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The meaning in empathy: Distinguishing conceptual encoding from facial mimicry, trait
empathy, and attention to emotion

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Abstract

In order to truly empathize with another, we need to recognize and understand how they feel. Perception-action models of empathy predict that attending to another's emotion will spontaneously activate the observer's own conceptual knowledge for the state, but it is unclear how this activation is related to facial mimicry, trait empathy, or attention to emotion more generally. In the current study, participants did spontaneously encode background facial expressions at a conceptual level even though they were irrelevant to the task (the Emostroop effect; Preston & Stansfield, 2008), but this encoding was not associated with mimicry of the faces, trait empathy, the ability to resolve competing semantic representations (color-naming Stroop task), or the tendency to be distracted by emotional information more generally (Intrusive Cognitions task). Our results suggest that trait empathy increases attention to emotional information, but conceptual encoding occurs across individuals as a natural consequence of attended perception.

Keywords: emotion, empathy, facial expression, individual differences, Stroop

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We often find ourselves imitating the expressions of actors or taking on the emotions of a character in a novel, feeling so engaged that their trials and tribulations become our own. How is it that we so readily comprehend and feel the states of others? Extensive research suggests that this ability for empathy, for understanding and feeling another's emotion, arises from our capacity to spontaneously map another's state on to our own feeling substrates (reviewed in Preston & de Waal, 2002). For example, when observing another's state, we activate our own neural feeling substrates (i.e., "neural resonance"), we quickly and intuitively comprehend their specific state (i.e., "conceptual understanding"), and we may mimic their expression (i.e., "mimicry") or feel their affect as our own (i.e., "emotional resonance") (reviewed in Preston & Hofelich, in press). Despite extensive demonstrations of each of these resonant phenomena, it is unclear how they interact to produce empathy.

Theories of emotion contagion (e.g., Hatfield, Cacioppo, & Rapson, 1993) posit that emotion is transferred from target to observer through spontaneous mimicry of the target's expression. Such mimicry is thought to feed back to activate the observer's own neural representations, producing emotional resonance and conceptual understanding of the other's state (e.g., Oberman, Winkielman, & Ramachandran, 2007). While blocking mimicry does impair facial emotion recognition (Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001), other studies fail to find recognition benefits from mimicry (e.g., Blairy, Herrera, & Hess, 1999). Taken together, we assume that mimicry occurs, even

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without effort, but little evidence suggests that it is the primary driver behind neural or emotional resonance or conceptual understanding.

In contrast, neural theories of empathy propose a “perception-action” mechanism (PAM; Preston & de Waal, 2002), in which information is processed by directly mapping action percepts onto neural representations for action production. Unlike facial mimicry, which can occur reflexively through fast, subcortical processes (Dimberg, Thunberg, & Elmehed, 2000), conceptual encoding involves slower cortical processes that proceed from primary visual cortex, anteriorly through the dorsal and ventral visual streams, and requires sufficient processing time and attention (i.e., “attended perception”; see Preston & Stansfield, 2008). Because of this design, attending to another’s state should “spontaneously” (i.e., effortlessly, but not without attention or awareness as the term “automatically” implies) activate the observer’s own relevant representations (e.g., concepts, memories, feelings). This associative activation enables understanding as well as intersubjective access to the other’s state (i.e., empathy). According to the PAM, when attention is high, the target is salient, and the observer has no competing responses, activation of these personal representations can also produce peripheral activation (e.g., increased mimicry and heart rate), which in turn feed back to augment the initial central representation (e.g., Damasio, 2000; Preston & Hofelich, in press). Thus, while attention is not required for facial mimicry in the PAM, because it can occur through fast or slow processing routes, it is assumed to be necessary and sufficient for conceptual level encoding to occur.

As evidence for the PAM, extensive research has demonstrated activation of observers’ personal representations from perceiving another’s behavior (Kaplan &

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Iacoboni, 2006), pain (Singer et al., 2004), and experience of fear and anger (Preston et al., 2007). Additionally, behavioral evidence from the Emostroop task indicates that people spontaneously encode others' emotion at a *conceptual* level (i.e., activating the semantic category "fear" from passive viewing of a fearful face; Preston & Stansfield, 2008). This "conceptual encoding" is exhibited by slower categorization of emotional adjectives placed over incongruent than congruent expressions, attributable to the fact that both the word and face activate competing semantic representations, even though encoding of the faces is not necessary for the task. Therefore, attended perception must spontaneously activate concepts that facilitate true understanding, and not just reflexive forms of mimicry or contagion.

