Emotion
2004, Vol. 4, No. 2, 156–172

1528-3542/04/$12.00 DOI: 10.1037/1528-3542.4.2.156

Automatic Affective Evaluation Does Not Automatically Predispose for Arm Flexion and Extension

Mark Rotteveel and R. Hans Phaf
University of Amsterdam

Affect may have the function of preparing organisms for action, enabling approach and avoidance behavior. M. Chen and J. A. Bargh (1999) suggested that affective processing automatically resulted in action tendencies for arm flexion and extension. The crucial question is, however, whether automaticity of evaluation was actually achieved or whether their results were due to nonautomatic, conscious processing. When faces with emotional expressions were evaluated consciously, similar effects were obtained as in the M. Chen and J. A. Bargh study. When conscious evaluation was reduced, however, no action tendencies were observed, whereas affective processing of the faces was still evident from affective priming effects. The results suggest that tendencies for arm flexion and extension are not automatic consequences of automatic affective information processing.

Emotions may have the function of preparing for direct action without explicit deliberation (Darwin, 1872/1998; Lang, Bradley, & Cuthbert, 1990) or any involvement of consciousness. Emotions are seen as responsible for the ability to swiftly perform appropriate actions, particularly in urgent and evolutionary "old" (i.e., frequently recurring in evolutionary history; LeDoux, 1996; Öhman, 1986) situations. Because affect is a central process in emotion (Ortony & Turner, 1990), the evaluation of external or internal stimuli on a positive–negative affect dimension may be closely linked to action, for instance, to approach or to avoid stimuli (Chen & Bargh, 1999; Davidson, Ekman, Saron, Senulis, & Friesen, 1990; Neumann, Förster, & Strack, 2003; Neumann & Strack, 2000). Action tendencies are assumed to be organized in at least two different motivational systems that enable approach or avoidance behavior (Bargh, 1997; Cacioppo, Priester, & Berntson, 1993; Lang et al., 1990). Chen and Bargh, for instance, explicitly claimed to have demonstrated the "existence of a direct link between automatic evaluation and approach/avoidance behavior" (p. 221). The crucial question is, however, whether automaticity of evaluation was actually achieved in their experiments, or whether their results were due, at least in part, to nonautomatic, conscious processing. In three experiments we varied stimuli, instructions, and experimental design to investigate whether action tendencies for arm flexion and extension are the immediate result of automatic affective information processing that "does not depend on the individual concurrently having the conscious and intentional goal of evaluating the stimuli" (Chen & Bargh, 1999, p. 221).

Chen and Bargh (1999) argued that one important function of automatic affective evaluation is to nonconsciously predispose behavior toward the attitude object. This theoretical position is in contrast to the traditional theoretical approach of affect–behavior relationships, namely that the selection of behavioral responses should be under conscious control. In the first experiment of Chen and Bargh (1999; see also Solarz, 1960, for a similar experiment), one group of participants was instructed to evaluate the stimulus word as negative by pushing the response lever away and to evaluate the stimulus word as positive by pulling the lever toward them. Shortly, these responses demanded affect-congruent actions. The other group

Mark Rotteveel, Department of Psychonomics and Department of Social Psychology, University of Amsterdam, Amsterdam, the Netherlands; R. Hans Phaf, Department of Psychonomics, University of Amsterdam, Amsterdam, the Netherlands.

We thank Nando Rensen, Jenneke van Ditzhuizen, Bianca Janssen, Marjolein Luman, Ruben van den Berg, Esther Boppert, Peter Kemper, Niels Plat, and Marthe van der Pol for their assistance in performing the experiments.

Correspondence concerning this article should be addressed to Mark Rotteveel, Department of Psychology, University of Amsterdam, Roetersstraat 15, 1018 WB Amsterdam, the Netherlands. E-mail: M.Rotteveel@uva.nl

of participants received the opposite instruction, which therefore demanded affect-incongruent actions. With positively valenced words, participants were faster when pulling the lever than when pushing the lever. With negatively valenced words, however, the lever was pushed faster than pulled. Chen and Bargh concluded that affect-congruent movements were performed faster than affect-incongruent movements. This pattern of results was found even when participants were instructed to push or pull only on mere presentation of the stimuli and respond irrespective of affective meaning (see Chen & Bargh, 1999, Experiment 2). Chen and Bargh argued that approach and avoidance behavior is linked directly to automatic stimulus evaluation because it apparently does not depend on the conscious goal of affective evaluation. They further argued that "this automatic link between evaluation and behavioral tendency is entirely nonconscious" (p. 221).

Chen and Bargh's (1999) position is further supported by the results of Experiment 3 in the Duckworth, Bargh, Garcia, and Chaiken (2002) study. In this experiment, in which participants also had to push or pull a lever on the mere presence of novel (but affectively valenced) images, similar findings were obtained as in Experiment 2 of the Chen and Bargh study. Because participants were only instructed to push or pull the lever irrespective of the affective valence of the stimuli (as in Chen and Bargh's Experiment 2), Duckworth et al. concluded, in line with Chen and Bargh, that "the automatic evaluation of novel stimuli has direct and immediate consequences for approach and avoidance behavioral tendencies" (p. 518).

According to Chen and Bargh (1999; see also Bargh, 1997; Cacioppo et al., 1993; Duckworth et al., 2002; Wentura, Rothermund, & Bak, 2000), "automatic evaluation . . . is an adaptive back-up system for those times when conscious processing is elsewhere or not focused on the goodness or badness of immediately present stimuli" (p. 217). In a stronger version of their argument, they also proposed that these automatic influences on behavior are only occasionally overridden by conscious interventions and surely do not depend on these conscious processes. They suggest that automatic evaluation (probably even of novel stimuli; see Duckworth et al., 2002) is therefore linked directly to pulling (i.e., arm flexion) and pushing (i.e., arm extension). They further proposed that automatic affective evaluation "is linked directly to the basic motivational states of approach and avoidance and, presumably through such motivations, to actional tendencies" (p. 222). Although they do not specify exactly which actions are influenced by these motivational states, this must include arm movements (i.e., arm flexion and extension) in view of their use of a lever that has to be pulled or pushed by hand.

The argument for a nonconscious and automatic link between affect and arm movement is further strengthened by experimental evidence suggesting a bidirectional relationship. Affective evaluations of novel and neutral ideographs were, for instance, congruently influenced by isometric arm flexion and extension (Cacioppo et al., 1993). Neutral ideographs were evaluated more positively when participants first flexed their arm, whereas neutral ideographs were evaluated more negatively when participants extended their arm. Moreover, emotional words were categorized faster as positively or negatively valenced while performing congruent (positive flexion, negative extension) arm movements (Neumann & Strack, 2000, Experiment 1). Furthermore, Neumann and Strack suggested that not only proprioceptive but also exteroceptive cues of movement might be involved in the evaluations. In their Experiment 2, illusory movement of positively and negatively valenced words made a congruent contribution to the speed of evaluation. Positively valenced words were categorized faster when they seemed to be moving toward participants than when they seemed to move away. Negatively valenced words, however, were categorized faster when they seemed to move away than when they seemed to move toward the participants. Recently, similar evidence was obtained in our laboratory for emotional faces that moved toward or away from the participant (Bonarius, 2002).

The argument of Chen and Bargh (1999) for an entirely automatic and nonconscious affect–behavior link is based primarily on the results of their Experiment 2. It was assumed in this experiment (as in Duckworth et al.'s, 2002, Experiment 3) that participants who were instructed to respond only to the mere presence of affectively valenced stimuli were not consciously evaluating the affectively valenced stimuli. Because a comparable pattern of results was obtained in Chen and Bargh's second experiment as in their first, it was concluded that automatic affective evaluation has fully automatic and direct behavioral consequences. This conclusion may, however, be premature. It can be argued that the results of Chen and Bargh's second experiment (see also Duckworth et al.'s, 2002, Experiment 3) were due to contamination by accidental conscious affective evaluation by some of the participants. It can be argued that conscious evaluation of the affectively valenced targets was not sufficiently prevented in their Experiment 2, nor in Duckworth et al.'s (2002) Experiment 3.

