Unconscious Affective Reactions to Masked Happy Versus Angry Faces Influence Consumption Behavior and Judgments of Value

Piotr Winkielman
University of California–San Diego

Kent C. Berridge
University of Michigan

Julia L. Wilbarger
University of Wisconsin–Madison

The authors explored three properties of basic, unconsciously triggered affective reactions: They can influence consequential behavior, they work without eliciting conscious feelings, and they interact with motivation. The authors investigated these properties by testing the influence of subliminally presented happy versus angry faces on pouring and consumption of beverage (Study 1), perception of beverage value (Study 2), and reports of conscious feelings (both studies). Consistent with incentive motivation theory, the impact of affective primes on beverage value and consumption was strongest for thirsty participants. Subliminal smiles caused thirsty participants to pour and consume more beverage (Study 1) and increased their willingness to pay and their wanting more beverage (Study 2). Subliminal frowns had the opposite effect. No feeling changes were observed, even in thirsty participants. The results suggest that basic affective reactions can be unconscious and interact with incentive motivation to influence assessment of value and behavior toward valenced objects.

Keywords: *affect; emotion; priming; motivation; consciousness; introspection*

Complex emotions can result from an extended sequence of cognitive appraisals (Ellsworth & Scherer, 2003). However, basic affective reactions may only involve minimal processing and be elicited by subliminal stimuli (Zajonc, 2000). In this article, we address three questions about such basic affective reactions. First, can they influence consequential behavior toward a hedonic stimulus, as in the case of consumption of an unfamiliar beverage? Second, how do basic affective reactions interact with motivation? Third, can affective reactions influence behavior without being accessible to conscious awareness? In investigating these questions, we integrate social psychological approaches to affect with contemporary biopsychological models of incentive motivation. We suggest that such integration can advance emotion theory as well as social psychological research on attitudes, judgment, and persuasion (Cacioppo & Gardner, 1999; Niedenthal & Kitayama, 1994).

To elicit basic affective reactions, researchers often employ subliminal presentations of emotional facial expressions. Emotional facial expressions are important social stimuli, and their processing appears to involve biological affect programs (Ekman, 1984). Subliminal presentations minimize contributions of complex cognitive processes and reduce strategic responding (Bargh,

Authors' Note: For their generous assistance at various stages of the project, we are grateful to Hart Blanton, Gerald Clore, Phoebe Ellsworth, Kent Harber, Jan Keenan, Daniel McIntosh, Yuko Munakata, Richard Nisbett, Bruce Pennington, Dolly Renick, Oliver Schultheiss, Jeanne Shinskey, Norbert Schwarz, Diederick Stapel, Valerie Stone, Elliot Valenstein, and Robert Zajonc. The work on this project was supported by the National Science Foundation Grant BCS-0217294 to Piotr Winkielman. Correspondence should be addressed to Piotr Winkielman, Department of Psychology, Department of Psychology, University of California, San Diego, 9500 Gilman Dr., La Jolla, CA 92093-0109; e-mail: pwinkiel@ucsd.edu.

PSPB, Vol. 31 No. 1, January 2005 121-135
DOI: 10.1177/0146167204271309

1996). Several lines of research suggest that subliminal facial expressions elicit basic affective reactions with both judgmental and physiological consequences. Niedenthal (1990) documented that subliminal expressions influenced preference ratings for cartoon drawings. Murphy and Zajonc (1993) exposed participants to subliminal or supraliminal expressions that varied in either valence (happy vs. angry) or gender (male vs. female). Under subliminal presentations, valence of the expression influenced judgments of subsequent ideographs, but under supraliminal presentations only gender information influenced judgments. Using facial electromyography, Rotteveel, de Groot, Geutskens, and Phaf (2001) found more frowning to ideographs preceded by angry than happy faces, but only after subliminal, not supraliminal, presentations. Neuroimaging studies suggest that subliminal angry and fearful faces activate the amygdala and related limbic structures, presumably via a direct pathway from the visual thalamus to the amygdala (Morris, Öhman, & Dolan, 1999; Whalen et al., 1998). Interestingly, supraliminal expressions activate limbic structures more under implicit processing conditions, when participants classify faces on gender, rather than explicit processing conditions, when participants classify faces on expression (Critchley et al., 2000).

Little is known about the nature of affective reactions elicited with different types of subliminal expressions, but it appears that such reactions are organized mainly on a positive-negative dimension (Zajonc, 2000). Accordingly, effects of happy versus angry subliminal expressions on judgments combine additively with effects of other basic affect inductions, such as mere exposure (Murphy, Monahan, & Zajonc, 1995). Furthermore, changes in global positive-negative judgments of stimuli can be obtained with different negative facial expressions, such as anger or disgust (Murphy & Zajonc, 1993; Niedenthal, 1990). Finally, under brief presentation conditions, participants have trouble extracting more than general negativity from different expressions, such as anger, fear, disgust, or sadness (Murphy, 2001).

In sum, the extant research on effects of subliminal expressions suggests that they elicit basic positive-negative affective reactions and that these reactions can have immediate judgmental and physiological consequences. Building on this research, the current studies employed subliminal expressions to address several questions about the nature of basic affective reactions.

Affect and Behavior

Facilitation of adaptive behavior has long been considered an important function of the affect system (Frijda, 1999). There is evidence that affective stimuli influence startle reflexes (Lang, 1993), as well as simple instrumental actions, such as immediate approach-avoidance movements (Chen & Bargh, 1999). However, there is less evidence that affective stimuli influence more complex behaviors, especially when such stimuli are presented subliminally. However, subliminal cognitive stimuli can influence relatively complex behaviors, such as selection of a game strategy (Neuberg, 1988) or decision to interrupt a conversation (Bargh, Chen, & Burrows, 1996). Note, however, that cognitive stimuli exert this influence by biasing the interpretation of an ambiguous target situation. Thus, the influence of a cognitive prime requires a semantic connection to the target (Higgins, 1996). In contrast, as we explain shortly, the influence of an *affective* prime may only require that the target engages affective and motivational processes, even if the prime and target do not share a semantic connection.

In the current studies, we examined this possibility by testing the impact of subliminal presentations of happy and angry faces on the actions of pouring and consuming a beverage. We selected drinking for several reasons. First, basic affective and motivational processes should have the most influence on a behavior toward a hedonic stimulus—a stimulus with some initial value. In fact, drinking is often used in social and biological psychology to explore such basic processes (Edwards, 1990; Laeng, Berridge, & Butter, 1993; Strahan, Spencer, & Zanna, 2003). Second, it is important to explore whether the impact of affective priming can go beyond ratings of simple drawings and influence a consequential behavior. By consuming an unfamiliar beverage, a person voluntarily ingests a substance that is potentially beneficial or harmful. Third, documenting a possible influence of affective primes on drinking is particularly informative because the value of a beverage is intrinsically predetermined by its taste and other sensory properties. If affective primes can overcome such predetermination, it would suggest a robust underlying affective reaction. Finally, drinking allows one to assess the impact of affective priming with "real-world" units such as volume and price.

Affect and Motivation

Previous research has focused on the role of basic affect in preference judgments (Zajonc, 2000). However, recent advances in biopsychology highlight the close connection between affect and motivation. Traditional theories of motivation postulated that *hedonic behavior* (behavior toward stimuli with affective value) was driven by need states (Hull, 1951). For example, people drink to reduce the unpleasant state of thirst. In contrast, contemporary biopsychological theories of motivation posit that hedonic behavior is largely determined by the stimulus' *incentive value:* whether the stimulus triggers a positive-negative affective response and promotes

approach-avoidance motivation. That is, modern theories combine affect and motivation in the same explanatory framework (Toates, 1986). Motivational states, such as thirst, are still important, but they work by directly influencing affective and motivational responses to the relevant features of the stimulus. This influence can be observed in a phenomenon known as alliesthesia—change in incentive value as a function of a relevant motivational state (Cabanac, 1971). For example, people perceive taste of water more favorably and want it more when they are thirsty, but not when they are hungry (Rolls, Rolls, & Rowe, 1983). Neuroscientific research highlights the close connection between affect and motivation postulated by incentive theories. For example, animal studies suggest that the mesolimbic dopamine system, the nucleus accumbens, and the amygdala support both affective and motivational responses (Berridge, 1996). Human neuroimaging studies also show activation of these systems to incentive stimuli, such as drugs or money (Knutson et al., 2001) and, important for the current studies, beverages (Berns et al., 2001) and emotional facial expressions (Critchley et al., 2000; Whalen et al., 1998).

The tight link between the affective and motivational systems suggests that stimuli, such as facial expressions, that elicit basic affective responses should modulate the incentive value of a subsequent hedonic target, such as a beverage, even though these events are ostensibly unrelated. Thus, we predicted that exposure to happy expressions should temporarily increase the incentive value of the beverage and facilitate consumption, whereas exposure to angry expressions should temporarily decrease the incentive value of the beverage and suppress consumption. Furthermore, we predicted that the modulation of incentive value should depend on the preexisting motivational state of the individual, just as the normal incentive value of a drink is modulated by preexisting thirst (Rolls et al., 1983). If such a modification is observed, it would suggest that preferences are jointly determined by basic affective processes, influenced by subliminal expressions, and basic motivational processes, influenced by a physiological need.

