked to make attractiveness judgments, 25 to make liking judgments, 23 to make competence judgments, 24 to make trustworthiness judgments, and 25 to make aggressiveness judgments.

Stimuli

In all the studies, we used a database of photographs of 70 amateur actors, 35 females and 35 males between 20 and 30 years of age (Lundqvist, Flykt, & Öhman, 1998). In the pictures, all actors wore gray T-shirts, and there were no beards, mustaches, earrings, eyeglasses, or visible makeup. We used frontal head-shot photographs of individuals with neutral expressions. Of the 70 photographs, 2 photographs of males were excluded because of poor quality; we also excluded 2 photographs of females in order to have equal numbers of male and female photographs.

To obtain reliable measures of trait inferences from facial appearance, we presented participants in the preliminary study with the photographs and asked them to judge the degree to which the person in each picture was attractive, likeable, competent, honest or trustworthy, aggressive, extraverted or enthusiastic, sympathetic or warm, dependable or self-disciplined, calm or emotionally stable, open to new experiences or complex, and ambitious. The judgments on the first five dimensions provided the criterion judgments for the five experiments. In the preliminary study, each face was presented on a separate questionnaire page, and the order of the trait judgments was fixed. All judgments were made on a 9-point scale ranging from 1 (*not at all*) to 9 (*extremely*). The photographs were randomly divided into three groups, each one containing the same number of males and females, and for each group of photographs, we generated two random orders. Participants were randomly assigned to one of the six sets of photographs (3 groups $\times$ 2 orders) and completed the task at their own pace. Each photograph was rated by 42 or 43 participants. The trait judgments were highly reliable. For the three groups of photographs, the Cronbach alphas were .97, .96, and .95 for attractiveness; .94, .91, and .89 for likeability; .92, .92, and .92 for trustworthiness; .85, .91, and .96 for competence; and .87, .75, and .89 for aggressiveness.

The mean trait judgments across participants served as the criterion judgments for the experiments. To the extent that limited exposure time is sufficient for people to form trait impressions from faces, the experimental judgments made under

time constraints would be expected to correlate with the criterion judgments. It should be noted that, for two reasons, this procedure underestimated the true correlation between judgments made in the absence of time constraints and judgments made with time constraints: The two sets of judgments were measured on different scales (see Procedure) and were made under different conditions (paper-and-pencil questionnaire vs. computer-controlled presentation).

Procedure

All five experiments followed the same procedure. Participants were told that this was a study about first impressions and that they should make their decisions as quickly as possible. The instructions emphasized that photographs would be presented for very brief periods of time and that we, the experimenters, were primarily interested in participants' first impressions, or gut feelings. Each experiment started with three practice trials in order to familiarize participants with the task.

For the experimental trials, the 66 faces (33 males and 33 females) were randomly divided into three sets of 22 such that each group had the same number of male and female faces. We created three experimental versions of the stimuli by counterbalancing the exposure time assigned to each set (100, 500, or 1,000 ms). For example, each face from the first set was presented for 100 ms in the first version, for 500 ms in the second version, and for 1,000 ms in the third version. Participants were randomly assigned to one of the three experimental versions. For each participant, 22 of the faces were presented for 100 ms, 22 were presented for 500 ms, and 22 were presented for 1,000 ms. Because we were interested in first impressions, each face was presented only once. Thus, the total number of trials was 66 per participant. The order of trials was randomized for each participant by the computer (i.e., the levels of exposure time were randomly intermixed).

Each trial started with a fixation point (+) presented for 500 ms at the center of the screen. Then a photograph was presented for 100 ms, 500 ms, or 1,000 ms. Immediately afterward, a question appeared in the location of the photograph (e.g., "Is this person competent?"). The only difference among the studies was the trait judgment that participants were asked to make. Participants responded using the computer keyboard, pressing the "/" (slash) key, which was labeled "yes," or pressing the "Z" key, which was labeled "no." Given the limited exposure times, we decided to use dichotomous trait judgments because they are simpler than continuous trait judgments. Further, in the correlation analyses (see the next paragraph), the criterion judgments were correlated with the proportions of trait attributions across participants (i.e., continuous scores; the probability of trait attribution). Following this yes/no judgment, the next screen asked participants to rate how confident they were in their judgment. This rating was made on a 7-point scale, ranging from 1 (*least confident*) to 7 (*most confident*). Participants responded by using the number keys at the top of the keyboard. The intertrial interval was 1,500 ms.