The instruction in Chen and Bargh's (1999) Experiment 2 to react to the presence of target stimuli (which disappeared on response) did not necessarily exclude all conscious affective evaluation. At least some participants could have noticed that the targets were affectively valenced and searched for a reason for their presence. A similar argument, for instance, was used by Bargh, Chaiken, Raymond, and Hymes (1996; see also Klauer & Musch, 2001) in the justification of their third experiment. Participants were instructed in three experiments to pronounce affectively valenced target adjectives as quickly as they could. These target adjectives were preceded by affectively valenced primes (i.e., sequential priming paradigm), and pronunciation latency was used as the critical dependent variable here. Basically, in all three experiments shorter latencies (i.e., affective priming) were obtained in congruent (i.e., positive–positive, negative–negative prime target combinations) than in incongruent (i.e., positive–negative, negative–positive prime target combinations) affective trials. In these experiments it was shown that affective priming may not depend on conscious evaluation by the participants. However, in their justification of Experiment 3, they remarked that,

> it is not unreasonable to suppose that repeatedly seeing and pronouncing adjectives . . . could passively prime the concepts of good and bad, or an evaluative processing goal. It is also possible that subjects consciously notice the valenced nature of the target stimuli and infer that the experiment has something to do with evaluation. (p. 117)

If we apply the same arguments to Chen and Bargh's (1999) Experiment 2 and Duckworth et al.'s (2002) Experiment 3, it cannot be ruled out that at least some of the participants, through the repetition of stimuli, could either passively prime the concepts of good and bad or consciously evaluate the affectively valenced stimuli. The conclusion that affect and behavior are fully linked automatically and that this link does not depend on (some) conscious affective evaluation may, therefore, be premature.

The question studied here is whether the link between automatic affective information processing and arm flexion and extension (see below) is automatic and entirely nonconscious, as proposed by Chen and Bargh (1999), or whether it is also mediated by more conscious affective evaluation processes. We add that we do not question automatic affective information processing per se but the assumed automatic follow-up link with pushing and pulling. Therefore, we dispute the general claim made by Chen and Bargh (1999) that "in a break from the traditional model [in which affect can be activated automatically but the response is under conscious control] . . . the behavioral component of the equation can be automatic as well" (p. 215). Before we can investigate this equation, however, it seems important to define what is meant by Chen and Bargh when they refer to an automatic link.

Chen and Bargh (1999) proposed that if an effect is ". . . not requiring any deliberate conscious processing . . . we can conclude that automatic evaluation of stimuli in turn automatically predisposes approach and avoidance reactions to them" (p. 218). Although this position with regard to automatic versus controlled processing deviates sharply from Shiffrin and Schneider (1977; see also Allport, 1989), for instance, it seems fair to follow Chen and Bargh's definition (see also Bargh, 1994) in our study. Conscious processing goals were therefore varied through instruction and experimental design. To maximize our chances of finding behavioral follow-up effects of automatic affective evaluation, we used facial expressions of emotion instead of words. Emotional faces, which are more likely to be processed automatically because of their evolutionary preparation (Öhman, 1986), may constitute more powerful affective stimuli than emotion words. In Experiment 1, participants were explicitly instructed to categorize faces (i.e., facial expressions of emotion) with the help of a button stand so that participants were forced to flex (as in pulling) or extend (as in pushing) their arm. In Experiment 2, participants were instructed to categorize the same stimuli as in Experiment 1, but now on a nonaffective (i.e., gender) dimension. In Experiment 3, the same stimuli were used as in the foregoing experiments, but this time as primes in a sequential priming task that is typically used to study automatic information processing (Fazio, Sanbonmatsu, Powell, & Kardes, 1986). It was expected that if arm flexion and extension are the automatic and immediate results of automatic affective evaluation, basically the same affective influence on arm flexion and extension should be found in all three experiments. If, however, nonautomatic affective evaluation is a prerequisite for affect-specific behavior, no effect on arm flexion and extension would be expected in at least the last two experiments.

Experiment 1

First, we needed to show that the findings of Chen and Bargh (1999, Experiment 1) and Solarz (1960) can be generalized to the nonverbal domain. We thus tried to conceptually replicate their findings with a different type of affective stimuli (i.e., positively and negatively valenced facial expressions of emotion) that presumably are processed more automatically (Öhman, 1986) than words. Recent evidence from neuroimaging studies, for instance, suggests that even nonconscious perception of angry faces evokes an amygdala response through subcortical pathways (Morris, Öhman, & Dolan, 1998, 1999). Similar to Solarz, but in contrast to Chen and Bargh, instruction (i.e., arm flexion with positively or arm flexion with negatively valenced targets) was varied within participants instead of between participants. Only female participants were included in the experiments because Solarz had found that the effects were larger for female than for male participants, and this would thus improve our chances of finding the expected effect.

The experimental apparatus was somewhat different from Chen and Bargh (1999) and also from Solarz (1960). Instead of a vertical lever (Chen & Bargh) or a horizontal lever (Solarz) that had to be pushed (by means of arm extension) or pulled (by means of arm flexion), participants were instructed to press buttons on a vertical stand (see below). In this fashion, responding with the button stand corresponds to arm flexion and extension in Cacioppo et al. (1993). According to Chen and Bargh, “Cacioppo, Priester, and Berntson (1993) have demonstrated a link between evaluation and motor responses but in the reverse direction from that of our hypothesis” (p. 217). Chen and Bargh suggested, in line with our reasoning (see also Förster & Strack, 1996), a conceptual similarity between arm flexion and arm extension and lever movement. If we would obtain a similar pattern of results as Chen and Bargh, Duckworth et al. (2002), and Solarz, this would further support this conceptual similarity.

Participants were instructed to move their right hand from a home button (placed in the middle of the stand) to a response button below or above on the stand (see Figure 1). As they pressed one out of two response buttons with the top or bottom side of their hand, they did not turn their hand when responding. Two different dependent measures (as in Solarz, 1960) could be obtained in this manner: the initiation time, or release time (RT), of the home button and the movement time (MT) needed for reaching and pushing the response button. RT constitutes an index of central processes and reflects stimulus evaluation, response selection, and programming the execution of motor movements, and is relatively independent of MT, which reflects the magnitude of the neuromuscular response (Fitts, 1954). RT increases as a function of the amount of stimulus information (Sternberg, 1966), for instance, or with the number of target alternatives (Brainard, Irby, Fitts, & Alluisi, 1962). MT, in contrast, is relatively unaffected by these parameters, but is affected by the distance toward the target and size of the target location (Fitts & Peterson, 1964). The influence of affect on latency times should primarily be found in RT (see Solarz, 1960) rather than in MT.

Figure 1. The experimental setup used in Experiments 1, 2, and 3. Three one-button boxes were fixed on a stand. Both response buttons were positioned perpendicularly above and below the home button. Participants were instructed to push the upper or lower button in response to a stimulus, and they consequently flexed or extended their arm, respectively.

It was expected, in line with Chen and Bargh (1999), Duckworth et al. (2002), and Solarz (1960), that in affect-congruent conditions (positively valenced faces with arm flexion and negatively valenced faces with arm extension) latencies would be shorter than in affect-incongruent conditions (positively valenced faces with arm extension and negatively valenced faces with arm flexion).

Method

Participants. Forty-eight first-year female psychology students (mean age = 21.3 years, *SD* = 4.23) from the University of Amsterdam, Amsterdam, the Netherlands, participated in the experiment for course credit. All participants had normal or corrected-to-normal vision, were right-handed, and signed informed consent. The experiment was announced as "judgment of emotional pictures."

Design. The evaluation task had a 2 (action: flexion vs. extension) × 2 (target valence: positive vs. negative emotional expressions) × 2 (target gender: female vs. male model) within-participants factorial design.

Two different response times were measured: the reaction from stimulus onset to the release of the home button (RT) and the MT needed for reaching the response button. Reaction times that deviated more than 2.5 standard deviations from the participants' average in that instruction condition (i.e., congruent or incongruent button) were excluded from the analysis. If RT data were excluded, corresponding MT data were also excluded and vice versa. Incorrect responses were also excluded from the reaction time analyses. The maximum number of outliers and incorrect responses was set at four per instruction condition per participant. The number of incorrect responses also served as a dependent variable.