Affect and Awareness

Can affective reactions to subliminal expressions occur without awareness of those reactions? Most scientists agree that a triggering affective stimulus can be unconscious but assume that the resulting affective reaction is itself conscious (e.g., Clore, 1994; Öhman, Flykt, & Lundqvist, 2000; Zajonc, 2000). In fact, the scientific term *unconscious affect* is typically used to refer to the unconsciousness of affect induction, not to the resulting affective state. However, a stronger notion of unconscious affect may be considered, similar to the strong notion of unconscious cognition (Kihlstrom, Mulvaney, Tobias, & Tobis, 2000). An *unconscious affect*, in the stronger sense, would be a reaction caused by valenced stimuli and with valenced behavioral consequences, which nonetheless is not subjectively felt, even upon introspection.

Several psychologists and neuroscientists have proposed the existence of unconscious affective processes, based on studies of animals, patients, drug addicts, and people under hypnotic analgesia (Berridge, 1999; Kihlstrom et al., 2000; Lang, 1993; LeDoux, 1996). However, unconscious affective reactions have not been demonstrated in normal adult human participants. One of the few indications of unconscious affect comes from a study that found modulation of participants' preference ratings by subliminal happy or angry expressions (Winkielman, Zajonc, & Schwarz, 1997). Despite changes in their preferences, in exit interviews, participants denied experiencing changes in conscious mood, even though they were alerted to such a possibility. Furthermore, when given an alternative attribution for their mood changes, participants still showed the affective priming effect. Nevertheless, failure to report an emotion or change its attribution might be due to inattention, lack of motivation, or memory distortion.

A more convincing demonstration of unconscious affect requires obtaining on-line ratings of conscious feelings immediately after subliminal exposure to the valenced stimulus. Thus, in current studies, we asked some participants to rate their momentary mood immediately after a series of subliminal expressions. If participants did not report any mood change immediately after the subliminal exposure, it would be difficult to argue that their failure to do so was due to attention or memory deficits, especially if they subsequently demonstrated behavioral and judgmental consequences of their affective reaction. To ensure that participants had a fair chance to detect any influence on their feelings, we gave them two scales tapping various aspects of emotional experience. As described in more detail later, Study 1 used a two-item scale asking participants to report their current mood on a broad positive-negative dimension and their current arousal. Study 2 used a Positive and Negative Affect Schedule (PANAS) scale containing 20 adjectives to assess mood using differentiated terms (e.g., *excited*, *scared*, *irritated*) or using a general positive-negative index. The PANAS scale has good reliability, is sensitive to changes over time, and is considered one of the best measures of current mood (Watson, Clark, & Tellegen, 1988). Finally, we interviewed participants at the end of the study about their affective reactions and tested whether they could detect the subliminal primes. Across these measures we predicted no effect on conscious feelings, despite evidence of affective influence

on drinking measures. This prediction was based on the assumption that subliminal facial expressions activate low-level affect mechanisms that can function independently from mechanisms underlying subjective experience, as observed in our earlier work (Winkielman et al., 1997).

OVERVIEW

In summary, the current studies were designed to address the following questions. First, can basic affective reactions triggered by subliminal expressions influence the pouring and consumption of a beverage? Second, does motivation (thirst) change the impact of affective primes? Third, do subliminal facial expressions alter conscious feelings? We investigated these questions in two studies using a modified version of the subliminal affective priming paradigm. In both studies, participants first rated their motivational state—thirst and hunger. Next, participants were exposed to a series of subliminal happy or angry faces in a task requiring gender classification of supraliminal neutral faces. After priming, participants received a hedonic stimulus—a fruit-flavored drink. We chose this specific drink because previous studies showed motivational modulation of its hedonic value, suggesting that emotional expressions could exert a similar effect (Laeng et al., 1993). Study 1 examined affective influence on behavior toward the beverage. Participants freely poured themselves the beverage and consumed as much as they wanted. Study 2 tested affective influence on perception of the beverage's value. Participants tasted a small predetermined sample of the beverage and then rated it. In both studies, presentation of the beverage task was counterbalanced with self-reports of current feelings, on either a 2-item scale (Study 1) or a 20-item scale (Study 2). We predicted the following: First, the impact of affective primes should be most pronounced on variables tapping the beverage's hedonic value, such as consumption (Study 1) and ratings of beverage desirability (Study 2). Second, the impact of affective primes should depend on motivational state (thirst). Third, the impact of affective primes should occur without a change in conscious mood.

STUDY 1

Method

Participants. Thirty-nine undergraduates (14 men, 25 women, mean age = 22 years) gave informed consent and participated in individual sessions for extra credit. Upon arriving, participants learned that the study investigated how "biological rhythms influence reaction times, sensations, and mood" and required them to perform a recognition task, to rate their mood, and to evaluate a beverage. To minimize demand characteristics, participants received instructions via computer and recorded their ratings on an anonymous questionnaire, with the experimenter out of view. After the study, all participants were debriefed and thanked.

Initial motivational state. Before participants were introduced to the computer task, they completed a "background" questionnaire rating their current level of thirst (0 = *not at all*, 11 = *very thirsty*) and hunger (0 = *not at all*, 11 = *very hungry*).

Sequence of experimental events. Figure 1 shows the sequence of experimental events. Participants were primed with subliminal expressions embedded in a gender classification task and then performed a beverage task and a mood rating task, as explained shortly. To establish a baseline of participants' drinking and rating responses, the experiment started with a set of eight baseline trials with neutral primes, followed by a set of eight test trials in which prime valence was manipulated between participants. Participants then received another set of baseline trials followed by another set of test trials with expressions of reversed valence from the initial test. No significant effects emerged in these later test trials in Study 1 or Study 2, so they are not further discussed. The absence of priming on the later test trials could reflect habituation of affective responses to facial expressions (Wright et al., 2001) or resistance to induction of opposite valence once stimulus valence has been established (Murphy & Zajonc, 1993; Winkielman et al., 1997).

Priming trials: Gender classification task. Subliminal expressions were embedded in a "gender-classification" task, in which participants reported the gender of easily visible neutral faces. Each trial started with a forward mask (50-ms cross), followed by a subliminal prime (16-ms expression), which was immediately replaced by a backward mask (400-ms neutral male or female face). Each baseline and test priming sequence contained eight trials with subliminal expressions of the same valence (i.e., all happy, all neutral, or all angry), with different individual faces on each trial. We chose eight trials per each priming sequence because this number of subliminal expressions appears sufficient for a transient activation of the low-level affective circuitry, whereas more trials lead to habituation (Whalen et al., 1998). We chose happy and angry faces for three reasons. First, these expressions worked in previous affective priming studies (Murphy & Zajonc, 1993; Winkielman et al., 1997). Second, it is easier to extract negative valence from briefly presented expressions of anger than from fear, disgust, or sadness (Murphy, 2001). Third, we did not want to elicit a specific consumption-related reaction, such as