Both mimicry-based and PAM models assume that resonant phenomena are related to individual differences in empathy, but the precise mechanism is not clear. For example, empathic individuals mimic more (Sonnyby-Borgstrom, 2002), are better at decoding others' expressed emotion (Zaki, Bolger, & Ochsner, 2008), and sometimes exhibit more neural resonance when observing another's pain (Singer et al., 2004). Similarly, females, who traditionally report higher trait empathy, also show higher EEG indicators of neural resonance than males when observing another's hand movement (Cheng et al., 2008). However, these differences likely reflect differential attention to affective stimuli, rather than enhanced mimicry or perception-action processes. For example, trait empathy has yet to correlate with the best behavioral measure of the PAM (the Emostroop task; Preston & Stansfield, 2008), or with neural resonance when participants are matched on attention to the other's state (Preston et al., 2007). Moreover, gender differences in EEG indicators of resonance (above) are not directly associated

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with trait empathy (Silas, Levy, Nielsen, Slade, & Holmes, 2010), and the female trait advantage is most often attributed to enhanced motivation rather than intrinsic empathic skill (Ickes, Gesn, & Graham, 2000).

The current study was designed to better understand the underlying proximate mechanism of empathy by interrelating, within subjects, conceptual encoding of another's facial affect, facial mimicry, and trait empathy. High and low trait empathy participants completed the Emostroop task while we measured facial electromyography (EMG) to the foreground word and background face. Two attentional processes were also measured that may better explain our individual differences. The color-naming Stroop task (e.g., MacLeod, 1991) was administered to test the alternative hypothesis that differences in Emostroop performance result from nonaffective differences in the ability to resolve the inherent semantic conflict. The Intrusive Cognition (IC) task, which measures the extent of attentional capture from emotional stimuli, was also administered to test the hypothesis that empathic differences emanate from more general, affective attentional biases (McKenna & Sharma, 1995).

This design allows us to test differences between mimicry-based and PAM models of emotion. Mimicry-based theories predict that mimicry of the background face in the Emostroop task should occur across participants and explain the degree of semantic interference, but should not be related to differences in attention. The PAM predicts that the Emostroop effect should be exhibited across participants, but should not relate to mimicry or trait empathy. If mimicry occurs as a result of conceptual processing, it should more strongly reflect stimuli at the center of attention (the Emostroop words) and trait empathy should be associated with differential attention to these stimuli (greater

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mimicry for words on the Emostroop and greater attentional capture by emotional words in the IC task).

Methods

Participants

Sixty undergraduate students from the University of Michigan (30 women; mean age 19.23, range 18-27) participated in the study for course credit or \$10. Participants were prescreened from a pool of students ($N = 1003$, $M = 2.77$, $SD = 0.46$) using the Doherty Emotion Contagion Scale (EC; Doherty, 1997) to include those with scores 1.5 standard deviations above or below each gender's mean (women $M = 3.09$, $SD = 0.42$; men $M = 2.69$, $SD = 0.40$; high empathy: $n = 34$, 21 women; low empathy: $n = 25$, 9 women). EMG was acquired for approximately half of the participants (high $n = 14$, 7 women; low $n = 14$, 6 women).

Overview

Facial EMG electrodes were applied followed by computerized tasks using E-Prime Version 2.0 (Psychology Software Tools, Inc., Pittsburgh, PA) delivered on a CRT monitor 30 in. away. Each participant completed the Emostroop task (Preston & Stansfield, 2008), the color-naming Stroop task (MacLeod, 1991), and the IC task (McKenna & Sharma, 1995), both of which have reasonably good reliability and validity (information available in the respective reviews, MacLeod, 1991; McKenna & Sharma, 1995). Tasks and the location of response buttons were ordered randomly across participants. Afterwards, participants completed three trait empathy measures with good reliability and validity: the EC (Cronbach's alpha = .90; Doherty, 1997), the Mehrabian

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and Epstein Scale of Emotional Empathy (ME; Cronbach's alpha = .84; Mehrabian & Epstein, 1972), and the Interpersonal Reactivity Index (IRI; Cronbach's alpha = .72 - .78; Davis, 1980).