Materials and apparatus. Forty pictures with emotional expressions from Ekman and Friesen (1976) and Matsumoto and Ekman (1988) served as targets. Both the happy and the angry expressions were taken from the same model. The set of targets was subdivided in two fixed series (A and B) that contained both 10 happy and 10 angry expressions of different models. Ten of these pictures were taken from female models and 10 were taken from male models. Therefore, each series contained 5 happy expressions of female models, 5 happy expressions of male models, 5 angry expressions of female models, and 5 angry expressions of male models. Each picture was projected on a milk-colored screen, with a vertical visual angle of 14° and a horizontal visual angle of 10.7°.

Twenty-four participants started with an affect-congruent (i.e., positive evaluations with pushing the upper button and negative evaluations with pushing the lower button) instruction block of trials (Series A for 12 participants and Series B for the other 12 participants). Subsequently, an affect-incongruent (i.e., positive evaluations with pushing the lower button and negative evaluations with pushing the upper button) block of trials (Series B for 12 participants and Series A for the other 12 participants) followed after an unrelated evaluation task (not using the button stand) that served to ease transition from congruent to incongruent instruction or vice versa. Participants rated Japanese ideographs as positively or negatively valenced to calibrate novel Japanese ideographs for use in other experiments. The other 24 participants followed the reversed order of instruction blocks.

The stimuli were projected from the back on the screen by means of a three-way projection tachistoscope with three digital data projectors (Hitachi CPX 955) that were each fitted with a ferro-electric liquid crystal shutter (Displaytech LV2500-AC, Longmont, CO). Each data projector as well as the three shutters were controlled by the application "Beam" (in-house software) with a Pentium II 400 MHz computer. Each series was preceded by six practice trials that contained pictures not included in both experimental series. Each trial started with the projection of a black fixation point for 400 ms that was placed in a mask. This mask consisted of a screen of random lines and shadows that were used to prevent leaking of light from the targets through the shutters. Targets were projected for 100 ms.

Responses could be given by means of three one-button boxes that were fixed to a vertical stand (see Figure 1). Participants were seated to the left of the stand and operated it with their right hand. The home button (fixed in the middle) had to be pushed loosely with the back of the right hand as long as no response was given (resting position). The height of this button was set for each participant individually so that the angle between the arm and upper arm was 110° for all participants in the resting position. In this way, both muscles (biceps and triceps) were equally tensed when holding the home button pressed. The response buttons were positioned above and below the home button (at a distance of 10.3 cm). In this way, participants could simply flex or extend their arm when responding without any need for precise aiming at the response buttons.

Procedure. Participants were instructed to evaluate (i.e., positively or negatively) facial expressions. They received either an affect-congruent or an affect-incongruent instruction. An affect-congruent instruction entailed the pressing of the lower button with negatively valenced faces and of the upper button with positively valenced faces. With the affect-incongruent instruction, the reference to the response buttons was reversed. All possible references in the instructions to *congruence* versus *incongruence, approach behavior* or *avoidance behavior,* or for that matter to *flexion* and *extension* were avoided. Before the first block of experimental trials, six practice trials were presented. After the participant finished the first block of trials, a second task was presented. Forty-eight ideographs had to be rated on an affective dimension with a different response box positioned on a table in front of the participant. Subsequently, the second block of trials was presented that was also preceded by six practice trials. The experiment was concluded by an exit interview in which participants were asked about their strategies and ideas about the experiment.

Results

Participants subjectively reported to be well able to evaluate the affective meaning of the pictures. No participants were excluded because of an excessive number of outlier observations. Twenty-two outliers (2.3%) were excluded from analysis from the affect-congruent conditions and 25 (2.6%) from the affect-incongruent conditions. There were fewer incorrect responses with affect-congruent instructions (1.9%) than with affect-incongruent instructions (3.1%; paired, two-tailed), $t(47) = 2.5$, $p < .05$.

Participants released the home button (see Table 1) faster with arm flexion for positively valenced targets (see Figure 2) than with flexion for negatively valenced targets, whereas the home button was released faster with extension for negatively valenced targets than with positively valenced targets, as was evidenced by the interaction, $F(1, 47) = 14.1$, $p < .001$, $\eta^2 = .23$, between action and valence in the 2 (action) × 2 (target valence) × 2 (target gender) analysis of variance (ANOVA) on RT. Planned comparisons revealed that for both arm flexion (paired, one-tailed), $t(47) = 4.0$, $p < .001$, and extension (paired, one-tailed), $t(47) = 2.8$, $p < .01$, latencies between positively and negatively valenced targets differed reliably.

Table 1
Means and Standard Deviations for Release Times in Experiment 1, With Arm Flexion and Extension

Condition	Flexion *M*	Flexion *SD*	Extension *M*	Extension *SD*
Positive				
Men	505.6	76.3	540.9	106.6
Women	511.5	80.1	539.3	110.4
Negative				
Men	525.8	103.5	479.9	74.6
Women	565.1	94.3	532.8	88.7

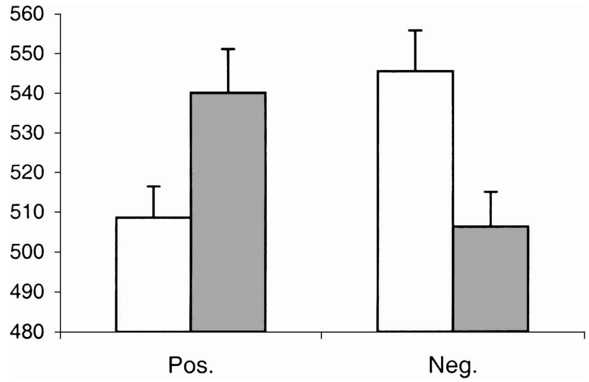

Figure 2. Means and standard errors for reaction times for arm flexion and extension in Experiment 1. Pos. = positively valenced; Neg. = negatively valenced; open bars = flexion; solid bars = extension.

Participants also released the home button faster for male than for female target faces, but this main effect of target gender, $F(1, 47) = 25.8$, $p < .0001$, $\eta^2 = .35$, was qualified by a Target Gender × Affective Valence interaction, $F(1, 47) = 33.0$, $p < .0001$, $\eta^2 = .41$. For positive female faces, RT was shorter, with both flexion and extension ($M = 525.4$, $SD = 96.9$ ms) than for negative ($M = 548.9$, $SD = 92.5$ ms) female faces, as was evidenced by Tukey's honestly significant difference (HSD) post hoc test, $V(47) = 4.4$, $p < .05$; whereas RT for positive male faces was longer ($M = 523.3$, $SD = 93.9$ ms) than for negative ($M = 502.9$, $SD = 92.6$ ms) male faces, $V(47) = 3.8$, $p < .05$. No further main or interaction effects were significant in this analysis.

In MT (see Table 2), we found no clear effect of affective valence for arm flexion or extension, $F(1, 47) < 1$. The two-way interaction, $F(1, 47) = 8.8$, $p < .005$, $\eta^2 = .12$, between target gender and affective valence that was obtained in RT was also found in MT. Overall latency was shorter with negatively than with positively valenced male faces, whereas with negatively valenced female faces, MT was longer than with positively valenced female faces. Both differences in affective valence within target gender were not significant, however, $V(47) = 1.9$, $V(47) =$

Table 2
Means and Standard Deviations for Movement Times in Experiment 1, With Arm Flexion and Extension

	Flexion		Extension	
Condition	*M*	*SD*	*M*	*SD*
Positive				
Men	177.8	62.9	181.5	65.5
Women	166.5	58.5	161.8	57.4
Negative				
Men	172.8	54.4	166.8	63.4
Women	184.1	95.8	169.2	56.3

2.3, respectively, according to Tukey's HSD post hoc test. We found no further main or interaction effects in this analysis.

Discussion

Faster (with respect to RT) and fewer incorrect responses were produced with affect-congruent than with affect-incongruent responses. These results show that effects similar to those of Chen and Bargh (1999), Duckworth et al. (2002, Experiment 3), and Solarz (1960) can be obtained with our experimental setup. Moreover, our results extended their results, respectively, from affective words and affectively valenced but novel images to affectively valenced facial expressions. No attempt was made to mask the affective nature of the task (the experiment was announced as an affective evaluation task). No conclusion can be drawn yet about whether arm flexion–extension was invoked automatically or by conscious processing goals. Strictly speaking, these results cannot be generalized to male participants, but Solarz' results suggested that familiar, albeit smaller effects can also be found in men.