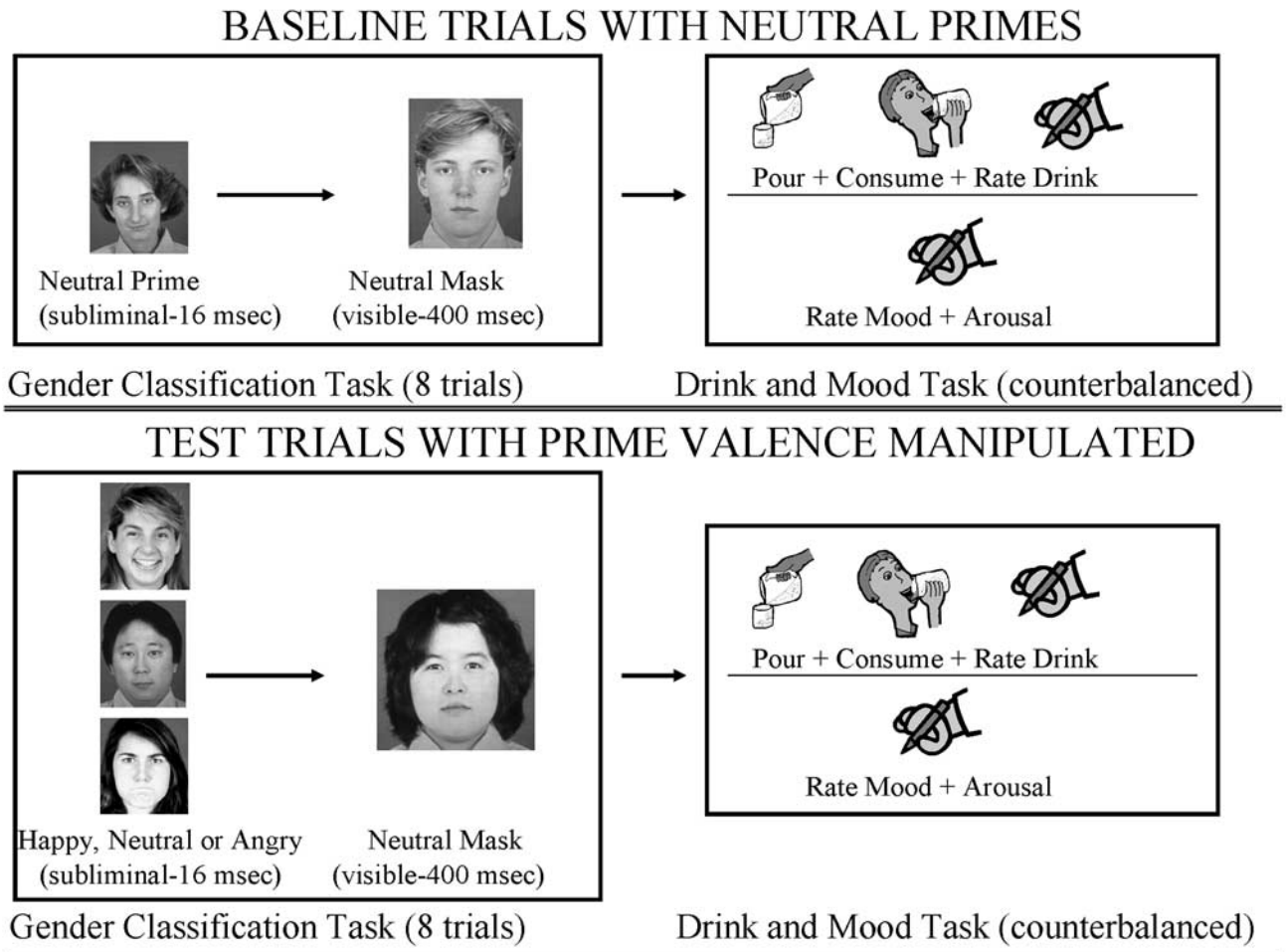

Figure 1 Sequence of events in Study 1 testing the influence of subliminal expressions on consumption behavior and feelings.
NOTE: Participants were primed with subliminal faces (baseline trials = 8 neutral expressions; test trials = 8 happy, 8 neutral, or 8 angry expressions) embedded in a task requiring gender classification of visible neutral faces. Priming trials were immediately followed by either ratings of mood and arousal or by presentation of the drink (in counterbalanced order).

disgust, but rather a general positive-negative affective reaction.

The face stimuli were 24 neutral faces, which served as primes and masks, and 8 happy and 8 angry faces, which served only as primes. Of these 40 faces, 20 were female and 20 male, and 20 were Japanese and 20 Caucasian. All came from the Japanese and Caucasian Facial Expressions of Emotion (JACFEE) set by Matsumoto and Ekman (1988). Images were 8 × 8 cm, shown in gray scale, centrally on a 15-inch monitor, 50 cm from the participant, using PsyScope software on a McIntosh computer.

Beverage and feelings task. After the gender classification task, participants rated their current feelings and performed a beverage task, in counterbalanced order. In the feelings task, we asked participants, "How do you feel right now, at this very moment?" (–5 = *unpleasant*, 5 = *pleasant*) and "How much arousal do you feel right now, at this very moment?" (–5 = *low*, 5 = *high*). In the beverage task, participants received an opaque pitcher containing 600 ml of a beverage prepared with water, sugar, and lemon-lime-flavored Kool-Aid powder. To ensure that the drink appeared novel after each set of the priming trials, the pitcher presented after each set of priming trials contained a beverage made of four different proportions of sugar and powder, counterbalanced across participants. Participants poured as much of the beverage as they wanted into a 250-ml cup and consumed as much as they wanted. Unknown to the participants, the amounts poured and consumed were recorded using an electronic scale. After pouring and drinking, participants gave four ratings: "How delicious is this drink?" (0 = *not delicious*, 10 = *extremely delicious*); "How much would you

like to drink right now?" (0 = *none*, 5 = *2 pints*); "How well did it quench your thirst?" (0 = *not at all*, 10 = *extremely well*); and "How much would you pay for a can of this drink?" (1 = *10 cents*, 10 = *1 dollar*).

Prime perceptibility task. A forced-choice recognition task evaluated participants' awareness of 16 emotion expressions presented during the test sequences (Winkielman et al., 1997). On each of 16 trials, a participant was first subliminally flashed an emotional expression masked by a neutral face. Immediately afterward, the participant saw two faces presented for 2 seconds on the left and right part of the screen (one of which had been the subliminal expression) and was asked to decide which faces were presented in the flash. Performance on this test was 51.6%, which was not significantly different from chance, $t(38) = 1$, $p = .30$. Regression tests revealed no relation between performance in the forced-choice test and the influence of subliminal priming on the critical dependent variables, including pouring, drinking, and mood (ts < 1). Thirst level did not correlate with forced-choice performance ($r = .05$). These results suggest that conscious recognition was not responsible for the observed effects of emotional expressions.

Results

Descriptive statistics and analytic method. We analyzed data using linear regressions with valenced phase responses (pouring, drinking, mood, arousal) as criterion variables and baseline phase responses, priming condition, and thirst level as predictor variables. Our coding for linear regression analyses assumed equal intervals between angry and neutral and between neutral and happy conditions (–1 = *angry*, 0 = *neutral*, 1 = *happy*, with higher scores indicating more positive valence). An alternative strategy was to dummy code separately for angry and happy priming conditions, which allows independent comparisons of the relative impact of angry versus happy priming on the criterion variable. However, this comparison was not central to the current research, and we did not collect a large enough sample size to pursue selective comparisons between angry and happy primes. Exploratory analyses did reveal, however, that angry and happy primes interacted with thirst in opposite directions. This result is consistent with our theoretical framework and our coding strategy assuming equal intervals.

Amount poured. Participants poured 56.21 ml (SD = 24.63) of the beverage during the neutral baseline phase and 53.92 ml (SD = 23.19) in the valenced test phase. To investigate the predictors of pouring, we regressed valenced-phase pouring onto baseline-phase pouring, thirst, priming, and the cross product of thirst and priming. In the first block of a hierarchical regression, we entered the baseline response, thirst, and priming. In the second block, we entered the cross product of thirst and priming. The first regression block revealed only a main effect for prior pouring levels: Participants who poured more during the baseline phase also poured more during the valenced phase. The nonstandardized regression coefficient indicated that for every 1-ml increase in pouring during the baseline phase, pouring in the valenced phase increased by .32 ml, $t(35) = 2.06$, $p < .05$.

The second regression block revealed an interaction between thirst and pouring, $B = 6.52$, $t(34) = 3.02$, $p < .01$. The interaction is shown in the top panel of Figure 2, which plots the amount poured as a function of priming and thirst, controlling for baseline pouring. At the high thirst level (1 SD above the sample mean for thirst), pouring increased as a function of priming, going up 21 ml between angry (37 ml), neutral (58 ml), and happy (79 ml) primes, $B = 21.31$, $t(34) = 3.53$, $p < .01$. That is, thirsty participants poured 114% more of the beverage after happy primes than after angry primes. At the mean level of thirst, pouring exhibited a marginally significant increase as a function of priming, going up 7.52 ml between angry (47ml), neutral (55ml), and happy (62ml) primes, $B = 7.52$, $t(34) = 1.80$, $p < .08$. That is, moderately thirsty participants poured 32% more of the beverage after happy than angry primes. At the low level of thirst (1 SD below the mean of thirst), the difference between priming conditions was not significant, $B = -6.27$, $t(35) < 1$. In summary, thirsty participants poured more than twice the amount of the beverage after happy primes than angry primes, but priming did not influence pouring of nonthirsty participants.

Amount consumed. In the baseline phase, participants drank 27.06 ml (SD = 22.76) or 48% of what they poured. In the valenced phase, participants drank 26.79 ml (SD = 26.44) or 50% of what they poured. To determine whether priming and thirst influenced drinking in the valenced phase, we regressed valenced phase drinking onto baseline drinking, thirst, priming in the first regression block, and the cross product of thirst and priming in the second block. The first block revealed only a main effect for prior drinking: Participants who drank more before priming also drank more after priming. The nonstandardized regression coefficient indicated that for every 1-ml increase in drinking before priming, post-prime drinking increased by .58 ml, $t(35) = 3.47$, $p < .001$. As with pouring, the second block revealed an interaction of thirst and priming on drinking, $B = 6.02$, $t(34) = 2.59$, $p < .01$. This interaction is shown in the bottom panel of Figure 2. At high level of thirst , priming caused an increase in drinking, going up 17 ml from angry (12 ml) to neutral (29 ml) and to happy (46 ml) primes, $B =$

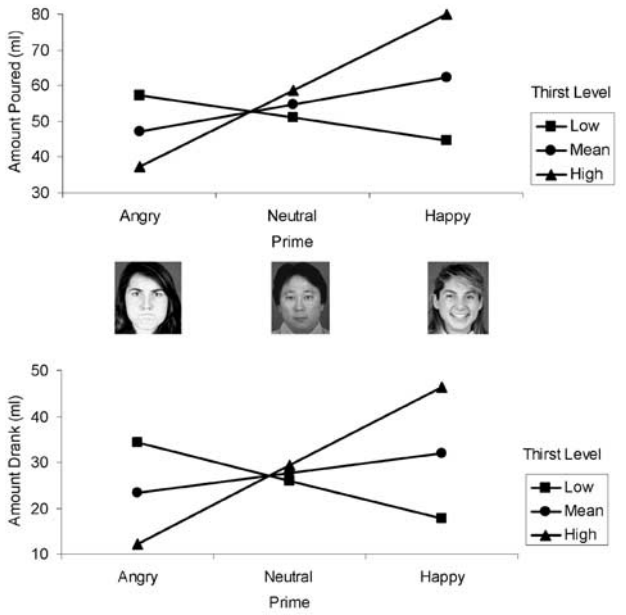

Figure 2 Amount of beverage in milliliters poured (top panel) and consumed (bottom panel) as a function of subliminal priming and initial thirst.