EMG Recording and Equipment

Facial EMG was measured during the Emostroop task from the *corrugator supercilli* (brow; associated with sad/angry affect) and *zygomaticus major* (cheek; associated with happy affect) muscles using pairs of Ag/AgCl electrodes on the left side of the face and collected with a BIOPAC MP150 system (sampling rate 500 Hz). Raw EMG signals were amplified by a factor of 500 and filtered online with a 10 Hz high-pass filter, integrated, and root-mean-squared. Trials were removed if there was an error, came directly after an error, or if mimicry exceeded four times the participant's standard deviation of the mean per muscle (owing to the right-skewed EMG distribution). Facial mimicry per trial was calculated by subtracting mean baseline activity (500-0 ms before stimulus onset) from mean trial activity (500-1000ms after stimulus onset, after Moody, McIntosh, Mann, & Weisser, 2007). Incongruent-neutral trials were not used as a baseline because they include emotional words that may also be mimicked (e.g., Niedenthal, Winkielman, Mondillon, & Vermeulen, 2009). Mimicry difference scores were standardized across trials, within participant and muscle, and averaged across trials with the same word-face combinations.

Tasks

Emostroop. Emostroop stimuli consisted of emotional adjectives superimposed over pictures of facial emotion created using Adobe Photoshop (Adobe Systems Inc., San Jose, CA). Facial stimuli were one of 16 Pictures of Facial Affect (PFA; Ekman &

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Friesen, 1976), including four actors (two female) displaying one of four expressions (happy, sad, angry, neutral). Overlaid adjectives were published prototypes (Shaver, Schwartz, Kirson, & O'Connor, 1987) for happy (*blissful, cheerful, gleeful, jolly, jovial, joyful, delighted, glad*), angry (*enraged, outraged, furious, wrathful, hostile, bitter, hateful, scornful*), and sad affect (*miserable, depressed, hopeless, gloomy, glum, grieving, sorrowful, woeful*). Participants were instructed to categorize the basic emotion of the adjective (happy, angry, sad) as quickly and accurately as possible. Of the 144 trials, word emotion matched the irrelevant background facial affect on a third (congruent) and did not match the facial emotion on two thirds (one third of these incongruent faces were emotional and one third were neutral). Two types of incongruent trials allowed us to measure two forms of evidence for conceptual encoding of the background face: the Emostroop effect (slower reaction time [RT] to classify adjectives over both types of incongruent than congruent faces) and a facilitation effect (faster RT when the background face is congruent than incongruent-neutral). Participants responded via buttons labeled H, A, or S with index, middle and ring fingers and received accuracy feedback after each trial. For analysis, trials were removed with incorrect responses and extreme dispersion (> 4 SD over participant mean, because of the right-skew).

Color-naming Stroop. The words *blue, red, green, and yellow* were presented in blue, red, green, or yellow font. Of the 48 randomly-selected trials, half presented words that represented the same color as the font (congruent; e.g., “green” typed in green font) and half represented a different color (incongruent; e.g., “green” typed in red font). The task began with eight practice trials to accustom participants to

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button locations. Interference is represented by slower responses to incongruent than congruent stimuli.

Intrusive Cognition. This task is traditionally referred to as the clinical or emotional Stroop task. However, slowed responses do not reflect semantic conflict between features of the stimulus as in the original Stroop or Emostroop tasks, but rather attentional capture from emotionally-salient information; therefore, we use the recommended, alternative term Intrusive Cognition task (see Algom, Chajut, & Lev, 2004). In separate blocks, positive (*glad, hope, treat, bliss, peace*), negative (*hurt, fear, crash, grief, death*), and neutral (*gate, note, clock, thumb, field*) words, matched on frequency and length, were presented in blue, red, green, or yellow font (McKenna & Sharma, 1995). Each word was presented once per color, producing three blocks of 20 trials. Participants responded to the color with index, middle, ring, and pinky fingers on their dominant hand. Positive interference is represented by longer RTs to positive than neutral stimuli; negative interference is represented by longer RTs to negative than neutral stimuli.