An interesting, but unexpected aspect of our results was the interaction between model gender and affective valence. Our female participants reacted faster overall (i.e., irrespective of flexion and extension) to negatively valenced male than to positively valenced male target faces in both RT and MT. This is in line with the finding of Chen and Bargh (1999) that responses were faster for negatively valenced words than for positively valenced words. Chen and Bargh interpreted this as further evidence for a greater automatic vigilance for, or sensitivity toward, negatively valenced information (Pratto & John, 1991; Taylor, 1991). In contrast, for female targets this pattern of results was reversed. Although we should be careful with the interpretation of these unexpected results, it seems that gender as a social identity is an important parameter for early vigilance and monitoring of the environment for potential danger and should be considered in further studies of the automatic vigilance hypothesis (Pratto & John, 1991).

In Experiment 2 of Chen and Bargh (1999) and Experiment 3 of Duckworth et al. (2002), participants were instructed to push or pull a lever whenever they detected the target stimulus (words and images, respectively). In these experiments as well, support was found for a relation between affect and arm movement, which may be part of a more general link between automatic affective information processing and action tendencies. Participants were, however, instructed to respond (i.e., arm flexion or extension) to clearly visible affectively valenced words and images. As already argued, it could not be excluded that some participants evaluated the affectively valenced words or images consciously (see Bargh et al., 1996, for a similar conception). Interestingly, the difference between affect-congruent and affect-incongruent conditions seems smaller in Chen and Bargh's Experiment 2 than in Experiment 1.[1] In our Experiment 2, we replaced the affective evaluation of Experiment 1 with a nonaffective judgment of the target faces, and thus attempted to divert attention from the affective features of the targets. Focusing the participants' attention to an affectively neutral task may be more effective in preventing accidental conscious affective evaluation than just omitting the explicit task of affective stimulus evaluation. It can be argued, however, that presenting an affectively neutral task could interfere with the immediate behavioral consequences of automatic affective stimulus evaluation. According to Chen and Bargh, however, automatic affective stimulus evaluation with direct behavioral consequences makes good adaptive sense "because it is able to occur when conscious goal-directed thought is elsewhere or when attentional resources are short in supply" (p. 221).

Experiment 2

Experiment 2 was completely similar to Experiment 1 in experimental setup, design, and affective stimuli, except for the instruction. Participants were instructed to categorize faces as either being male or female. It is often assumed that affect can be processed automatically and without conscious process-

[1] Unfortunately, neither effects sizes, standard deviations, nor standard error of the means are given in Chen and Bargh (1999).

ing (see Bargh et al., 1996; Dimberg, Thunberg, & Elmehed, 2000; Draine & Greenwald, 1998; Duckworth et al., 2002; Murphy & Zajonc, 1993; Rotteveel, de Groot, Geutskens, & Phaf, 2001; Rotteveel & Phaf, in press). With this gender-categorization instruction, affective processing can be induced that does not depend necessarily on conscious processes (Morris, Friston, et al., 1998), although some conscious processing of affect cannot be excluded. In comparison with Experiment 2 of Chen and Bargh (1999), however, the conscious processing of affect seems at least hindered more thoroughly with this task, whereas automatic affective information processing can take place simultaneously. The contrast of this instruction with that of Experiment 1 is typically used to study "the functional dissociation between pathways for the conscious explicit appraisal of facial expressions . . . and pathways for automatic implicit processing of salient facial expressions" (Critchley et al., 2000, p. 102). If the influence of affect on arm flexion and extension is automatic and does not heavily depend on conscious affective evaluation, the same pattern of results should be expected as in Experiment 1. If, however, conscious affective evaluation is required for the initiation of action tendencies for arm flexion and extension (but not for the affective information processing), this pattern of results should not be present.

Method

Participants. Forty-eight first-year female psychology students (mean age = 20.9 years, *SD* = 1.24) from the University of Amsterdam participated in the experiment for course credit. All participants had normal or corrected-to-normal vision, were right-handed, and signed informed consent. The experiment was announced as "gender judgment of faces."

Design. The judgment task had a 2 (target gender: female vs. male model) × 2 (target valence: positive vs. negative emotional expression) × 2 (action: flexion vs. extension) within-participants factorial design. RT, MT, and percentage of incorrect responses were again measured. The same exclusion criteria for response times were used as in Experiment 1.

Materials and apparatus. Only changes with respect to Experiment 1 are discussed here. Affect-congruent trials were mixed with affect-incongruent trials by including in both blocks of trials angry as well as happy facial expressions of both genders. Twenty-four participants started with Series A, whereas the remaining participants started with Series B.

Procedure. Participants were instructed to judge face gender (i.e., man or woman). It was mentioned that the faces showed expressions, but that these were irrelevant to the experimental task. The experiment again consisted of two different instruction blocks, but this time the instruction specified the relation between upper or lower button and model gender. Upper and lower buttons alternatively corresponded to male and female responses in the two instruction blocks. All possible references in the instructions to *movement* or *congruence* versus *incongruence, approach behavior* or *avoidance behavior,* or for that matter to *flexion* and *extension* were avoided. Before the first block, six practice trials were presented. After finishing the first block, a second task (i.e., ideograph evaluation) was again performed to ease transition between instruction conditions. Subsequently, the second block of trials was presented, which was also preceded by six practice trials. The experiment was again concluded by an exit interview.

Results

Participants reported to be well able to evaluate the gender of the faces, and almost all participants reported to have also noticed the emotional expressions. For 1 participant, the average of one condition was replaced by the overall average in that condition across participants because more than four outliers and incorrect responses were identified in this participant's affect-incongruent responses. Overall, we excluded 22 outliers (2.3%) from the analysis of the affect-congruent trials and 25 (2.6%) from the affect-incongruent trials. Slightly more incorrect responses were made with affect-incongruent responses (4.3%) than with affect-congruent responses (4.2%). This difference was according to a paired *t* test, $t(47) < 1$, which was not significant.

No effect (see Table 3) of affect was obtained in RT for flexion or extension, as was evidenced by the ab-

Table 3
Means and Standard Deviations for Release Times in Experiment 2, With Arm Flexion and Extension

	Flexion		Extension	
Condition	*M*	*SD*	*M*	*SD*
Positive				
Men	512.5	75.9	514.7	79.3
Women	489.7	80.2	498.0	70.3
Negative				
Men	493.4	72.8	506.2	69.4
Women	512.2	87.8	520.4	90.8

sence of an Affect × Action interaction, $F(1, 47) < 1$, in the 2 (target gender) × 2 (target valence) × 2 (action) ANOVA. The home button was released faster (irrespective of arm flexion or extension) for positive female targets (M = 493.9, SD = 75.1 ms) than for negative female targets (M = 516.3, SD = 88.9 ms), as was revealed by Tukeys HSD post hoc test, $V(47) = 4.2$, $p < .05$, for the Model Gender × Affective Valence interaction, $F(1, 47) = 23.3$, $p < .0001$, $\eta^2 = .33$. No significant difference, $V(47) = 2.6$, between negative male faces (M = 499.8, SD = 71.0 ms) and positive male faces (M = 513.6, SD = 77.2 ms) was obtained. This two-way interaction resembles the pattern of results, at least for the female facial expressions, as those obtained in Experiment 1. This suggests that affective valence had no clear effect on arm flexion and extension even though it appears to have been processed. No further main or interaction effects were significant in this analysis.

We obtained no influence, $F(1, 47) = 1.1$, *ns,* of affect on flexion or extension (see Table 4) in MT in the 2 (target gender) × 2 (target valence) × 2 (action) ANOVA. There was, however, a main effect of action, $F(1, 47) = 5.1$, $p < .05$, $\eta^2 = .10$, which indicated that MT was shorter for extension (M = 155.0, SD = 56.8) than for flexion (M = 164.4, SD = 64.5). Participants also moved their arm faster, $F(1, 47) = 6.4$, $p < .05$, $\eta^2 = .12$, with male (M = 155.9, SD = 56.6) than with female targets (M = 163.4, SD = 64.7). No further main or interaction effects occurred in this analysis.