NOTE: Values are estimated by linear regression (priming coded: angry = –1, neutral = 0, happy = +1) at different thirst levels (low = 1 *SD* below the mean, mean = sample mean, high = 1 *SD* above the mean) and adjusted for baseline levels.

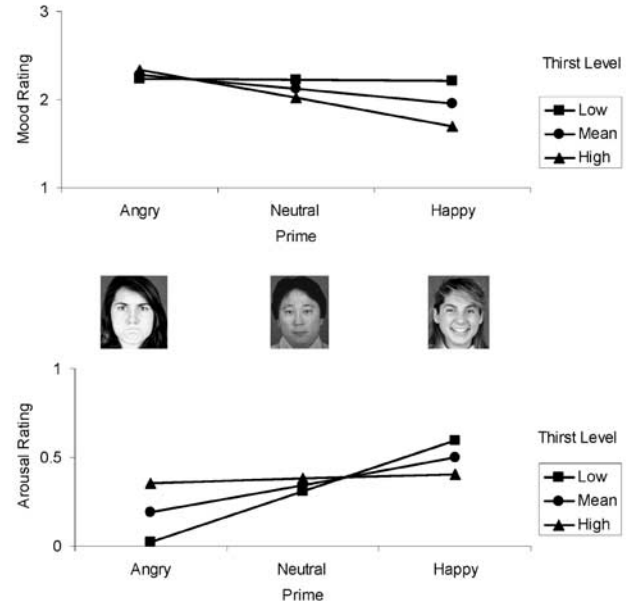

Figure 3 Ratings of mood (top panel) and arousal (bottom panel) as a function of subliminal priming and initial thirst. Mood and arousal were each measured on a –5 to +5 scale, ranging from positive-negative to low-high, respectively. Values are estimated by linear regression and adjusted for baseline levels.

17.11, $t(34) = 2.73$, $p < .01$. In percentages, thirsty participants drank 280% more of the beverage after happy primes than after angry primes. At the mean level of thirst, prime did not significantly increase drinking, $B = 4.38$, $t(34) < 1.00$ (23 ml after angry, 27 ml after neutral, 32 ml after happy primes, representing an 18% difference). Finally, at the low level of thirst, priming also did not influence drinking, $B = -8.36$, $t(35) = 1.22$, $p < .24$, 34 ml after angry, 26 after neutral, and 17 ml after happy primes). In summary, thirsty participants drank more beverage after happy primes than angry primes, but nonthirsty participants did not.

Feeling ratings. Equivalent analyses also assessed mood and arousal ratings. We regressed valenced-phase feeling ratings onto baseline-phase feeling ratings, thirst, priming, and the cross product of thirst and prime. The results, shown in Figure 3, revealed only a main effect of prior levels. Participants who reported more positive mood in the baseline phase also reported more positive mood in the valenced phase, $B = 1.09$, $t(35) = 10.35$, $p < .01$. Likewise, participants who reported more arousal in the baseline phase also reported more arousal in the valenced phase, $B = .939$, $t(35) = 21.5$, $p < .01$. No main effects or interaction of priming and thirst occurred, regardless of the level of thirst, even when feelings were rated immediately after the presentation of valenced priming (before drinking). In fact, the pattern for thirsty participants' mood trended nonsignificantly ($p = .35$) in the prime-incongruent direction (2.34 after angry, 2.02 after neutral, and 1.70 after happy primes), and their pattern for arousal was nearly flat (0.36 after angry, 0.38 after neutral, 0.40 after happy primes).

Median-split on thirst. The just presented analyses used linear regressions to estimate the priming effect at three levels of thirst. The results showed that at high level of thirst, affective primes reliably influenced participants' consumption without influencing their feelings. Similar results hold when the data are analyzed by dividing participants into two independent groups using a median split on thirst. To illustrate this, Figure 4 plots the prime effect on consumption behavior and subjective experience for participants who scored at or above the thirst median. As shown, priming influenced consumption behavior of thirsty participants (left panel), but not their subjective experience (right panel).

Correlations between consumption and feeling measures. Finally, we analyzed the correlations between feeling ratings and consumption behaviors during the valenced phase. Mood did not correlate with pouring, $r(39) = .03$, or drinking, $r(39) = .05$. Similarly, arousal did not correlate with pouring, $r(39) = .01$, or drinking, $r(39) = .01$. More important, these low correlations were not due to the lack of variability or sensitivity of our subjective report measures. This is indicated by a significant correlation between arousal and mood, $r(39) = .52$, $p < .01$, replicating

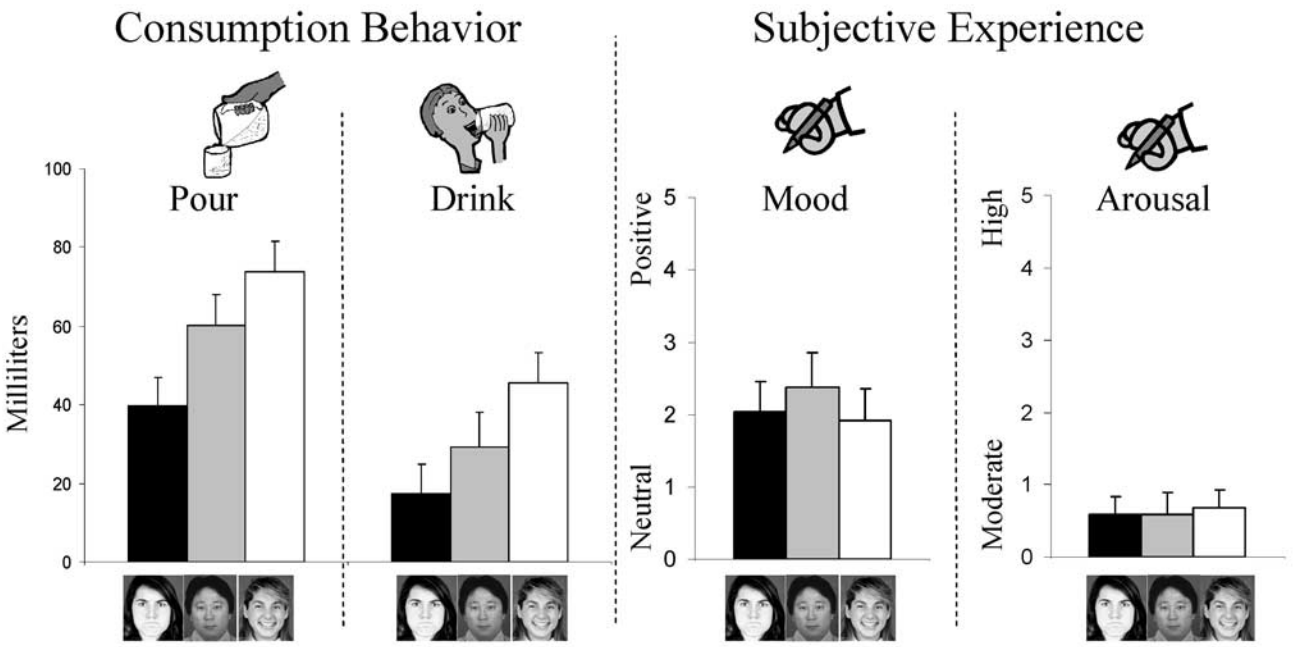

Figure 4 Means and standard errors for measures of consumption behavior (pouring and drinking) and subjective experience (mood and arousal) among thirsty participants.
NOTE: Values are for participants at or above median thirst and are adjusted for baseline levels.

the previously documented association between moderate arousal and positive mood (Thayer, 1996).

Beverage ratings during the baseline phase. To assess whether participants' motivational state influenced their perception of the initial value of the drink, we correlated their ratings of the beverage during the baseline phase with their initial level of thirst. Thirst correlated positively with ratings of the beverage's deliciousness, $r(39) = .39$, $p < .05$, and its thirst-quenching ability, $r(39) = .36$, $p < .05$. This effect represents an enhancement of stimulus value by appetite state (alliesthesia), as documented previously (Cabanac, 1971).

Beverage ratings during the valenced phase. As the final task, after pouring and consuming the beverage and rating subjective experience, participants rated the beverage. Analyses revealed no main effect of priming and no interaction effect of priming and thirst on beverage ratings. We address this absence of beverage rating effects in the next study.

Discussion

Study 1 results confirmed our predictions that subliminal facial expressions would alter consumption and that their influence would depend on relevant motivational state. In particular, thirsty participants poured more and drank more of a beverage after exposure to happy faces but poured less and drank less after exposure to angry faces. Remarkably, despite these changes in behavior, thirsty participants reported no change in their subjective state, even when their mood was assessed immediately after the subliminal primes. Nonthirsty participants' pouring and drinking did not change after subliminal priming. A potentially puzzling finding was the absence of priming effects on beverage ratings, obtained after participants finished drinking as much as they wished. After all, previous studies reported effects of subliminal expressions on ratings of visual patterns, such as cartoons or ideographs (Murphy & Zajonc, 1993; Niedenthal, 1990; Winkielman et al., 1997). The discrepancy could be due to procedural differences between previous studies and our study. First, previous studies explored immediate impressions of visual patterns presented for only 1 or 2 seconds. In contrast, we allowed participants to pour and consume as much and for as long as they wanted before giving ratings, resulting in a greater delay between subliminal priming and target rating. If subliminal priming influences only the initial impressions, then its effect could have dissipated by the time our participants rated the drink (for a discussion of this issue, see Zajonc, 2000). Second, thirsty participants' consumption of different amounts (after happy versus angry faces) might have confounded any priming effect on drink ratings, especially if additional consumption of a moderately tasty beverage depressed subsequent ratings. Third, we found that the strongest priming effect required high thirst. This raises the possibility that letting participants quench their thirst before rating the beverage can eliminate the priming effect on ratings. To

address these issues, Study 2 modified the procedure for assessment of beverage ratings.