An alpha level of .05 was used in all statistical tests. Tukey honestly-significant post hoc tests were used to confirm pair-wise differences.

Results

Confirming Group Differences

Using independent Welch's *t*-tests, we confirmed differences between high and low empathy groups on all trait empathy measures: EC (high $M = 3.12$, low $M = 2.18$, $t(53.95) = 8.75$, $p < .001$), ME (high $M = 46.88$, low $M = -3.08$, $t(44.28) = 6.50$, $p < .001$), and IRI subscales ($t > 3.06$, $p < .005$).

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Emostroop

Behavior. We confirmed the basic Emostroop effect using a mixed analysis of variance (ANOVA) on RT across trial type (congruent, incongruent-emotional, incongruent-neutral; within participant) and empathy group (high, low; between-subjects). Participants classified adjectives slower when over incongruent than congruent expressions (Emostroop effect, $F(2, 120) = 25.15$, $p < .001$, partial $\eta^2 = .29$; Figure 1). Further demonstrating conceptual encoding of the irrelevant faces, follow-up paired comparisons revealed that: 1) incongruent-emotional trials were slower than congruent and incongruent-neutral trials ($z > 4.5$, $p < .001$) and 2) congruent trials were faster than incongruent-neutral trials (facilitation effect, $z = 2.56$, $p = .03$). High and low empathy participants did not differ on the Emostroop effect (trial type-by-group interaction, $F(2, 56) = 0.27$, $p = .77$, $\eta^2 = .002$) or overall RT (main effect of group, $F(1, 26) = 0.48$, $p = .49$, $\eta^2 = .008$).

[Figure 1 about here]

Facial mimicry. To determine whether people mimicked the categorized word or the irrelevant face, and if this was affected by trait empathy, mixed ANOVAs were performed for each muscle (*corrugator* and *zygomatic*) comparing word (happy, angry, sad) and face emotion (happy, angry, sad, neutral) within subjects and empathy group between subjects. Main effects of empathy group are not reported since mimicry was standardized within participant.

Mimicry of the classified word. The most prominent mimicry was for the affect of the classified word (Figure 1). The *corrugator* was more active for negative words (sad $M = 0.05$ and angry $M = 0.04$ greater than happy $M = -0.09$, $p < .066$; sad

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versus angry, $p = .97$) and this word mimicry tended to be stronger in high empathy participants (main effect of word emotion, $F(2, 297) = 6.44, p = .002, \eta^2 = .04$; word-by-group interaction, $F(2, 297) = 2.45, p = .09, \eta^2 = .014$; main effect of word in high empathy, $F(2, 154) = 9.33, p < .001, \eta^2 = .10$ and low empathy, $F(2, 143) = 0.37, p = .69, \eta^2 = .005$). The *zygomatic* was similarly more active for positive words, but only in high empathy participants (happy $M = 0.11$ greater than sad $M = -0.10, p = .046$, but not significantly greater than angry $M = -0.03, p = .29$; sad versus angry, $p = .78$; main effect of word emotion overall, $F(2, 297) = 1.27, p = .27, \eta^2 = .008$; word-by-group interaction, $F(2, 297) = 3.78, p = .02, \eta^2 = .02$; main effect of word in high empathy, $F(2, 154) = 4.15, p = .02, \eta^2 = .05$; main effect of word in low empathy, $F(2, 142) = 0.36, p = .26, \eta^2 = .018$).

Mimicry of the background face. In contrast to word mimicry, results for both muscles suggest that the background face was not strongly mimicked (main effects, $F(3, 297) < 2.0, p > .12, \eta^2 < .018$) and did not influence word mimicry (word-by-face interactions, $F(3, 297) < 1.96, p > .12, \eta^2 < .018$). As a more powerful test of whether the background face affected mimicry, we examined whether word mimicry would change depending on the congruence or incongruence of the face (ignoring the specific facial emotion). To do this, we reran the mixed ANOVA on each muscle using word emotion as a repeated factor, as in the prior tests. But this time, we used trial type instead of specific facial emotion to further examine possible interactions from facial mimicry. Because *corrugator* activity is equivalent for sad and angry expressions (e.g., Blair et al., 1999), incongruent-emotional trials that paired sad and angry affect were removed for this test;

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instead, incongruent-emotional pairings were only included if they were with happy affect.