Discussion

We found no influence of affect on arm flexion and extension when attention was diverted away from the affective valence by the instruction to evaluate target gender, although almost all participants reported to have noticed the affective content of the targets. The alternative explanation of an overall absence of affective processing is further made implausible by the finding of a similar interaction as in Experiment 1 between affective valence and target gender in RT. Smiling female faces were categorized faster than angry female faces, whereas no reliable difference was found between the categorization of happy and angry male facial expressions. It thus seems that affect was noticed and processed, at least partially, but that full attention toward affective evaluation is required (as in Experiment 1) to evoke any influence of affect on arm flexion and extension. Another alternative explanation for the absence of congruency effects could be the mixed design of affect-congruent and affect-incongruent trials in this experiment in contrast with Experiment 1. It can be argued that performing affect-congruent and affect-incongruent responses in a mixed fashion (in contrast to a blocked fashion as in Experiment 1) diluted the affect arm flexion–extension relationship. Context dependency is assumed in this explanation and is, therefore, probably more favorable of a theoretical position that proposes a nonautomatic than a fully automatic link between affect and arm flexion–extension (see also the General Discussion section).

The congruency effects obtained in Chen and Bargh's (1999) Experiment 2 and Duckworth et al.'s (2002) Experiment 3 may have been due to contamination by participants' conscious processing of the affective content of the stimuli in the absence of another attention-consuming task. Before we can draw such a conclusion, replication of these results seems warranted in an alternative paradigm (with arm flexion and extension) that would allow the dissociation of automatic affective evaluation effects from automatic influences of affect on arm flexion and extension.

In the sequential priming procedure (Neely, 1977), a prime stimulus is presented first and subsequently followed (after a stimulus onset asynchrony; SOA) by a target stimulus that has to be judged on a shared dimension. Fazio et al. (1986; see also Bargh, Chaiken, Govender, & Pratto, 1992), for instance, found that affective evaluations were faster when prime and target words (presented with an SOA of 300 ms) had a congruent valence (e.g., *puppy* and *wonderful*) than when prime and target words had an incongruent valence (*puppy* and *disgusting*). Chen and Bargh (1999) commented with respect to this paradigm:

> because the duration of the attitude object prime was too short to permit any conscious set or expectancy concerning the valence of the upcoming adjective . . . , any

Table 4
Means and Standard Deviations for Movement Times in Experiment 2, With Arm Flexion and Extension

	Flexion		Extension	
Condition	*M*	*SD*	*M*	*SD*
Positive				
Men	163.1	70.1	149.2	49.8
Women	169.1	63.5	155.0	51.7
Negative				
Men	163.0	59.1	148.6	44.0
Women	162.3	66.5	167.3	75.9

> influence of the attitude object prime on latency to classify the target as good or bad could only occur if the attitude object had automatically activated the attitude associated with it in memory. (p. 216)

This affective priming effect is now well established for valenced words (Bargh et al., 1992; Hermans, De Houwer, & Eelen, 1994), for valenced pictures (Banse, 2001; Fazio, Jackson, Dunton, & Williams, 1995; Hermans et al., 1994), and even for completely novel words and sounds (Duckworth et al., 2002). The sequential priming paradigm seems suitable to test for the dissociation between automatic affective evaluation and automatic action tendencies for arm flexion and extension. This is because overall response times, reflecting the sequential affective priming effect, can be differentiated in affect-specific arm flexion and extension latencies (see Experiment 3).

Although conscious evaluation appears necessary for finding action tendencies for arm flexion and extension, only an explicit task context of affective evaluation may be sufficient for this purpose. Klinger, Burton, and Pitts (2000) argued, for instance, that (nonconscious) activation of response tendencies is heavily dependent on conscious task demands. Klinger et al. demonstrated that affective priming by affectively valenced words occurred only with evaluation (i.e., positive, negative) of affective target words (see Experiment 1). When a lexical decision had to be made (see Experiment 2), however, the affective priming effect disappeared. Prime words influenced judgments on target words only when primes and targets were compatible with regard to the response dimension. In other words, attention to the relevant dimension (i.e., affect) may be a prerequisite even for the activation of automatic response tendencies. In the gender-judgment task, action tendencies for arm flexion and extension may thus have been absent because attention was focused on a nonaffective dimension. Because in the sequential affective priming paradigm targets can be evaluated on an affective dimension, a diverted attention explanation could not be raised for the results obtained in such a paradigm. In Experiment 3, we studied the influence of affective stimuli (serving as primes in a sequential priming task) that were not consciously evaluated but were presented in the context of explicit evaluation of affective target stimuli.

Experiment 3

The same type of facial stimuli as in Experiments 1 and 2 now served as primes instead of as targets. Different affective scenes (e.g., sunny beaches, garbage dumps) served as targets. The SOA between prime and target was chosen at 100 ms, on the one hand, to resemble target presentation time of Experiments 1 and 2 and, on the other hand, to ensure automatic influences of the prime stimuli. It was expected that an effect of target valence on flexion and extension (i.e., as in Experiment 1) reaction times would be found. Second, it was expected that if affective information processing results automatically in action tendencies, then influences of prime faces on arm flexion and extension reaction times should be obtained. If, however, this influence is nonautomatically mediated, no effect of the faces on arm flexion and extension latencies should be obtained. Third, an affective priming effect should be obtained. That is, when valence of target and trial correspond (i.e., positive–positive, negative–negative combinations), responses should be faster and more accurate than when they do not correspond (i.e., positive–negative, negative–positive combinations; see Bargh et al., 1992; Fazio et al., 1995; Fazio et al., 1986; Hermans et al., 1994). This opens up the possibility of finding evidence for automatic affective processing of the (prime) faces in the absence of action tendencies for arm flexion and extension.

Method

Participants. Forty-eight first-year female psychology students (mean age = 20.9 years, SD = 2.6) from the University of Amsterdam participated in the experiment for course credit. All participants had normal or corrected-to-normal vision, were right-handed, and signed informed consent. The experiment was announced as "categorization of affective stimuli."

Design. The judgment task had a 2 (action: flexion vs. extension) × 2 (target valence: positive vs. negative pictures) × 2 (prime valence: positive vs. negative emotional expressions) within-participants factorial design.

Materials and apparatus. Only changes with regard to Experiment 1 and Experiment 2 are discussed here. Forty-eight pictures with emotional expressions from Ekman and Friesen (1976), Matsumoto and Ekman (1988), and Martinez and Benavente (1998) served as primes. The happy and angry expressions were taken from the same model. The set of primes was divided into two series (A and B) that each contained 12 happy and 12 angry expressions from 24 different models. Of these pictures, 12 were taken from female and 12 were taken from male models. Forty-eight pictures (no faces) from Lang, Öhman, and Vaitl (1988) served as targets. Twenty-four pictures were rated mildly positive, and 24 were rated mildly negative by American women (Lang, Bradley, & Cuthbert, 1995). Targets were combined with each series (A and B) in such a way that six positive targets were combined with 3 happy male and 3 happy female expressions, and six positive targets were combined with 3 angry male and 3 angry female expressions. Six negative targets were combined with 3 angry male and 3 angry female expressions, and six negative targets were combined with 3 happy male and 3 happy female expressions. Four different couplings of primes and targets were prepared for each series (A and B). These couplings were rotated over the participants. The order of trials was randomized for each participant, separately.

Each series was preceded by six practice trials that contained pictures (primes and targets) not included in the experimental material. Each trial started with the projection of a black fixation point for 400 ms that was placed in a mask. Primes were subsequently projected for 100 ms and were directly followed by the target pictures, which were projected for 150 ms.

Procedure. Participants were instructed to evaluate the valenced targets. It was mentioned that facial expressions would precede these targets, but it was emphasized that the targets had to be rated. They received either a target-affect-congruent ("press the lower button with negatively valenced targets, press the upper button with positively valenced targets") or a target-affect-incongruent instruction ("press the upper button with negatively, and the lower button with positively valenced targets"). All reference to *congruence* or *incongruence, approach behavior* or *avoidance behavior,* or for that matter to *flexion* and *extension* was avoided. After finishing the first block, the same intervening task was performed, as in Experiments 1 and 2. Subsequently, the second block of trials was presented, again preceded by six practice trials. The experiment was concluded by an exit interview.

Results

Participants reported to be well able to evaluate the affective valence of the targets. Overall, 33 outliers (2.9%) were excluded from the analysis of the affect-congruent conditions and 27 (2.3%) from the affect-incongruent conditions. Slightly more incorrect responses were made with affect-incongruent (4.7%) than with affect-congruent responses (4.0%). This difference was not significant.