STUDY 2

The goal of Study 2 was to reassess the effect of subliminal priming on beverage ratings. In contrast to Study 1, participants did not pour the drink themselves but instead received a fixed and small quantity of the beverage to sample with only one sip. In addition, because participants did not have to pour the beverage themselves, they tasted it immediately after priming. We predicted that under these conditions, subliminal affective priming should more clearly influence perception of beverage value. We also used a more differentiated measure to examine the impact of subliminal expressions on conscious mood. The two-item global scale used in Study 1 captures only limited attributes of affective experience. So, perhaps some aspect of mood changed, but the scale did not allow participants to report it. Therefore, in Study 2, we used a PANAS questionnaire to measure 20 nuances of experience (Watson et al., 1988). This scale provided a more stringent test of our hypothesis that subliminal priming induces an affective reaction that is introspectively inaccessible. The design of Study 2 was otherwise similar to that of Study 1. Participants first rated their current level of thirst and hunger. Next, they were exposed to eight subliminal happy or angry facial expressions embedded in the gender classification task. On the first set of priming trials, all subliminal faces were neutral to establish a baseline of rating responses. In the second set of trials, we manipulated the valence of subliminal expressions between participants. To simplify the design, the primes included happy and angry expressions, but not neutral expressions. After each set of eight priming trials, participants performed a beverage rating task or a mood rating task in counterbalanced order.

Method

Participants. Twenty-nine undergraduates gave informed consent and participated for extra credit in a psychology course (6 male students, 23 female students, mean age = 20 years). After completing the study, all participants were debriefed and thanked.

Beverage sampling and ratings. Consumption was restricted by offering participants only a 40-ml beverage in an 80-ml cup. Participants took a single sip and then answered the following questions. Three questions assessed perception of the hedonic and incentive value of the beverage: (a) "How delicious is the drink?" (b) "How much of this drink would you like to drink right now?" and (c) "How much would you pay for a can of this drink?" (scale anchors as in Study 1). To assess whether affective priming influenced perception of the sensory aspects of the beverage, the question about thirst quenching was replaced by the question, "How sweet is this drink?" (0 = *not sweet at all* to 10 = *extremely sweet*).

Mood ratings. Participants rated their affective experience on the PANAS questionnaire by indicating on a 5-point scale how they felt "right now, at this very moment," using the following 20 items: interested, distressed, excited, upset, strong, guilty, scared, hostile, enthusiastic, proud, irritable, alert, ashamed, inspired, nervous, determined, attentive, jittery, active, and afraid (anchors ranging from 1 = *slightly or not at all* to 5 = *extremely*).

Prime perceptibility task. The subliminal presentation was verified using the same methods as in Study 1 and again did not significantly exceed chance (54%). Neither was the score in the forced-choice test significantly related to the influence of facial expressions on critical dependent variables (ratings of drink value and ratings of mood) or on level of thirst (ts < 1).

Results

Willingness to pay. Participants indicated their willingness to pay for a hypothetical can of the beverage on a scale ranging from 10 cents to 1 dollar (U.S.). After the valenced priming phase, participants were willing to pay 31 cents. Because priming influenced only immediate reactions in Study 1, we tested whether the effects differed between participants who rated the drink immediately after priming and participants who first completed the intervening mood questionnaire. A multivariate analysis of variance (MANOVA) assessed the effects of independent variables prime (happy vs. angry) and order (beverage rating first vs. mood rating first), as well as the covariate of baseline willingness to pay, on the dependent variable of postpriming willingness to pay. The analysis revealed a prime-by-order interaction, $F(1, 28) = 4.41$, $p < .05$. Test of simple effects revealed that participants who rated the beverage first were willing to pay 37 cents after happy primes and 19 cents after angry primes, $F(1, 28) = 4.72$, $p < .04$. For participants who rated mood first, priming had no influence on willingness to pay (33 vs. 34 cents, $p = .44$). In short, affective priming nearly doubled the drink's monetary value, but this effect was short-lived and only occurred when participants responded immediately after priming.

A MANOVA testing for the interaction of priming, order, and thirst (as measured by our continuous 11-point scale on beverage ratings) revealed only a marginally significant prime-by-thirst effect, $F(2, 28) = 3.43$, $p = .07$. However, because such interaction was significant in Study 1, and because the statistical power of Study 2 was low compared to Study 1, we performed linear regressions testing for effects of priming at different levels of

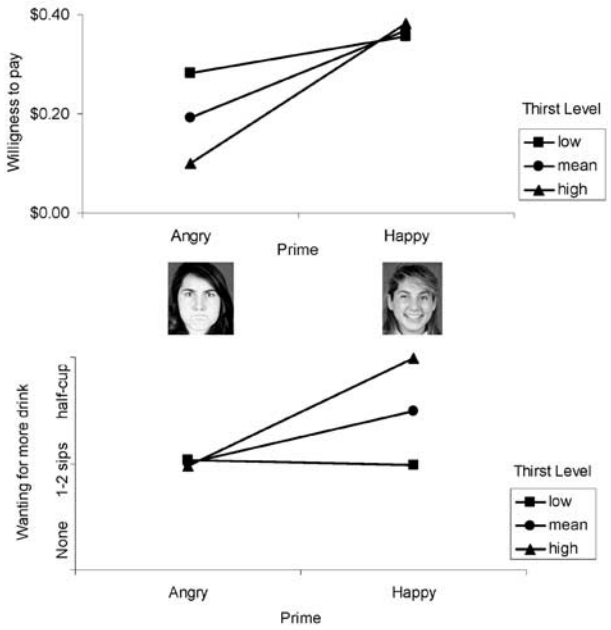

Figure 5 Ratings of the drink as a function of subliminal priming and initial thirst.

NOTE: Top panel: willingness to pay (in cents) among participants who rated the beverage first. Bottom panel: wanting for more beverage, regardless of order (scale values: *none, 1-2 sips, half-cup, 1 cup, 1 pint*, and *2 pints*). Values are estimated by linear regression at different thirst levels and adjusted for baseline levels.

thirst. Those regressions treated the valenced-phase ratings as criterion variables and baseline-phase ratings as covariates. Priming was coded so that higher scores indicated more positive valence (0 = angry, 1 = happy).

The top panel in Figure 5 shows the pattern of results. At the high level of thirst (1 *SD* above the mean), participants were willing to pay 28 cents more after happy than angry primes (38 vs. 10 cents), $B = .28$, $t(13) = 2.25$, $p = .05$. At the mean level of thirst, participants were willing to pay 17 cents more after happy than angry primes (36 vs. 19 cents), which was marginally significant, $B = .17$, $t(13) = 2.03$, $p < .08$. At the low level of thirst (1 *SD* below the mean), participants were willing to pay no more after happy than angry primes (36 vs. 28 cents), $B = .08$, $t(13) = .67$, $p < .53$. Hunger did not influence willingness to pay, suggesting motivational specificity (ts < 1). In summary, thirsty participants who rated the drink immediately after priming were willing to pay triple the price after happy primes than after angry primes, but nonthirsty participants were not.

Wanting for more beverage. Participants rated how much beverage they wanted to drink on a 0 to 5 scale (with values labeled as *none, 1-2 sips, half-cup, 1 cup, 1 pint*, and *2 pints*). Participants rated their postpriming level of wanting more of the beverage at 1.27, or slightly more than 1 to 2 sips. The bottom panel of Figure 5 plots the effects of priming at different thirst levels. Linear regression analyses revealed a significant effect of priming for participants at high thirst level, who wanted to drink 1.02 units more after happy primes than after angry primes (2.0, or about half-cup versus 0.98, or about 1-2 sips), $B = 1.02$, $t(28) = 2.16$, $p < .05$. At the mean thirst level, there was a nonsignificant increase of .48 units in wanting to drink more after happy than angry primes (1.48 vs. 1.0), $B = .48$, $p = .16$. At the low thirst level, prime had no effect on wanting to drink more (.98 vs. 1.03), $B = .05$, $p = .92$. No such effects were obtained with hunger (ts < 1). In summary, thirsty participants wanted to drink more after being primed with happy versus angry facial expressions, but nonthirsty participants did not.

Other ratings. Subliminal affective priming did not influence participants' ratings of liking or sweetness. We return to this issue in the discussion.