To test whether judgments made under limited exposure time correlate with judgments made in the absence of time constraints, we correlated the proportions of trait attributions for each face (at each exposure time) with the mean criterion judgments for that face. Further, for each experiment, we analyzed the proportions of trait attributions, the response times for the trait judgments, and the mean confidence in judgments as a function of exposure time. We removed response time outliers by deleting response times that were 3 standard deviations above the participant's mean. In all experiments, less than 2% of the trials were excluded.

RESULTS AND DISCUSSION

Correlation of Time-Constrained With Time-Unconstrained Judgments

As shown in Table 1, even after 100-ms exposure to a face, trait judgments were highly correlated with judgments made in the absence of time constraints. Although the correlations for all judgments but attractiveness increased with the increase in

TABLE 1

Correlations Between Time-Constrained Trait Judgments From Facial Appearance and Judgments Made in the Absence of Time Constraints

	Exposure time					
	100 ms		500 ms		1,000 ms	
Trait judgment	Zero-order correlation	Partial correlation	Zero-order correlation	Partial correlation	Zero-order correlation	Partial correlation
Trustworthiness	.73	.63	.66	.59	.74	.69
Competence	.52	.39	.67	.58	.59	.50
Likeability	.59	.40	.57	.46	.63	.50
Aggressiveness	.52	.52	.56	.58	.59	.61
Attractiveness	.69	—	.57	—	.66	—

Note. The partial correlations control for judgments of attractiveness made after the same exposure time. All correlations were significant, $p < .001$, $p_{rep} > .98$.

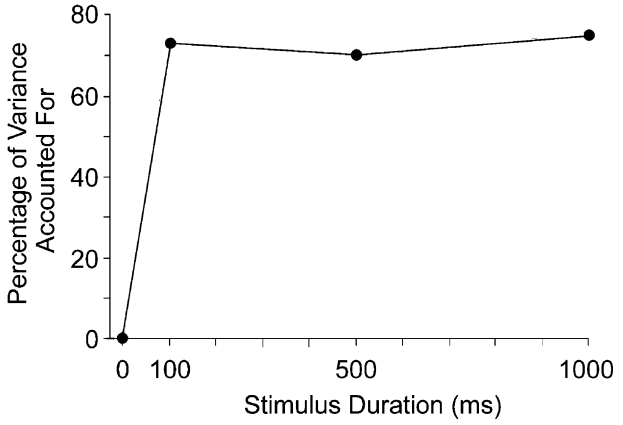

Fig. 1. Percentage of variance in judgments made in the absence of time constraints accounted for by time-constrained trait judgments.

exposure from 100 to 1,000 ms, none of these changes was significant. We compared the correlations at 100 and 500 ms, at 500 and 1,000 ms, and at 100 and 1,000 ms using Williams's test for dependent correlations (Steiger, 1980). None of these tests reached significance.

We expected that we would find the highest correlation for judgments of attractiveness. Attractiveness, after all, is a property of facial appearance. However, the correlations for judgments of trustworthiness were slightly higher. We also conducted partial correlation analyses, controlling for judgments of attractiveness, to rule out the possibility that the judgments made after limited exposure time simply reflected an attractiveness halo effect. Although the correlations were reduced (Table 1), they remained highly reliable for all judgments. Comparing the difference between the zero-order and the partial correlations at the different levels of exposure time suggests that the effect of attractiveness on trait judgments was reduced with increased exposure to the faces. The partial correlations increased with increased exposure time, but as in the case of the zero-order correlations, none of the changes reached significance.