The congruence or incongruence of the background face did not affect *zygomatic* mimicry of words (word-by-trial-type interaction, $F(4, 216) = 1.00, p = .41, \eta^2 = .02$), but marginally affected *corrugator* mimicry (word-by-trial-type interaction, $F(4, 216) = 2.33, p = .06, \eta^2 = .04$). Follow-up repeated-measures ANOVAs testing the strength of word mimicry within each trial type confirmed that mimicry in the *corrugator* was stronger when congruent faces were behind words, rather than incongruent or neutral (congruent, $F(2, 54) = 6.16, p = .004, \eta^2 = .18$; incongruent-emotional, $F(2, 54) = 2.80, p = .07, \eta^2 = .09$; incongruent-neutral, $F(2, 54) = 0.25, p = .78, \eta^2 = .01$). Thus, some mimicry of the background face must have occurred, at least for negative expressions, on congruent trials.

Effects of mimicry on response time. To compare predictions from mimicry-based and perception-action theories, we examined whether Emostroop RT could be predicted by the degree of face or word mimicry (regressing mimicry against RT across trials, with trial type as a repeated factor and participant as a random factor). Face and word mimicry were tested separately, using data from the corresponding muscle only (e.g., *corrugator* responses to angry or sad stimuli and *zygomatic* responses to happy). Only mimicry-based theories expect Emostroop slowing to be caused by preceding mimicry of the background face.

As with the overall mimicry effects, and supporting the PAM, Emostroop RT was more affected by word than face mimicry. Word mimicry tended to affect RT differently across trial types and word emotions (three-way-interaction, $F(2, 22) = 2.95, p = .07, \eta^2 =$

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.18). Separate follow-up regressions within trial type and word emotion revealed that word mimicry speeded RT only when the background faces were of a different emotion (incongruent-emotional, $\beta = -122.7$, $F(1, 48) = 4.73$, $p = .03$), particularly when classifying sad words ($\beta = -227.62$, $F(1, 23) = 6.93$, $p = .02$; all other tests $F(1, 23) < 0.045$, $p > .83$).

Supporting the PAM, word classification speed on the Emostroop was not associated with face mimicry ($F(1, 22) = .21$, $p = .66$, $\eta^2 = .009$), confirming that semantic encoding of facial emotion, and its effect on word classification, is not predicted by preceding mimicry.

Color-naming Stroop and Intrusive Cognition

To confirm the basic attentional effects and their relationship to trait empathy, mixed ANOVAs compared RT across trial types within participant (incongruent/congruent for color Stroop; positive/negative/neutral for IC) and between empathy groups. Replicating the color-naming Stroop effect, participants took longer to identify a word printed in an incongruent ($M = 958.5$ ms) than a congruent color ($M = 819.2$ ms; $F(1, 60) = 124.63$, $p < .001$, $\eta^2 = .66$). However, this effect did not differ between high and low empathy participants (trial type-by-empathy-group interaction, $F(1, 60) = 0.34$, $p = .56$, $\eta^2 = .0005$), who responded at similar speeds (main effect of group, $F(1, 60) = 0.42$, $p = .52$, $\eta^2 = .01$).

Participants exhibited a marginal IC effect, with slower responses to both negative ($M = 848.8$ ms) and positive ($M = 872.8$ ms) compared to neutral words ($M = 830.7$ ms; main effect of word, $F(2, 116) = 2.49$, $p = .09$, $\eta^2 = .04$). This effect tended to differ by empathy group (trial-type-by-group interaction, $F(2, 116) = 2.42$, $p = .09$, $\eta^2 = .04$),

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because only high empathy participants exhibited IC effects (positive $M = 916.1$ ms, negative $M = 904.1$ ms, neutral $M = 851.4$ ms; main effect of word in high empathy, $F(2, 68) = 3.45$, $p = .04$, $\eta^2 = .09$; low empathy, $F(2, 48) = 1.25$, $p = .30$, $\eta^2 = .05$). Thus, for high empathy participants, emotional words of both valences captured attention, demonstrating a more pervasive effect than the traditional task.