Mood ratings. Table 1 presents PANAS ratings by priming condition and item type. We examined the priming influence on mood in several ways. First, we analyzed a subset of positive items ($\alpha = .83$). Second, we analyzed a subset of negative items ($\alpha = .84$). Third, we analyzed a global mood index, created by subtracting negative items from positive items ($\alpha = .72$, mean after happy = 1.18, $SE = .08$, mean after angry 1.14, $SE = .08$). Priming influenced none of these mood scores, regardless of task order and thirst level. Finally, we analyzed the priming effect on each of the 20 mood scale items. At the high and mean level of thirst, participants showed no prime effects on any mood item. At the low level of thirst, participants showed one marginal effect ($p = .08$), rating themselves as slightly more irritated after angry (1.55) compared with happy primes (0.97). But, again, at the high thirst level, there was no hint of this effect ($p = .67$), with participants rating their irritation as lower after angry (1.59) than happy primes (1.77). Furthermore, a single marginal effect at low thirst should be interpreted with caution given there were 20 mood ratings. As a whole, the absence of mood effects is consistent with Study 1, in which priming also did not influence ratings of subjective experience.

Median split on thirst. In the just presented analyses, we used linear regressions to estimate the priming effect at three levels of thirst. We found that at a high thirst level, priming reliably influenced selected beverage ratings without influencing mood. Similar results hold when the data are analyzed by dividing participants into two independent groups using a median split on thirst. To illustrate, Figure 6 plots the priming effect on beverage ratings and mood for participants who scored at or above the thirst median. As shown, for those thirsty participants, priming influenced beverage evaluation (left panel), but not subjective experience (right panel).

TABLE 1: Means and Standard Errors of Responses to Positive and Negative Mood Items on the PANAS Scale by Priming Condition

	Prime					*Prime*			
	Angry		*Happy*			*Angry*		*Happy*	
Positive Mood	M	SE	M	SE	*Negative Mood*	M	SE	M	SE
Interested	3.031	.135	2.824	.139	Distressed	1.587	.140	1.514	.145
Excited	2.016	.140	1.769	.145	Upset	1.318	.087	1.302	.090
Strong	2.044	.194	2.096	.201	Guilty	1.115	.046	1.234	.048
Enthusiastic	2.261	.123	2.434	.128	Scared	1.306	.088	1.244	.091
Proud	1.991	.172	2.010	.178	Hostile	1.203	.105	1.139	.109
Alert	2.937	.188	2.925	.195	Irritable	1.531	.138	1.431	.143
Inspired	1.886	.232	1.908	.240	Ashamed	1.156	.040	1.047	.042
Determined	2.441	.131	2.599	.136	Nervous	1.274	.123	1.135	.127
Attentive	3.087	.127	3.121	.132	Jittery	1.266	.120	1.287	.124
Active	2.578	.215	2.595	.223	Afraid	1.059	.045	1.151	.046
Total	2.440	.072	2.414	.075	Total	1.293	.027	1.236	.028

NOTE: For each adjective, participants rated to what extent they felt this way right now on a scale ranging from 1 = *slightly or not at all* to 5 = *extremely*. Means are adjusted for baseline levels. PANAS = Positive and Negative Affect Schedule.

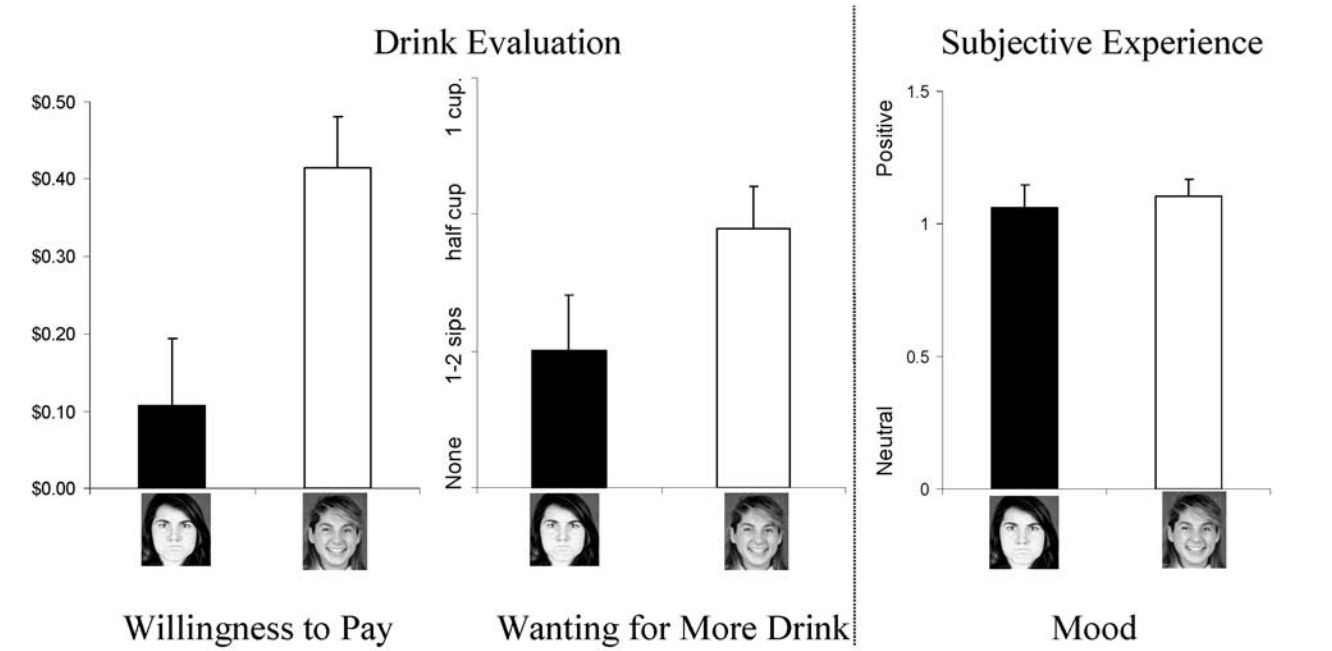

Figure 6 Means and standard errors for measures of beverage evaluation and subjective experience among thirsty participants.
NOTE: Left panel: willingness to pay among participants who rated the beverage first. Middle panel: wanting for more beverage, regardless of order. Right panel: global mood index from the Positive and Negative Affect Schedule (PANAS) scale (positive items minus negative items). Values are for participants at or above median thirst and are adjusted for baseline levels.

Correlation between mood and beverage ratings. Finally, we examined the relation between mood ratings and the beverage ratings that were significantly influenced by priming. The level of positive, negative, and global mood was not correlated with willingness to pay for the beverage or with wanting for more beverage (ps > .5).

Discussion

The results of Study 2 indicate that when participants receive a restricted amount of the beverage as an evaluative target, the valence of subliminal facial expressions can influence ratings of the beverage's incentive value—willingness to pay and wanting to drink more. As in Study 1, the pattern of results suggests that thirst amplifies the influence of affective priming and that priming effects are restricted to immediate impressions. Finally, participants whose beverage ratings were influenced by priming reported no change in subjective experience, even immediately after priming, despite an opportunity to report on 20 nuances of mood.

GENERAL DISCUSSION

Both studies suggest that subliminal affective primes can influence consumption behavior and ratings of target's value without simultaneously influencing conscious feelings. In Study 1, affective primes altered thirsty participants' pouring and drinking. In Study 2, affective primes altered thirsty participants' immediate rating of willingness to pay and their wanting for more drink. In both studies, affective primes failed to change the same thirsty participants' ratings of mood, arousal, or 20 other dimensions of affective experience, even when mood was measured immediately after subliminal exposure. These findings extend previous research in several ways.

Basic affect has consequences. Previous research has found that basic affective reactions influence reflexes, immediate judgments, and simple approach-avoidance responses (Neumann, Förster, & Strack, 2003). The current studies show that basic affective reactions elicited by subliminal stimuli also influence more elaborate real-world behaviors with biological consequences, such as consuming an unfamiliar beverage. These findings fit well with proposals that basic affective processes operate in service of action (Frijda, 1999). We address the specific mechanisms of such influence in the next section.

Preferences need motivation. Previous research focused on the idea that "preferences need no inferences" or that basic affective reactions require minimal processing (Zajonc, 2000). The current studies highlight that basic affect interacts with motivation. This finding invites an integration of social psychological approaches to emotion with biopsychological theories, which view stimulus value as determined jointly by affect and motivation (Berridge, 1999). Thus, we propose a model of the current results according to which subliminal affective primes act via mechanisms that normally modulate the incentive value of targets under relevant appetite states. Specifically, we propose that thirst enhanced the initial incentive value of the drink via physiological alliesthesia, as reflected in thirsty participants' higher baseline ratings of the drink (Cabanac, 1971). This elevated baseline value was then transiently multiplied up or down by subliminal happy and angry expressions. For participants who were not thirsty, the initial incentive value of the drink was closer to zero, so the subliminal multiplication of evaluative reaction by emotional expressions was negligible. We further propose that these changes in the incentive value of drinks led to differences in consumption behavior (Study 1) and ratings of price and wanting (Study 2). Our "incentive value" explanation is consistent with the finding that priming did not simultaneously influence ratings of more standard hedonic and sensory dimensions of the beverage, such as deliciousness or sweetness.

Future studies could test this "incentive systems" model of affective priming. For example, we predict that affective priming of nonbeverage incentives (e.g., food or mates) will be influenced less by thirst, but more by relevant motivational states (e.g., hunger or desire). Consistent with this idea, the current priming effects on beverage variables did not depend on hunger, suggesting motivational specificity (Rolls et al., 1983). Our model also predicts that basic affective reactions may modulate responses to social targets that act as rewards, such as money or status, given that such targets activate affective-motivational circuitry in a manner similar to food, drink, and mates (for a review, see Winkielman & Berridge, 2003).

