

Preparing and Motivating Behavior Outside of Awareness

Henk Aarts,* Ruud Custers, Hans Marien

The observation that the mere activation of the idea of a behavioral act moves the human body without the person consciously deciding to take action has long been a topic of scientific interest (1–3). Initially, this ideomotor principle was used to explain extraordinary ac-

tion concept (5). Specifically, we investigated that activating the behavior representation of exertion through subliminal priming prepares the execution of the corresponding behavior and that this priming actually motivates effortful behavior when that representation is co-

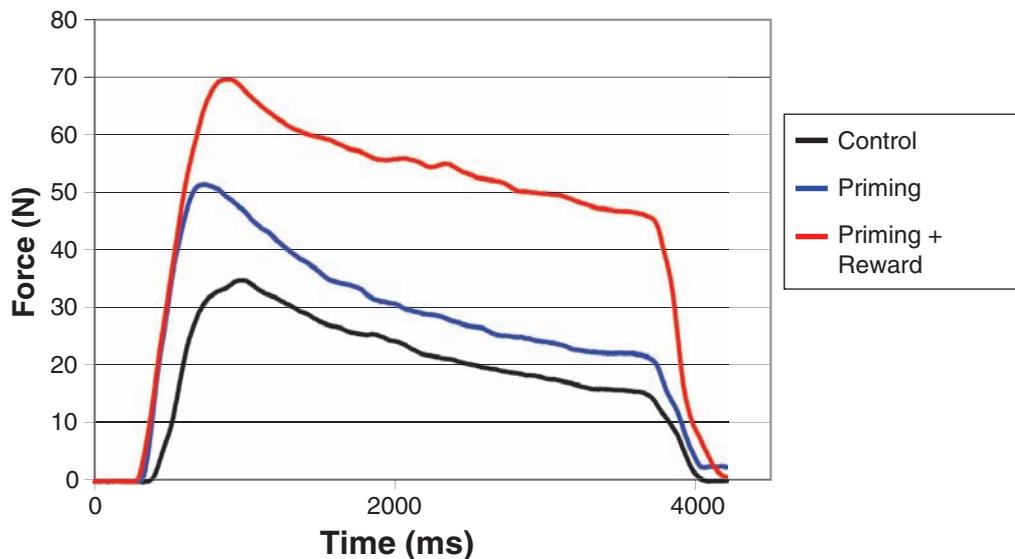


Fig. 1. Mean pattern of force over time as a function of the experimental treatments.

tivities such as compliance under hypnosis, automatic writing, dowsing, and swinging pendulums. Lately, research on social cognition and neuroscience has revealed that seeing or reading about a behavior available in the individual's repertoire increases the tendency to perform it, which has been interpreted as a result of the common code that action concepts share with motor programs. Whereas activating the mental representation of behavior outside of awareness—that is, subliminal priming—indeed prepares people to initiate rapidly the corresponding behavior, an important issue recently addressed is how such subliminal priming effects may acquire an intrinsic motivational property in the sense that people mobilize additional resources and actually spend effort on a task (4). We studied the emergence of such unconscious motivation by examining how subliminal priming of the action concept of physical exertion causes people to spend effort.

Building on research on the basic role of affective value in reward learning and motivation, we propose that the mechanism that turns subliminal priming of action concepts into motivation relies on the tagging of positive affect to the

activated with positively valenced stimuli that act as a reward signal. To test this, we subjected 42 participants to a priming task that enabled us to combine the subliminal priming of words representing exertion with briefly presented, although consciously visible positive words [Supporting Online Material (SOM) text]. Accordingly, three different conditions were created: a (control) condition in which only positive stimuli were presented, a (priming) condition in which exertion was subliminally primed but not directly paired with positive stimuli, and a (priming-plus-reward) condition in which exertion was subliminally primed and immediately linked to positive stimuli.

After the manipulations, we recorded handgrip force, which allowed us to differentiate between action preparation and motivation. Participants were instructed to squeeze a hand grip for 3.5 s when the word “squeeze” appeared on the screen. Results (Fig. 1) showed that participants in the priming and priming-plus-reward conditions started to squeeze earlier and increased their force faster than those in the control condition: The reaction time was shorter, and the initial

slope toward the maximal force (rate of increase in applied force) was steeper in these two priming conditions. This faster initiation of the response to squeeze the hand grip and the faster development of force indicate that acting forcefully was more strongly prepared (2). Crucially, participants in the priming-plus-reward condition displayed more total effort (mean force over time) than those in the other two conditions, showing enhanced motivation (fig. S1 presents the mean scores on the three measures for each cell in the design).

These results confirm that subliminally priming exertion prepares people to display forceful action, but when these subliminal primes are accompanied with a positive stimulus it motivates people to spend extra effort. Previous research on motivation agrees that positive affect acts as a motivator to engage in a task or behavior when it refers to a reward for performing the behavior, even if the reward is subliminally primed (6). We tested a more basic and content-free process by showing that such motivation also emerges when the activation of the behavior representation of exertion is directly accompanied by positive stimuli that do not explicitly pertain to the execution of the behavior itself but nevertheless act as reward signals. These effects occur even though participants were unaware of their contingency with the reward signals. This study thus demonstrates the human capacity to rely on mental processes in preparing and motivating behavior outside of awareness.

References and Notes

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Supporting Online Material

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Materials and Methods

Fig. S1

References and Notes

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Supporting Online Material

Method

Participants and Design.

Forty-two undergraduates of Utrecht University were randomly assigned to the cells of a 3 (control vs. priming vs. priming-plus-reward) between-participants design and received € 4 or course credits for their participation. Effects were tested with ANOVA according to this design.