[Table 1 about here]

Task interrelationship

To determine how individual differences in conceptual encoding, trait empathy, and attentional processes are interrelated, we intercorrelated trait empathy data and the degree of task interference, within participants. Interference scores were generated by subtracting median RT to congruent from incongruent stimuli (Emostroop and color-naming Stroop) or to neutral from positive or negative words (IC). Results are presented in Table 1. The three different forms of interference were not intercorrelated ($p > .15$, power ($r = .3$) = 0.74), suggesting that conceptual encoding of the background face does not reflect individual differences in attentional filtering or bias. This lack of relationship remained even if high and low empathy participants were examined separately ($p > .11$). However, performance on the attentional tasks was predicted by trait empathy, with more emotionally empathic (ME) participants being more captured by emotional words, which is analogous to the finding above that only high empathy participants exhibited the IC effect. Participants who are more likely to engage in fantasy (IRI) were also more captured by positive IC words, while those with more empathic concern (IRI) were less affected by incongruent word ink on the color-naming Stroop task.

Discussion

Despite great disagreement regarding the nature of empathy, most agree that empathy requires that we understand another's emotion and is somehow related to neural resonance, emotional resonance, facial mimicry, and trait empathy. However, it is unknown how these phenomena are related at the level of the mechanism. The current study began to address this by comparing conceptual encoding of facial emotion, mimicry, and selective attention within individuals and between those who are more or less empathic.

The original Emostroop effect (Preston & Stansfield, 2008) was replicated, confirming that people spontaneously encode others' emotion at a conceptual, semantic level, even when irrelevant to the task. Moreover, this encoding did not emanate from mimicry of the background face, require an empathic disposition or a tendency to attend to emotional information, supporting the PAM view that this encoding occurs spontaneously as a natural consequence of attended perception.

Little evidence was found for mimicry of the background faces, except for trends for word mimicry to change depending on whether the background face was congruent or not. While mostly marginal, these effects are important to examine further because they may indicate strategic attention, such as rapidly classifying the trial as congruent or incongruent and then allocating attention toward (congruent) or away (incongruent) from the faces to benefit performance. Alternatively, the initial word processing could simply prime subjects to encode the background face when they match.

In contrast, mimicry and trait empathy did appear interrelated and to result from differences in attention. In the Emostroop, participants predominantly mimicked the

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emotion of the focal word they were categorizing, consistent with work showing that mimicry is predicted by the degree of visual processing and attention (Achaibou, Pourtois, Schwartz, & Vuilleumier, 2008), is sensitive to information processing goals, and facilitates recognition accuracy of emotional concepts (Niedenthal et al., 2009). This word mimicry was also stronger in high empathy participants, who were also more captured by the emotion of positive and negative words in the IC task. This is a novel result in and of itself since attentional capture is usually specific to negative or individually-salient words, like "war" for veterans with PTSD (e.g., McKenna & Sharma, 1995). Thus, although mimicry can occur without attention, it is also modulated by the degree of attention to the stimulus and is not necessary to access conceptual information about facial affect.

Future work can clarify and extend our findings. For example, we did not find effects of trait empathy on the degree of conceptual encoding. Presumably, however, the tendency of empathic people to attend more to affective information would benefit them in cases where it is harder to determine how the other feels or when other stimuli compete for attention. Also, we assume that attention is required to process the other's emotion at a specific, conceptual level (e.g., not just at the level of valence or involving reflexive mimicry), but we need to establish the precise extent of visual processing required for this encoding. Thus far, our pilot data support the requirement for conscious attention (Hofelich & Preston, unpublished observations). We also assumed that greater mimicry of the words was due to the fact that they were central to the task; however, it could be that mimicry is generally more sensitive to words than faces. We are currently testing this hypothesis by administering a similar version of the task with the instructions reversed

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(classify the face, ignore the word). If correct, mimicry should track the faces instead of the words in this case.

Overall, we find that any attention to others' emotion spontaneously produces conceptual encoding, but that individuals differ in the extent to which they are driven to attend to this information. Future research should particularly examine how individuals monitor, allocate, and reorient attention to control the degree of involvement in others' states, and the role that these processes play in the prosocial response. By applying cognitive and neural information-processing models to real-world social phenomena, we can form a more complete and nuanced understanding of important intersubjective phenomena.