The first hypothesis stated that target valence would have an affect-congruent effect on flexion and extension. As can be seen in Figure 3, participants released the home button indeed (see also Table 5) faster with arm flexion for positively valenced targets than with flexion for negatively valenced targets, whereas the home button was released faster with extension for negatively valenced targets than with positively valenced targets, as was evidenced by the Action × Target Valence interaction, $F(1, 47) = 12.2$, $p < .01$, $\eta^2 = .21$, in the 2 (action) × 2 (target valence) × 2 (prime valence) ANOVA on RT. Planned comparisons revealed that for both arm flexion (paired, one-tailed), $t(47) = 3.79$, $p < .001$, and extension (paired, one-tailed), $t(47) = 2.0$, $p < .05$, reaction times between positively and negatively valenced targets differed reliably.

In the second hypothesis, we expected that prime valence would have an affect-congruent effect on flexion and extension. The Action × Prime Valence interaction (see Figure 3) did not, however, reach significance, $F(1, 47) = 1.1$, *ns,* indicating an absence of a direct link between prime valence and arm movement. The third hypothesis stated that prime and target valence should interact. The Target × Prime Valence interaction on RT (see Figure 4) indicated an affective priming effect, $F(1, 47) = 28.1$, $p < .0001$, $\eta^2 = .37$. If prime and target had a corresponding valence, participants reacted faster than when prime and target valence differed. Planned comparisons revealed that positively and negatively valenced targets that were preceded by positively or negatively valenced primes differed reliably (paired, one-tailed), $t(47) = 5.2$, $p < .0001$ (paired, one-tailed); and, $t(47)$

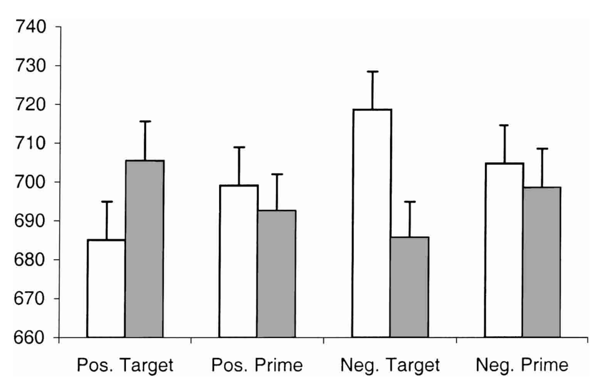

Figure 3. Means and standard errors for reaction times for arm flexion and extension in Experiment 3. Pos. = positively valenced; Neg. = negatively valenced; open bars = flexion; solid bars = extension.

Table 5
Means and Standard Deviations for Release Times for Arm Flexion and Extension in Response to Affectively Valenced Targets in Experiment 3

	Flexion				Extension			
	Pos. prime		Neg. prime		Pos. prime		Neg. prime	
Condition	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Positive target	668.3	95.9	701.9	95.3	691.2	93.4	719.7	104.5
Negative target	730.0	90.7	707.5	100.9	694.0	92.2	677.3	88.6

Note. Pos. = positively valenced; Neg. = negatively valenced.

= 2.26, $p < .05$, respectively. No further main or interaction effects were significant in the analysis of RT.

We tested the influences of the affective primes and targets for their differential contribution to the affective priming effect and differences in action (i.e., flexion-extension, or extension-flexion). Planned comparisons of the differential influence of prime valence (positive vs. negative) on the difference between flexion and extension responses (i.e., flexion minus extension) for positively valenced targets did not reach significance (mean difference = −5.0 ms, paired, one-tailed), $t(47) = -0.42$. The influence of prime valence on the extension-flexion difference (i.e., extension-flexion) with negatively valenced targets also did not reach significance (mean difference = −5.8 ms, paired, one-tailed), $t(47) = -0.55$. In contrast, the planned comparisons of the differential influence of target valence on the extension-flexion difference with negatively valenced primes was significant (mean difference = −48.0 ms, paired, one-tailed), $t(47) = -2.7$, $p < .01$; as was the difference between

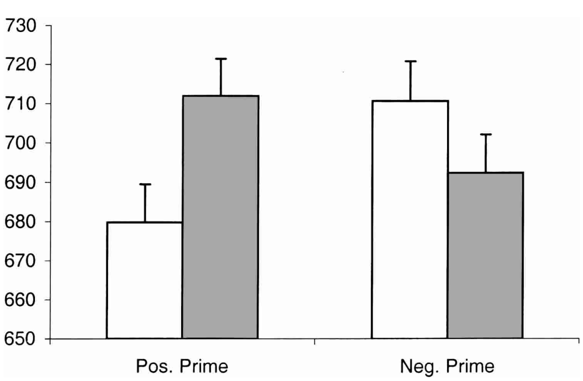

Figure 4. Means and standard errors for overall reaction times for affectively valenced targets preceded by affectively valenced primes in Experiment 3. Pos. = positively valenced; Neg. = negatively valenced; open bars = positive target; solid bars = negative target.

flexion and extension responses with positively valenced primes (mean difference = −58.8 ms, paired, one-tailed), $t(47) = -3.6$, $p < .001$. Evidence for affective processing of the primes was clearly obtained for the reaction times. The affective influences of the primes did not further spread to arm flexion and extension.

For MT (see Table 6), we found an Action × Target Valence interaction, $F(1, 47) = 5.1$, $p < .05$, $\eta^2 = .10$. Planned comparisons revealed that flexion with positively valenced targets ($M = 224$, $SD = 83.9$ ms) differed (paired, one-tailed), $t(47) = 2.4$, $p < .05$, from flexion with negatively valenced targets ($M = 242.5$, $SD = 96.2$ ms). Extension with negatively valenced targets ($M = 227.4$, $SD = 82.5$ ms) differed (paired, one-tailed), $t(47) = 1.7$, $p < .05$, also from extension with positively valenced targets ($M = 240.5$, $SD = 86.1$ ms). The Prime Valence × Target Valence interaction, $F(1, 47) = 4.2$, $p < .05$, $\eta^2 = .08$, indicated an affective priming effect (positive-positive: $M = 225.0$, $SD = 72.1$ ms; negative-negative: $M = 234.2$, $SD = 93.7$ ms; positive-negative: $M = 235.7$, $SD = 86.1$ ms; negative-positive: $M = 239.4$, $SD = 96.4$ ms). Planned comparisons revealed that both positively and negatively valenced targets that were preceded by positively valenced primes differed (paired, one-tailed), $t(47) = 2.2$, $p < .05$, reliably. However, targets did not differ when they were preceded by negatively valenced primes. In addition, we obtained an Action × Target Valence × Prime Valence interaction, $F(1, 47) = 15.6$, $p < .001$, $\eta^2 = .25$. This interaction is probably because of the fact that in flexion conditions with negative primes (and extension conditions with positive primes), initial facilitation by corresponding affective valences (i.e., affective priming) of prime and target was offset by the required incongruent action. In contrast, in flexion conditions with positive primes (and extension with negative primes), action and valence correspondence of primes and targets supported

Table 6
Means and Standard Deviations for Movement Times for Arm Flexion and Extension in Response to Affectively Valenced Targets in Experiment 3

	Flexion				Extension			
	Pos. prime		Neg. prime		Pos. prime		Neg. prime	
Condition	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Positive target	226.2	81.2	221.7	87.3	223.9	62.6	257.0	102.5
Negative target	228.4	84.3	256.5	105.9	243.0	88.1	211.8	74.1

Note. Pos. = positively valenced; Neg. = negatively valenced.

each other. No further main or interaction effects proved significant in this analysis for MT.

General Discussion

There was no influence of prime valence on arm flexion and extension. In contrast, for both reaction time measures in Experiment 3, we obtained faster responses for arm flexion with positively valenced targets than with negatively valenced targets, and for arm extension with negatively valenced targets than with positively valenced targets. Also, a sequential affective priming effect (Fazio et al., 1995; Hermans et al., 1994) occurred in the overall (i.e., irrespective of flexion or extension) responses to affectively valenced pictures. The latter effect constitutes strong evidence that the affective valence of the primes was actually processed and probably was processed automatically according to the reasoning of Bargh (Bargh et al., 1992; see also Fazio et al., 1986). This dissociation strongly suggests that only the former is automatic. Moreover, when attention was drawn to nonaffective features of valenced targets (see Experiment 2), we found no influence of affect on action tendency, in spite of some evidence that affect was actually processed. The link between automatic affective information processing and the initiation of action tendencies, at least when operationalized by arm flexion and extension, seems not necessarily unconscious and automatic, as defined by Chen and Bargh (1999), even when such processing was facilitated by the choice of affective stimuli (i.e., facial expressions of emotion; Öhman, 1986).