Unconscious affect. Previous research explored unconscious cognition and unconscious triggering of consciously felt emotions. Several scientists have raised the possibility that people can have "unconscious emotions," but few relevant studies exist. To our knowledge, the current data offer the first demonstration in a nonclinical, human sample that affective reactions can be subliminally triggered and can change behavior yet still remain inaccessible to introspection. However, we acknowledge that negative results are never conclusive, so it remains possible that a mood change occurred but was not detected. Nevertheless, the magnitude of priming effects on behavior in the current studies suggests that participants' inability to report changes in conscious mood was not due to the weakness of their affective reactions. After all, those affective reactions were strong enough to alter pouring and drinking behavior.

Let us stress that we do not propose that affective reactions to subliminal stimuli are always unconscious. In fact, previous studies induced conscious feelings with several kinds of subliminal stimuli and procedures, including gory scenes embedded in movies (Robles, Smith, Carver, & Wellens, 1987), snakes presented to phobic participants (Öhman & Soares, 1994), mere-exposed ideographs (Monahan, Murphy, & Zajonc, 2000), and words related to participants' goals (Chartrand, 2002). However, those studies differ in several ways from current work (for more discussion, see Berridge & Winkielman, 2003). First, we used facial expressions of happiness or anger as subliminal primes—a class of stimuli that is highly familiar and may be processed with low-level neural mechanisms (Morris et al., 1999). These low-level mechanisms may be involved in producing the effects of unconscious affective reactions on behavior and ratings but be distinct from neural mechanisms underlying conscious feelings (Anderson & Phelps, 2002). In contrast, more complex or less familiar stimuli (words, bloody scenes, novel drawings, etc.) may require more advanced processing and therefore be

more likely to elicit conscious feelings. Second, compared to previous research, the current studies used a fairly subtle affect induction procedure. We used happy or angry faces, which are comparatively mild stimuli, compared to gory scenes or snakes. We also presented eight repetitions of those faces, a comparatively small number of exposures, and the faces were presented to nonphobic participants. Finally, the current study used an involving masking task (gender identification) that may have obliterated conscious mood effects of subliminal priming. Future studies may investigate how these factors determine whether subliminal primes influence conscious feelings.

Most important, our point here is not that reactions to subliminal affective stimuli are always unconscious but that changes in subjective experience are not always *required* for basic affective reactions to occur and to influence evaluation of subsequent events. In other words, the critical aspect of our results is the demonstration of "two implicits for the price of one" (J. F. Kihlstrom, personal communication, 2002). Thus, our studies replicate earlier demonstrations of *implicit affective perception* and contribute the novel demonstration of *implicit affective reaction*, which can influence behavior without being consciously accessible.

One implication of this finding for social psychological theory is that the impact of basic affective reactions can fall outside the domain of models that postulate a critical role for conscious feelings in affective influence (e.g., the "feeling-as-information" model; Schwarz & Clore, 1996). Instead, we propose that basic affective stimuli can sometimes act via unconscious processes to directly alter the target's incentive value.

Future research might address the specificity of subliminally elicited affective reactions. As discussed in the introduction, the crucial property of reactions to different subliminal expressions appears to be simple valence. However, this conclusion is based on studies using immediate judgments, and different methods may reveal more specificity. For example, in neuroimaging studies, *supraliminal* faces elicit different patterns of activation to fear, anger, sadness, and disgust (e.g., Whalen, 1998). So, perhaps *subliminal* expressions of fear, anger, disgust, or sadness produce different affective states with unique physiological patterns and action tendencies (Harmon-Jones & Sigelman, 2001). If so, this would suggest that affect can be unconscious not only in its positive/negative form but also in the form fully deserving the label "unconscious emotion" (Berridge & Winkielman, 2003; Winkielman & Berridge, 2004).

Affect or cognition? Previous research showed that subliminal words may influence participants' behaviors in ambiguous situations (Bargh et al., 1996; Neuberg, 1988). These effects occur because cognitive primes temporarily change the accessibility of knowledge relevant for interpreting the ambiguous target (Higgins, 1996). Our findings extend this research by suggesting that affective priming can influence behavior even when the primes and behavior are not directly related by semantic content. As we proposed, this effect occurs because affective priming changes the underlying affective state and thus modifies evaluative responses to the target's incentive value.

Still, it is worth considering an alternative explanation of our results in terms of *unconscious cognition* or the idea that affective priming can function like semantic priming (Clore & Colcombe, 2003). In fact, under some conditions, subliminal faces can activate semantic associations (Baldwin, Carrell, & Lopez, 1990). Thus, skeptics could argue that in our studies, affective primes influenced behavior via cognitive reinterpretation of the consumption situation by thirsty participants who may have been thinking about the upcoming taste test.

In general, there are theoretical reasons not to start with a "default" cognitive explanation for affective phenomena (Zajonc, 2000). Empirical evidence also suggests that affective influence does not work like semantic influence (e.g., Innes-Ker & Niedenthal, 2002). Specifically, several findings in the current studies challenge a cognitive account and favor an affective-motivational account. First, the cognitive account predicts that the target of goodness-badness interpretation should be determined primarily by what participants first attend to after subliminal priming. However, affective priming influenced only the beverage variables, not mood variables, even when participants reported mood first. A cognitive account also predicts that all relevant beverage ratings should be influenced. However, in Study 2, significant effects occurred only in ratings related to the beverage's incentive value (willingness to pay and wanting for more) and not in other applicable ratings (sweetness, deliciousness). Finally, a cognitive account cannot easily explain why a specific appetite state (thirst, but not hunger) modified the impact of affective priming on behavior. Clearly, more research is needed, but presently our affective-motivational explanation offers a parsimonious account for why subliminal facial expressions influenced consumption behavior and only selected ratings, why thirst played an amplifying role, and why conscious mood was not influenced. Finally, our affective-motivational explanation is consistent with a range of findings on psychological and neural mechanisms underlying processing of facial expressions and consumption stimuli, whereas the cognitive explanation makes little contact with this literature (Berridge & Winkielman, 2003).

Could affective stimuli other than facial expressions elicit similar effects? This possibility is important to test because facial expressions' ability to influence approach-avoidance behaviors may relate to their function as quick signals of approval and disapproval. In contrast, if the mediating process involves general changes in negative and positive affect, as we propose, similar effects on behavior should occur with a variety of stimuli, including stimuli related to survival (e.g., snakes, mates) and objects with socially acquired value (e.g., politicians, money). Recent work suggests that *supraliminal* stereotype-related pictures elicit basic affective reactions, as reflected by startle modulation (Amodio, Harmon-Jones, & Devine, 2003). If so, perhaps such socially constructed stimuli could influence behavior even when presented subliminally and even when the behavior is semantically unrelated to primed content. Again, according to our model, such influence should be most pronounced if the behavior is directed at a target high in incentive value, either because of the person's current motivational state or the target's intrinsic motivational quality.

CONCLUSION

Our results indicate that the effects of subliminal facial expressions are not limited to ratings of simple stimuli but can bivalently change a consequential behavior—the amount of an unfamiliar beverage that thirsty participants consume. Furthermore, our results suggest that the impact of basic affective reactions depends on a prior motivational state. Finally, our results demonstrate that subliminally triggered affective reactions can, under some conditions, remain consciously inaccessible yet surface moments later to influence behavior and evaluation of an affect-laden event.

REFERENCES

Amodio, D. M., Harmon-Jones, E., & Devine, P. G. (2003). Individual differences in the activation and control of affective race bias as assessed by startle eyeblink responses and self-report. *Journal of Personality and Social Psychology, 84*, 738-753.

Anderson, A. K., & Phelps, E. A. (2002). Is the human amygdala critical for the subjective experience of emotion? Evidence of intact dispositional affect in patients with lesions of the amygdala. *Journal of Cognitive Neuroscience, 14*, 709-720.

Baldwin, M. W., Carrell, S. E., & Lopez, D. F. (1990). Priming relationship-schemas: My advisor and the pope are watching me from the back of my mind. *Journal of Experimental Social Psychology, 26*, 435-454.

Bargh, J. A. (1996). Automaticity in social psychology. In E. T. Higgins & A. W. Kruglanski (Ed.), *Social psychology: Handbook of basic principles* (pp. 169-183). New York: Guilford.

Bargh, J. A., Chen, M., & Burrows, L. (1996). Automaticity of social behavior: Direct effects of trait construct and stereotype priming on action. *Journal of Personality and Social Psychology, 71*, 230-244.

Berns, G. S., McClure, S. M., Pagnoni, G., & Montague, P. R. (2001). Predictability modulates human brain response to reward. *Journal of Neuroscience, 21*, 2793-2798.

Berridge, K. C. (1996). Food reward: Brain substrates of wanting and liking. *Neuroscience and Biobehavioral Reviews, 20*, 1-25.

Berridge, K. C. (1999). Pleasure, pain, desire, and dread: Hidden core processes of emotion. In D. Kahneman, E. Diener, & N. Schwarz (Eds.), *Well-being: The foundations of hedonic psychology* (pp. 525-557). New York: Russell Sage Foundation.

Berridge, K. C., & Winkielman, P. (2003). What is an unconscious emotion: The case for unconscious "liking." *Cognition and Emotion, 17*, 181-211.

Cabanac, M. (1971). Physiological role of pleasure. *Science, 173*, 1103-1107.