How much of the variance in time-unconstrained judgments can be accounted for by time-constrained judgments? To answer this question, we conducted three regression analyses (one for each level of exposure time) in which time-unconstrained judgments (5 types of judgment $\times$ 66 faces) were regressed on time-constrained judgments and dummy variables controlling for the type of judgments (4) and the face stimuli (65). As shown in Figure 1, with the increase in exposure from 100 to 1,000 ms, the variance accounted for increased only 2.2%. Although we did not include conditions in which participants were exposed to faces for more than 1,000 ms, it is reasonable to assume that the explained variance could not be improved with longer exposures. Assuming that the average reliability of the judgments is .90, the ceiling of the explained variance should be, on average, 81.0%. Given that the procedures for collecting the time-constrained judgments and the time-unconstrained (criterion) judgments were different and that these differences could have increased the error variance, the accounted-for variance at 1,000-ms exposure (74.9%) seems very close to the possible ceiling.

Analysis Within Experiments

All judgments showed the same pattern as a function of exposure time. As shown in the top panel of Figure 2,[1] when exposure time increased from 100 to 500 ms, judgments became more negative (for all judgments, $p < .05$, $p_{rep} > .91$, $d > 0.85$). Faces were perceived as less attractive, less likeable, less trustworthy, less competent, and more aggressive. The mean level of judgments stabilized at the 500-ms exposure, and no significant changes were observed for the increase to 1,000-ms exposure. As shown in the middle panel of Figure 2, when exposure time increased from 100 to 500 ms, response times for all five judgments decreased (for all judgments, $p < .05$, $p_{rep} > .93$, $d > 0.91$). As with the trait judgments, little change was observed when exposure time increased from 500 to 1,000 ms; although response times continued to decrease, the only significant effect was for trustworthiness judgments, $t(23) = 4.14$, $p_{rep} = .99$, $d = 1.73$.

As shown in the bottom panel of Figure 2, when exposure time increased from 100 to 500 ms, confidence in all five judgments increased. The only effect that did not reach significance was for judgments of aggressiveness, $t(24) = 1.47$, $p_{rep} = .84$, $d = 0.60$ (for the other four judgments, $p < .05$, $p_{rep} > .93$, $d > 0.94$). When exposure time increased from 500 to 1,000 ms, confidence in judgments, except judgments of competence, increased again. Although this increase in confidence was significant only for attractiveness judgments, $t(19) = 2.59$, $p_{rep} = .95$, $d = 1.19$, and approached significance for trustworthiness judgments, $t(23) = 1.94$, $p_{rep} = .90$, $d = 0.81$, the combined p value from all five experiments was .028 ($z = 2.20$), and the average effect size d was 0.41.

Relations Between Trait Inferences

We conducted principal-components analyses with Varimax rotation to test whether person impressions became more differentiated as a function of increased exposure to the faces. As shown in Table 2, the analyses for both the 100-ms and the 500-ms exposure times identified only one factor, suggesting a coarse positive/negative discrimination. All positive traits had high positive loadings on the factor, and aggressiveness had a high negative loading. This factor accounted for 62.5% of the variance in judgments made after 100-ms exposure and 58.3% of the variance in judgments made after 500-ms exposure. The difference in the explained variance suggests that judgments made after 100-ms exposure were more correlated than judgments

[1]The analyses we report here were conducted at the level of participants (i.e., analyzed the mean judgments across faces). We conducted the same analyses at the level of faces (i.e., analyzed the mean judgments across participants) and obtained identical results.