The experimental setup of our experiments was different from that of Solarz (1960), Chen and Bargh (1999), and Duckworth et al. (2002, Experiment 3), and we need to be careful in drawing strong conclusions. On the one hand, one cannot completely rule out the possibility that because of these differences in experimental setup, the automatic link between automatic affective evaluation and action tendencies for arm flexion and extension was absent. On the other hand, the similarity in patterns of results between our Experiments 1 and 3 (only for the targets) and those in the Solarz, Chen and Bargh, and Duckworth et al. studies strongly suggests that similar conceptual mechanisms were measured. If one accepts this argument, our conclusion that action tendencies for arm flexion and extension does not result automatically from automatic affective information processing is warranted. In line with this remark of caution, it should also be noted that our results were obtained with female participants only, and with facial expressions of emotion, and affectively valenced scenes as target stimuli. We have not yet obtained similar effects with word stimuli. However, there is no a priori reason to suspect that different results would be obtained with words.

Action tendencies for arm flexion and extension apparently do not result automatically from automatic affective information processing, but there is evidently a link. Cacioppo et al. (1993) suggested that this link entails probably a form of higher order Pavlovian conditioning (see also Neumann & Strack, 2000). Arm flexion is usually closely coupled in time (because of countless repetitions during an individual's lifetime) with the consumption of desired goods, whereas arm extension is temporally mostly coupled in time with the onset of unconditioned aversive stimuli. This explanation does not seem limited to arm flexion and extension, but applies also, according to Förster and Strack (1996), to head movements and affective information processing for instance. They found that participants who were induced to nod while encoding affectively valenced words in a recognition task were more likely to recognize positive words, whereas participants who were induced to shake their heads were more likely to recognize negative words. It should be noted that Cacioppo et al. sought an explanation for their attitudinal effects of arm movements and effects, whereas Chen and Bargh (1999), Duckworth et al. (2002), and Solarz (1960) measured differences in latency times because of affective information processing. Nonetheless, the suggested explanation by Cacioppo et al. for the link between positive affect and arm flexion and negative affect and arm extension seems to apply to both directions (see also Chen and Bargh, 1999), but should be investigated further.

Chen and Bargh (1999) acknowledged that although they assume a fully automatic link between affect and lever pulling (i.e., arm flexion) and pushing (i.e., extension), this link can be overruled accidentally by contextual factors for instance. They proposed that "it may be possible to generate quite different effects within the same paradigm" (p. 222). This argument seems to be underlined by Clore and Ortony (2000). They argued on the basis of an unpublished experiment by Brendl, cited in Clore and Ortony, 2000, that "when arm flexion can be interpreted as withdrawing one's hand from an object . . . , and when arm extension can be interpreted as reaching for the object" (p. 51), the opposite pattern of results (i.e., incongruent facilitation or congruent inhibition) can be obtained. They proposed,

> hence, it is the situated meaning of flexion and extension that is critical; the affective appraisals are manifested in the motivational realm as the desired end states of approaching or avoiding stimuli, rather than simply as triggers for distance-modulating behaviors (muscular flexion or extension). (Neumann & Strack, 1998, as cited in Clore & Ortony, 2000, p. 51)

The theoretical points of view of Chen and Bargh (1999) and Clore and Ortony (2000) differ in the importance of automatic information processing. Whereas Chen and Bargh proposed automatic affective evaluation as an adaptive back-up system with behavioral effects that (in the strong version of their argument) "are the status quo and are only occasionally overridden by conscious intervention" (p. 217), Clore and Ortony made no allowances for them, whatsoever. Clore and Ortony emphasized, in contrast, deliberation and conscious control in the affect–behavior link. Our results, primarily, seem to contradict the theoretical position of Chen and Bargh (1999) that automatic affective information processing could result automatically in action tendencies involving arm flexion and extension. We have established no direct evidence, however, for Clore and Ortony's hypothesis that it is the situated meaning, for instance, of arm flexion and extension that is important for the link between affect and action. Participants in our experiments were simply not aware of the situated meaning of arm flexion and extension. It seems rather plausible, though, that if action tendencies for arm flexion and extension depend on conscious appraisals, the situated meaning and context for these movements would be incorporated in these processes.

Action tendencies for arm flexion and extension do not necessarily represent all sorts of action tendencies related to affect. Simple generalizations of our conclusions to other behavioral consequences of affect should, therefore, be avoided. It could be argued that our conclusions apply to action tendencies for all behavior that is associated chronically (i.e., conditioned during lifetime, as proposed by Cacioppo et al., 1993; but see Förster & Strack, 1996) with affective information processing (e.g., postural movements, head nodding, and shaking). Other behavior such as facial muscle movement, for instance, probably has not only a deliberate but also an automatic link with affect, as may be derived from the long tradition of facial research within the domain of emotions (Darwin, 1872/1998; Ekman & Friesen, 1971). In fact, we previously obtained evidence that affective influences on facial muscles (corrugator and zygomaticus muscles) could be larger with suboptimal (i.e., less conscious) than optimal (i.e., fully conscious) presentation (Rotteveel et al., 2001; see also Dimberg et al., 2000). Besides this automatic link between affect and (covert) facial expressions, there is also evidence for an influence of social context on facial expressions (e.g., Hess, Banse, & Kappas, 1995). A fully automatic affect–behavior link (that can be modulated) thus cannot be excluded for all bodily movements, but does not seem to involve arm flexion and extension.

If the link between affective information processing and arm flexion and extension behavior could have been considered entirely automatic, the latter would have constituted an implicit measure of affect. Implicit dependent measures of affect are of interest mainly because they can reflect affective states without accompanying consciousness. Because consciousness sometimes inhibits (Murphy & Zajonc, 1993; Rotteveel et al., 2001; Rotteveel & Phaf, in press), or may even distort (Phaf & Wolters, 1997), affective processing, the availability of an implicit measure would be very helpful to gain further insight into the nonconscious (core) processes underlying emotions. Arm flexion and extension does not appear useful, however, as a pure implicit measure of affect. Arm flexion and extension as an affective response remains implicit in the weaker sense that participants are not fully aware of the link between affect and arm flexion and extension (e.g., between happiness and smiling), even when this response is caused by explicit deliberation. In this manner, arm flexion and extension may still be useful to establish dissociations between consciously mediated, but implicit, affective responses and consciously reported affective judgments (e.g., preference judgments). An example may be provided in Experiment 2 of Chen and Bargh (1999) or Duckworth et al.'s (2002) Experiment 3. Although participants were instructed only to push or pull the lever on mere stimulus presentation, they appeared to have evaluated the valenced targets consciously. Congruent movements were performed faster than incongruent movements in the absence of an explicit affective judgment task. This alone already represents a dissociation between implicit and explicit measures, but it is still possible that corresponding explicit judgments could be made. When further conscious processing inhibits or distorts these judgments, arm flexion and extension may still be useful for tapping affect.

The link between affect and arm flexion and extension appears to be largely dependent on deliberative and conscious information processing. This does not necessarily mean that all types of action tendencies are due to conscious affective evaluation. Initial activation of facial muscles, for instance, does not appear to depend necessarily on stimulus awareness in some conditions (Dimberg et al., 2000; Rotteveel et al., 2001). Also, the startle response (Lang et al., 1990) is probably linked immediately to affect and is widely used as an implicit measure of affect (e.g., in animal research). Only with respect to action tendencies concerning arm flexion and extension do we propose a dependence on conscious appraisals here, and further research will be needed to investigate the specific nature of this dependence for other types of action (e.g., head nodding and shaking, postural movements).

References

Allport, A. (1989). Visual attention. In M. I. Posner (Ed.), *Foundations of cognitive science* (pp. 631–682). Cambridge, MA: MIT Press.

Banse, R. (2001). Affective priming with liked and disliked persons: Prime visibility determines congruency and incongruency effects. *Cognition & Emotion, 15,* 501–520.