Cacioppo, J. T., & Gardner, W. L. (1999). Emotion. *Annual Review of Psychology, 50*, 191-214.

Chartrand, T. L. (2002). *Mystery moods and perplexing performance: Consequences of succeeding and failing at a nonconscious goal.* Manuscript in revision.

Chen, M., & Bargh, J. A. (1999). Consequences of automatic evaluation: Immediate behavioral predispositions to approach or avoid the stimulus. *Personality and Social Psychology Bulletin, 25*, 215-224.

Clore, G. L. (1994). Why emotions are never unconscious. In P. Ekman & R. J. Davidson (Eds.), *The nature of emotion: Fundamental questions* (pp. 285-290). New York: Oxford University Press.

Clore, G. L., & Colcombe, S. (2003). The parallel worlds of affective concepts and feelings. In J. Musch & K. C. Klauer (Eds.), *The psychology of evaluation: Affective processes in cognition and emotion.* Mahwah, NJ: Lawrence Erlbaum.

Critchley, H., Daly, E., Phillips, M., Brammer, M., Bullmore, E., Williams, S., et al. (2000). Explicit and implicit neural mechanisms for processing of social information from facial expressions: A functional magnetic resonance imaging study. *Human Brain Mapping, 9*, 93-105.

Edwards, K. (1990). The interplay of affect and cognition in attitude formation and change. *Journal of Personality and Social Psychology, 59*, 202-216.

Ekman, P. (1984). Expression and the nature of emotion. In K. Scherer & P. Ekman (Eds.), *Approaches to emotion* (pp. 319-343). Hillsdale, NJ: Lawrence Erlbaum.

Ellsworth, P. C., & Scherer, K. R. (2003). Appraisal processes in emotion. In R. J. Davidson, H. Goldsmith, K. R. Scherer (Eds.), *Handbook of the affective sciences* (pp. 572-595). New York and Oxford, UK: Oxford University Press.

Frijda, N. H. (1999). Emotions and hedonic experience. In D. Kahneman, E. Diener, & N. Schwarz (Eds.), *Well-being: The foundations of hedonic psychology* (pp. 190-210). New York: Russell Sage Foundation.

Harmon-Jones, E., & Sigelman, J. (2001). State anger and prefrontal brain activity: Evidence that insult-related relative left prefrontal activation is associated with experienced anger and aggression. *Journal of Personality and Social Psychology, 80*, 797-803.

Higgins, E. T. (1996). Knowledge activation: Accessibility, applicability, and salience. In E. T. Higgins & A. Kruglanski (Eds.), *Social psychology: Handbook of basic principles* (pp. 133-168). New York: Guilford.

Hull, C. L. (1951). *Essentials of behavior.* New Haven, CT: Yale University Press.

Innes-Ker, A., & Niedenthal, P. M. (2002). Emotion concepts and emotional states in social judgment and categorization. *Journal of Personality and Social Psychology, 83*, 804-816.

Kihlstrom, J. F., Mulvaney, S., Tobias, B. A., & Tobis, I. P. (2000). The emotional unconscious. In E. Eich, J. F. Kihlstrom, G. H. Bower, J. P. Forgas, & P. M. Niedenthal (Eds.), *Cognition and emotion* (pp. 30-86). New York: Oxford University Press.

Knutson, B., Adams, C. M., Fong, G. W., & Hommer, D. (2001). Anticipation of increasing monetary reward selectively recruits nucleus accumbens. *Journal of Neuroscience, 21*, 1-5.

Laeng, B., Berridge, K. C., & Butter, C. M. (1993). Pleasantness of a sweet taste during hunger and satiety: Effects of gender and "sweet tooth." *Appetite, 3*, 247-254.

Lang, P. J. (1993). The three-system approach to emotion. In N. Birbaumer & A. Öhman (Eds.), *The structure of emotion: Psychophysiological, cognitive, and clinical aspects* (pp. 18-30). Seattle, WA: Hogrefe & Huber.

LeDoux, J. (1996). *The emotional brain: The mysterious underpinnings of emotional life.* New York: Simon & Schuster.

Matsumoto, D., & Ekman, P. (1988). *Japanese and Caucasian Facial Expressions of Emotion (JACFEE) and Neutral Faces (JACNeuF).* Report available from Intercultural and Emotion Research Laboratory, Department of Psychology, San Francisco State University.

Monahan, J. L., Murphy, S. T., & Zajonc, R. B. (2000). Subliminal mere exposure: Specific, general and diffuse effects. *Psychological Science, 11*, 462-466.

Morris, J. S., Öhman, A., & Dolan, R. J. (1999). A subcortical pathway to the right amygdala mediating "unseen" fear. *Proceedings of the National Academy of Sciences, 96*, 1680-1685.

Murphy, S. T. (2001). The nonconscious discrimination of emotion: Evidence for a theoretical distinction between affect and emotion. *Polish Psychological Bulletin, 32*, 9-15.

Murphy, S. T., Monahan, J. L., & Zajonc, R. B. (1995). Additivity of nonconscious affect: Combined effects of priming and exposure. *Journal of Personality and Social Psychology, 69*, 589-602.

Murphy, S. T., & Zajonc, R. B. (1993). Affect, cognition, and awareness: Affective priming with optimal and suboptimal stimulus exposures. *Journal of Personality and Social Psychology, 64*, 723-739.

Neuberg, S. L. (1988). Behavioral implications of information presented outside conscious awareness: The effect of subliminal presentation of trait information on behavior in the Prisoner's Dilemma game. *Social Cognition, 6*, 207-230.

Neumann, R., Förster, J., & Strack, F. (2003). Motor compatibility: The bidirectional link between behavior and evaluation. In J. Musch & K. C. Klauer (Eds.), *The psychology of evaluation: Affective processes in cognition and emotion* (pp. 7-49). Mahwah, NJ: Lawrence Erlbaum.

Niedenthal, P. M. (1990). Implicit perception of affective information. *Journal of Experimental Social Psychology, 26*, 505-527.

Niedenthal, P. M., & Kitayama, S. (1994). *The heart's eye: Emotional influences in perception and attention.* San Diego: Academic Press.

Öhman, A., Flykt, A., & Lundqvist, D. (2000). Unconscious emotion: Evolutionary perspectives, psychophysiological data and neuropsychological mechanisms. In R. Lane & R. Nadel (Eds.), *Cognitive neuroscience of emotion* (pp. 296-327). New York: Oxford University Press.

Öhman, A., & Soares, J. J. F. (1994). "Unconscious anxiety": Phobic responses to masked stimuli. *Journal of Abnormal Psychology, 103*, 231-240.

Robles, R., Smith, R., Carver, C. S., & Wellens, A. R. (1987). Influence of subliminal visual images on the experience of anxiety. *Personality & Social Psychology Bulletin, 13*, 399-410.

Rolls, E. T., Rolls, B. J., & Rowe, E. A. (1983). Sensory-specific and motivation-specific satiety for the sight and taste of food and water in man. *Physiology and Behavior, 30*, 185-192.

Rotteveel, M., de Groot, P., Geutskens, A., & Phaf, R. H. (2001). Stronger suboptimal than optimal affective priming? *Emotion, 1*, 348-364.

Schwarz, N., & Clore, G. L. (1996). Feelings and phenomenal experiences. In E. T. Higgins & A. W. Kruglanski (Eds.), *Social psychology: Handbook of basic principles* (pp. 433-465). New York: Guilford.

Strahan, E. J., Spencer, S. J., & Zanna, M. P. (2003). Subliminal priming and persuasion: Striking while the iron is hot. *Journal of Experimental Social Psychology, 38*, 556-568.

Thayer, R. E. (1996). *The origin of everyday moods: Managing energy, tension, and stress.* New York: Oxford University Press.

Toates, F. (1986). *Motivational systems.* Cambridge, UK: Cambridge University Press.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality & Social Psychology, 54*, 1063-1070.

Whalen, P. J. (1998). Fear, vigilance and ambiguity: Initial neuroimaging studies of the human amygdala. *Current Directions in Psychological Science, 7*, 177-188.

Whalen, P., Rauch, S. L., Etcoff, N. L., McInerney, S. C., Lee, M. B., & Jenike, M. A. (1998). Masked presentations of emotional facial expressions modulate amygdala activity without explicit knowledge. *Journal of Neuroscience, 18*, 411-418.

Winkielman, P., & Berridge, K. C. (2003). Irrational wanting and subrational liking: How rudimentary motivational and affective processes shape preferences and choices. *Political Psychology, 24*, 657-680.

Winkielman, P., & Berridge, K. C. (2004). Unconscious emotion. *Current Directions in Psychological Science, 13*, 120-123.

Winkielman, P., Zajonc, R. B., & Schwarz, N. (1997). Subliminal affective priming resists attributional interventions. *Cognition and Emotion, 11*, 433-465.

Wright, C. I., Fischer, H., Whalen, P. J., McInerney, S. C., Shin, L. M., & Rauch, S. L. (2001). Differential prefrontal cortex and amygdala habituation to repeatedly presented emotional stimuli. *Neuroreport, 12*, 379-383.

Zajonc, R. B. (2000). Feeling and thinking: Closing the debate over the independence of affect. In J. P. Forgas (Ed.), *Feeling and thinking: The role of affect in social cognition* (pp. 31-58). Cambridge, UK: Cambridge University Press.

Received November 3, 2003
Revision accepted April 13, 2004