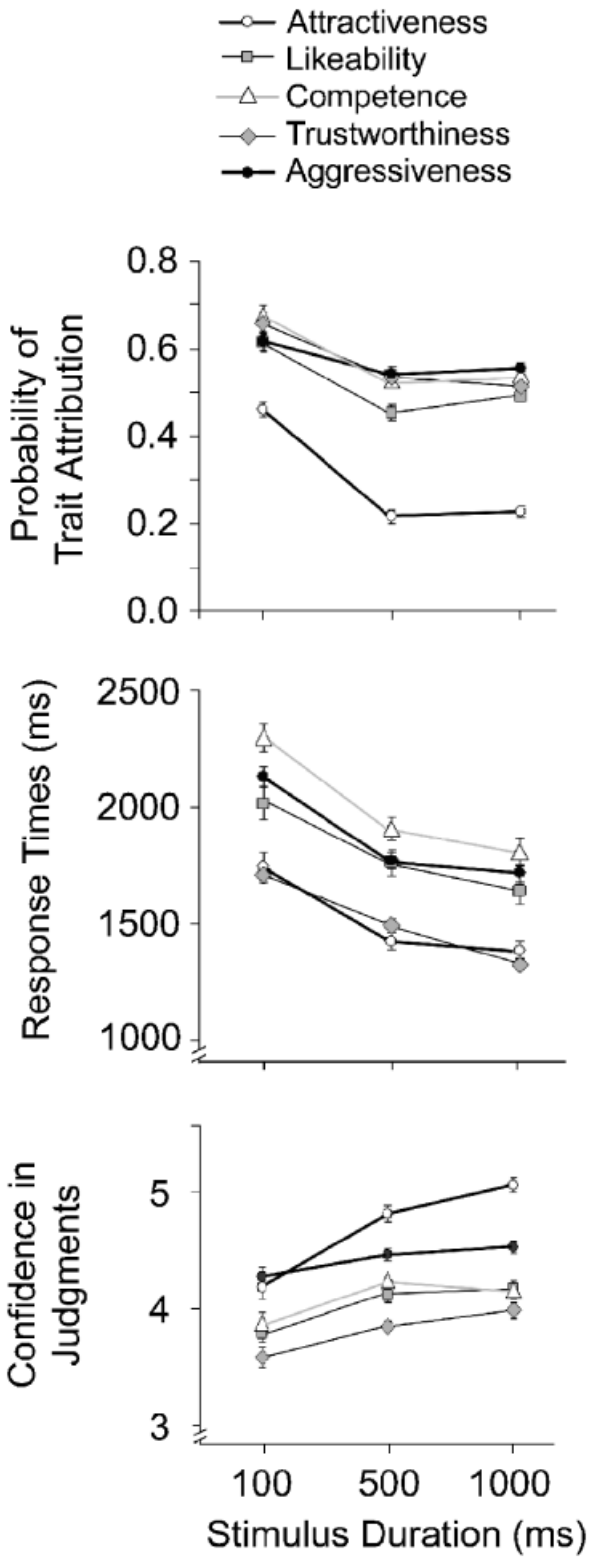

Fig. 2. Probability of trait attribution (top panel), response time (middle panel), and confidence in trait judgment (bottom panel) as a function of the trait being judged and exposure time. The probability of trait attribution of aggressiveness is reversed (i.e., higher probability means fewer attributions of aggressiveness) so that for all traits, higher probabilities reflect more positive valence. Confidence judgments were made on a 7-point scale, ranging from 1 (*least confident*) to 7 (*most confident*). Error bars show within-subjects standard errors.

TABLE 2

Factor Loadings of Trait Judgments on Factors Identified in the Principal Components Analysis With Varimax Rotation

	Exposure time			
			1,000 ms	
Trait judgment	100 ms: Factor 1	500 ms: Factor 1	Factor 1	Factor 2
Trustworthiness	.85	.83	.61	.61
Competence	.81	.84	.91	.06
Likeability	.81	.81	.79	.33
Attractiveness	.81	.72	.84	.00
Aggressiveness	−.66	−.58	−.01	−.96

Note. For each exposure time, factor analyses were performed on the aggregated judgments for each face. Only factors with eigenvalues greater than 1 were extracted.

made after 500-ms exposure. In contrast to the analyses for the 100- and 500-ms exposure times, the analysis for the 1,000-ms exposure time identified two orthogonal factors, suggesting a more differentiated person impression. The first factor accounted for 50.5% of the variance, and the second accounted for 27.8%. The first factor comprised all positive traits, and the second factor contrasted aggressiveness and trustworthiness. Attractiveness and competence were practically unrelated to aggressiveness in this factor solution.

GENERAL DISCUSSION

Our findings suggest that as minimal an exposure as 100 ms is sufficient for people to make a specific trait inference from a stranger's face. For all five traits, judgments made after 100-ms exposure to a face were highly correlated with judgments made in the absence of time constraints. In fact, additional exposure time did not increase these correlations. In this context, revisiting the response times for the judgments is informative. Response times decreased when exposure time increased from 100 to 500 ms. However, response times were measured from the offset of the face to the response. Thus, in the 500-ms condition, participants had an extra 400 ms to compute their judgments. If participants computed the judgments faster in the 500-ms condition than in the 100-ms condition, the response times should have decreased by more than 400 ms in the former condition. However, for all five judgments, the response times in the 500-ms condition decreased by less than 400 ms, suggesting that the judgments were computed as fast, if not faster, in the 100-ms condition as in the 500-ms condition.