Bargh, J. A. (1994). The four horsemen of automaticity: Awareness, intention, efficiency, and control in social cognition. In R. S. Wyer & T. K. Srull (Eds.), *Handbook of social cognition* (2nd ed., Vol. 1, pp. 1–40). Hillsdale, NJ: Erlbaum.

Bargh, J. A. (1997). The automaticity of everyday life. In R. S. Wyer (Ed.), *Advances in social cognition* (Vol. 10, pp. 1–62). Mahwah, NJ: Erlbaum.

Bargh, J. A., Chaiken, S., Govender, R., & Pratto, F. (1992). The generality of the attitude activation effect. *Journal of Personality and Social Psychology, 62,* 893–912.

Bargh, J. A., Chaiken, S., Raymond, P., & Hymes, C. (1996). The automatic evaluation effect: Unconditionally automatic attitude activation with a pronunciation task. *Journal of Experimental Social Psychology, 32,* 104–128.

Bonarius, H. (2002). *Emotion, illusory movements, and action readiness.* Unpublished master's thesis, University of Amsterdam, the Netherlands.

Brainard, R. W., Irby, F. S., Fitts, P. M., & Alluisi, E. A. (1962). Some variables influencing the rate of gain of information. *Journal of Experimental Psychology, 63,* 105–110.

Cacioppo, J. T., Priester, J. R., & Berntson, G. G. (1993). Rudimentary determinants of attitudes. II: Arm flexion and extension have differential effects on attitudes. *Journal of Personality and Social Psychology, 65,* 5–17.

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., & Ortony, A. (2000). Cognition in emotion: Always, sometimes, or never? In R. D. Lane & L. Nadel (Eds.), *Cognitive neuroscience of emotion* (pp. 24–61). New York: Oxford University Press.

Critchley, H., Daly, E., Philips, 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.

Darwin, C. (1998). P. Ekman (Ed.). *The expression of the emotions in man and animals* (3rd ed.). New York: Oxford University Press. (Original work published 1872)

Davidson, R. J., Ekman, P., Saron, C. D., Senulis, J. A., & Friesen, W. V. (1990). Approach-withdrawal and cerebral asymmetry: I. Emotional expression and brain physiology. *Journal of Personality and Social Psychology, 58,* 330–341.

Dimberg, U., Thunberg, M., & Elmehed, K. (2000). Unconscious facial reactions to emotional facial expressions. *Psychological Science, 11,* 86–89.

Draine, S. C., & Greenwald, A. G. (1998). Replicable unconscious semantic priming. *Journal of Experimental Psychology: General, 127,* 286–303.

Duckworth, K. L., Bargh, J. A., Garcia, M., & Chaiken, S.

(2002). The automatic evaluation of novel stimuli. *Psychological Science, 13,* 513–519.

Ekman, P., & Friesen, W. V. (1971). Constants across culture in the face and emotion. *Journal of Personality and Social Psychology, 17,* 124–129.

Ekman, P., & Friesen, W. V. (1976). *Pictures of facial affect.* Palo Alto, CA: Consulting Psychologists Press.

Fazio, R. H., Jackson, J. R., Dunton, B. C., & Williams, C. J. (1995). Variability in automatic activation as an obtrusive measure of racial attitudes: A bona fide pipeline? *Journal of Personality and Social Psychology, 69,* 1013–1027.

Fazio, R. H., Sanbonmatsu, D. M., Powell, M. C., & Kardes, F. R. (1986). On the automatic activation of attitudes. *Journal of Personality and Social Psychology, 50,* 229–238.

Fitts, P. M. (1954). The information capacity of the human motor system in controlling the amplitude of movements. *Journal of Experimental Psychology, 47,* 381–391.

Fitts, P. M., & Peterson, J. R. (1964). Information capacity of discrete motor responses. *Journal of Experimental Psychology, 67,* 103–112.

Förster, J., & Strack, F. (1996). Influence of overt head movements on memory for valenced words: A case of conceptual–motor compatibility. *Journal of Personality and Social Psychology, 71,* 421–430.

Hermans, D., De Houwer, J., & Eelen, P. (1994). The affective priming effect: Automatic activation of evaluative information in memory. *Cognition & Emotion, 8,* 515–533.

Hess, U., Banse, R., & Kappas, A. (1995). The intensity of facial expression is determined by underlying affective state and social situation. *Journal of Personality and Social Psychology, 69,* 280–288.

Klauer, K. C., & Musch, J. (2001). Does sunshine prime loyal? Affective priming in the naming task. *The Quarterly Journal of Experimental Psychology, 54,* 727–751.

Klinger, M. R., Burton, P. C., & Pitts, G. S. (2000). Mechanisms of unconscious priming: I. Response competition, not spreading activation. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26,* 441–455.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1990). Emotion, attention, and the startle reflex. *Psychological Review, 97,* 377–395.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1995). *International Affective Picture System (IAPS): Technical manual and affective ratings.* Gainesville: University of Florida, The Center for Research in Psychophysiology.

Lang, P. J., Öhman, A., & Vaitl, D. (1988). *The International Affective Picture System* [Photographic slides]. Gainesville: University of Florida, The Center for Research in Psychophysiology.

LeDoux, J. E. (1996). *The emotional brain.* New York: Simon & Schuster.

Martinez, A. M., & Benavente, R. (1998). *The AR face database*. (CVC Tech. Rep. No. 24).

Matsumoto, D., & Ekman, P. (1988). *Japanese and Caucasian facial expressions of emotion* (JACFEE) [slides]. San Francisco: University of California, Human Interaction laboratory.

Morris, J. S., Friston, K. J., Büchel, C., Frith, C. D., Young, A. W., Calder, A. J., & Dolan, R. J. (1998). A neuromodulatory role for the human amygdala in processing emotional facial expressions. *Brain, 121,* 47–57.

Morris, J. S., Öhman, A., & Dolan, R. J. (1998, June). Conscious and unconscious emotional learning in the human amygdala. *Nature, 393,* 467–470.

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

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.

Neely, J. H. (1977). Semantic priming and retrieval from lexical memory: Roles of inhibitionless spreading activation and limited-capacity attention. *Journal of Experimental Psychology: General, 106,* 226–254.

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. 371–391). Mahwah, NJ: Erlbaum.

Neumann, R., & Strack, F. (2000). Approach and avoidance: The influence of proprioceptive and exteroceptive cues on encoding of affective information. *Journal of Personality and Social Psychology, 79,* 39–48.

Öhman, A. (1986). Face the beast and fear the face: Animal and social fears as prototypes for evolutionary analyses of emotion. *Psychophysiology, 23,* 123–145.

Ortony, A., & Turner, T. J. (1990). What's basic about basic emotions? *Psychological Review, 97,* 315–331.

Phaf, R. H., & Wolters, G. (1997). A constructivist and connectionist view on conscious and nonconscious processes. *Philosophical Psychology, 10,* 287–307.

Pratto, F., & John, O. P. (1991). Automatic vigilance: The attention-grabbing power of negative social information. *Journal of Personality and Social Psychology, 61,* 380–391.

Rotteveel, M., de Groot, P., Geutskens, A., & Phaf, R. H.

(2001). Stronger suboptimal than optimal affective priming? *Emotion, 1,* 348–364.

Rotteveel, M., & Phaf, R. H. (in press). Loading working memory enhances affective priming. *Psychonomic Bulletin & Review.*

Shiffrin, R. M., & Schneider, W. (1977). Controlled and automatic human information processing: II. Perceptual learning, automatic attending, and a general theory. *Psychological Review, 84,* 127–190.

Solarz, A. K. (1960). Latency of instrumental responses as a function of compatibility with the meaning of eliciting verbal signs. *Journal of Experimental Psychology, 59,* 239–245.

Sternberg, S. (1966, August). High-speed scanning in human memory. *Science, 153,* 652–654.

Taylor, S. E. (1991). Asymmetrical effects of positive and negative events: The mobilization–minimization hypothesis. *Psychological Bulletin, 110,* 67–85.

Wentura, D., Rothermund, K., & Bak, P. (2000). Automatic vigilance: The attention-grabbing power of approach- and avoidance-related social information. *Journal of Personality and Social Psychology, 78,* 1024–1037.

Received June 25, 2002
Revision received October 6, 2003
Accepted October 6, 2003 ■