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Figure Legend

Figure 1. Behavioral performance and mimicry on the Emostroop task. Median reaction time is given for congruent (filled bar), incongruent-neutral (graded bar) and incongruent-emotional (unfilled bar) trials, with examples of each type of Emostroop stimuli overlaid (note: the contrast of the overlaid word here is enhanced for display purposes; the contrast is lower in the actual task because the display size is much larger). Mean standardized mimicry scores to the different word emotions are shown for each muscle in low and high empathy participants. EMG responses are presented by word emotion (A=angry, H=happy, S=sad), with congruent scores represented by solid lines and incongruent-emotional scores represented by dashed lines. Error bars represent standard error.

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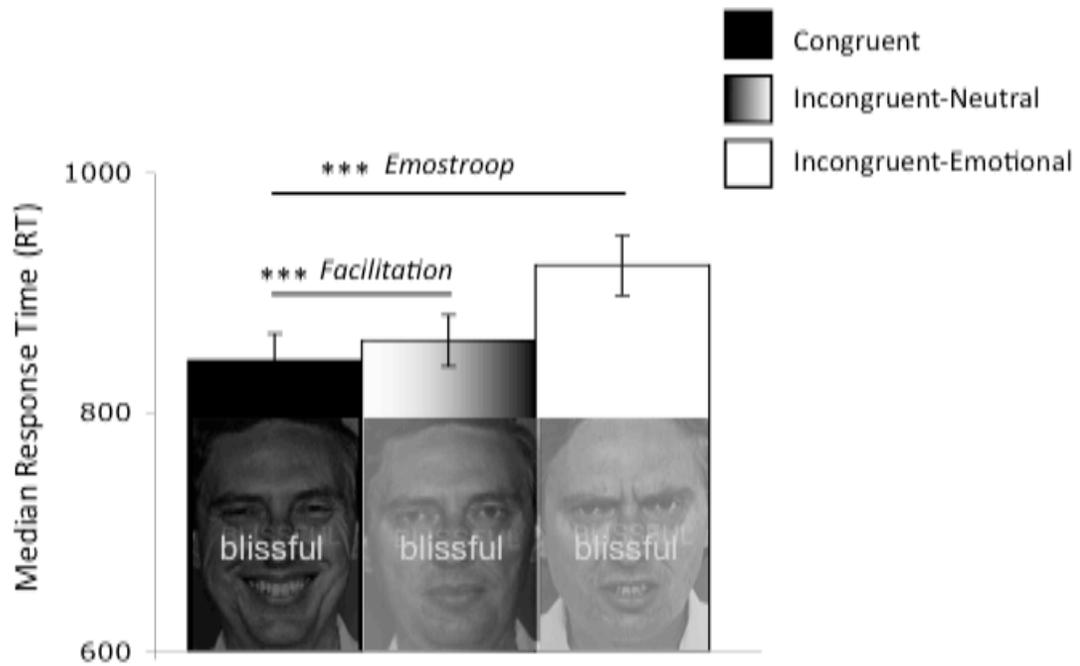
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Table 1. Correlations between interference scores across tasks and with continuous measures of trait empathy from the Mehrabian and Epstein scale (ME), Doherty Emotional Contagion scale (EC), and subscales of the Interpersonal Reactivity Index (IRI). Stroop refers to the color-naming Stroop task; IC refers to the Intrusive Cognition Task, which is divided into interference scores for positive and negative words (compared to neutral). * $p < .05$; *** $p < .001$

	Task Intercorrelations			
	Emostroop	Stroop	IC Neg	IC Pos
Emostroop		.19	.17	-.03
Color Stroop			-.09	-.07
Intrusive Cognition Negative Bias				.70***
Intrusive Cognition Positive Bias				
ME Empathy Scale	.06	-.13	.29*	.25
Doherty EC Scale	-.13	-.20	.17	.22
IRI: Fantasy	-.02	-.10	.14	.27*
IRI: Emotional Contagion	.03	-.27*	.12	.11
IRI: Perspective Taking	-.12	-.18	.19	.17
IRI: Personal Distress	-.13	-.09	.13	.14

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Performance



Facial Mimicry