Although judgments were formed after 100-ms exposure to the faces, participants' trait judgments shifted systematically as a function of increased exposure time. When exposure time increased from 100 to 500 ms, judgments became more negative. The positivity in judgments made after 100-ms exposure shows that the person positivity bias (Sears, 1983) may be particularly pronounced under conditions of minimal information in a safe

experimental environment. When exposure time increased from 500 to 1,000 ms, none of the judgments shifted significantly, which suggests that a 500-ms exposure was sufficient for participants to create a subjectively satisfying trait impression. This interpretation is consistent with the findings for confidence. The increase in confidence was larger when exposure time increased from 100 to 500 ms than when it increased from 500 ms to 1,000 ms. Although judgments did not change when exposure time increased from 500 to 1,000 ms, confidence in judgments did increase for four of the five judgments. These findings suggest that minimal exposure to faces is sufficient for people to form trait impressions, and that additional exposure time can simply boost confidence in these impressions. That is, additional encounters with a person may serve only to justify quick, initial, on-line judgments.

We expected that the highest correlation between judgments made after 100-ms exposure and judgments made in the absence of time constraints would be for judgments of attractiveness. However, trustworthiness judgments showed the highest correlation. In hindsight, this finding is not surprising. Evolutionary psychologists have argued that detection of trustworthiness is essential for human survival (Cosmides & Tooby, 1992). Further, functional neuroimaging studies show that detection of trustworthiness in a face may be a spontaneous, automatic process linked to activity in the amygdala (Winston, Strange, O'Doherty, & Dolan, 2002), a subcortical brain structure implicated in the detection of potentially dangerous stimuli (Amaral, 2002). Work with patients with bilateral amygdala damage shows impaired ability to discriminate between trustworthy and untrustworthy faces (Adolphs, Tranel, & Damasio, 1998). These findings are consistent with the idea that people can be especially efficient in making inferences of trustworthiness, as shown by our findings. In fact, only judgments of attractiveness were as fast as judgments of trustworthiness in the present study.

We showed that a 100-ms exposure to a face suffices for people to make a trait inference, but we did not show that this is the minimum exposure that allows such inferences. Grill-Spector and Kanwisher (2005) showed that object categorization decisions were as fast as object detection decisions, concluding that "as soon as you know it is there, you know what it is." In fact, the accuracy of decisions was above chance for durations as short as 33 ms in their study. Identifying the lower limit of exposure time for inferring socially significant attributes from faces is an important task. Maybe, as soon as a face is there, you know whether to trust it. One implication of the current findings is that different trait judgments can have different time thresholds. For example, trustworthiness in a face may be inferred earlier than competence in a face.

To the extent that people form differentiated person impressions from facial appearance, additional exposure to a face can facilitate the formation of such impressions. The data from the factor analysis are consistent with this hypothesis. With increased exposure time, trait judgments became less correlated, suggesting a more fine-grained discrimination. For example, after 1,000-ms exposure, judgments of aggressiveness were independent of judgments of attractiveness and competence. The partial correlation analysis, showing that the effect of attractiveness on trait judgments decreased with increased exposure time, is also consistent with this hypothesis.

CONCLUSIONS

As minimal an exposure time as a tenth of a second is sufficient for people to make a specific trait inference from facial appearance. Additional exposure time increases confidence in judgments and allows for more differentiated trait impressions. However, the judgments are already anchored on the initial inference. Coupled with findings suggesting that inferences from facial appearance may be uncontrollable (Hassin & Trope, 2000, Experiment 4), our findings suggest that trait inferences from facial appearance can be characterized as fast, intuitive, System 1 processes. Lavater (1772/1880) might have been right about one thing: "Whether they are or are not sensible of it, all men [and women] are daily influenced by physiognomy" (p. 9). Not only trait inferences from facial appearance, but more generally inferences about other people may be effortless (e.g., Todorov & Uleman, 2003; Uleman, Blader, & Todorov, 2005). Person impressions are created effortlessly on-line from minimal information.

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