Procedure and Materials.

Based on a pilot-study, five words were selected that clearly describe the concept of physical exertion (e.g., exert, vigorous). Also, we used five positive adjectives (e.g., good, pleasant) and 5 neutral adverbs (e.g., furthermore, around).

Participants worked in a soundproof cubicle in which the experiment was presented on a computer with a 100-Hz CRT screen, connected to a hand dynamometer of a Biopac™ system measuring handgrip-force.

Priming task. After practice with the equipment, the experiment started with a task designed to combine the subliminal priming of the concept of exertion with consciously visible positive stimuli (for combining subliminal with consciously visible stimuli, see e.g., *SI*). Subliminal presentation of the exertion primes was used for two important reasons. First, this procedure rules out the possibility of demand characteristics, because participants are unaware of the presented action-concept during the procedure. Second, changes in measures of behavior would provide evidence for nonconscious processes, as participants are unaware of the co-activation of the action-concept and positive affect. In this task, participants had to detect dots that were presented either above or below (positive and neutral) words briefly presented on the screen. This feature of the task ensured us that participants attend to the post-

masked subliminal primes. Participants practiced the task with unrelated stimuli words, and then worked on 50 experimental trials.

In these 50 trials, the five positive and five neutral words were all presented five times. In the *priming-plus-reward condition*, the five exertion words were each presented subliminally on five trials in direct combination with the five different positive words (25 trials), and five random letter strings were presented in combination with the five different neutral words (25 trials). In the *priming condition* the exertion words were paired with neutral words (25 trials), and the random letter strings were paired with positive words (25 trials). In a *control condition*, five random letter strings were paired with the five positive and five neutral words. Note that in each condition participants were exposed to neutral and positive words. The only difference was that the action-concept of exertion was either directly paired to positive affect (priming-plus-reward condition), primed but not directly linked to positive affect (priming condition), or not primed at all (control condition). The order of the 50 trials was randomized.

Each trial consisted of the following events: A random letter string (e.g., GBLPNSKR) presented for 1000 ms, signaling the beginning of the trial, immediately followed by the subliminal prime word - either exertion word or random letter string - that was displayed for 30 ms. After that, again a random letter string appeared for 100 ms (post-mask), followed by a consciously visible word - either a neutral or a positive word - that was presented for 150 ms. Occasionally, a dot was presented for 30 ms (not post-masked, hence consciously visible), either above or beneath the neutral or positive word. Participants indicated whether they had seen a dot or not, and 2500 ms later a new trial started (S2).

Handgrip-force task. Next, participants were told that they were participating in a study designed to examine the suitability of a new research instrument: the handgrip-force device. Accordingly, they were asked to squeeze the handgrip with their dominant hand when the

word “squeeze” appeared on the screen, and to stop squeezing when the word was erased (after 3500 ms). This task was repeated three times. Participants did not receive performance feedback. One participant was removed from the analysis due to a cramp during the task.

Participants were also asked to indicate how hard they tried to squeeze into the hand-grip. Crucially, no significant differences emerged, $F < 1$. This finding indicates that the subliminal priming of the concept of exertion did not lead to an increase in conscious awareness of exerting effort, thus supporting the claim that differences in behavior are due to largely nonconscious mental processes.

Supporting figure

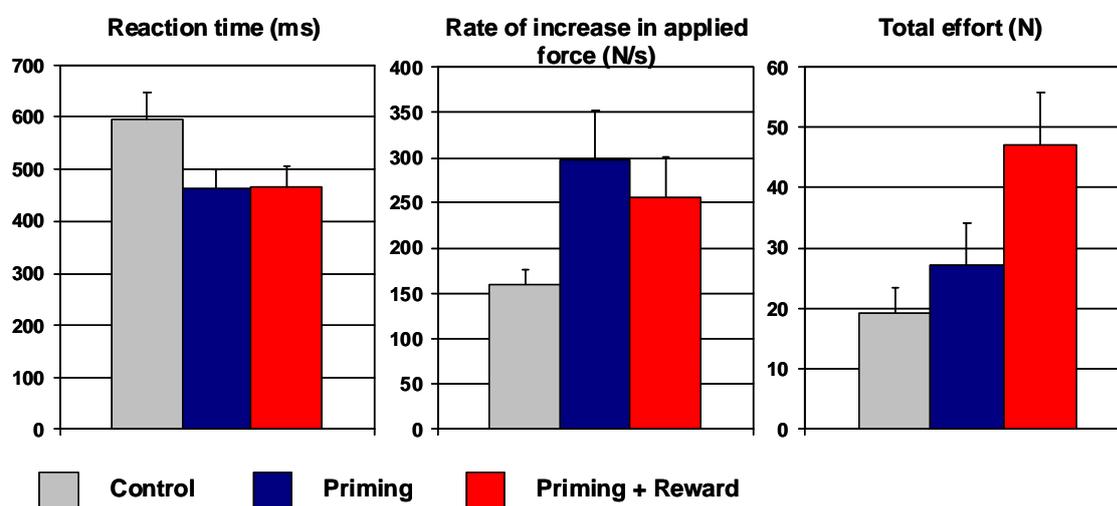


Fig. S1. Means for reaction time, rate of increase in applied force ($S3$), and total effort across the 3 handgrip trials. This figure shows that priming and priming-plus-reward produced shorter reaction times and larger rate of increase in applied force scores in comparison to the control condition. Importantly, only priming-plus-reward caused participants to employ more total effort. All critical F -tests are significant at $p = 0.05$. Error bars represent the standard error.

References and Notes supporting online materials

- S1. R. Custers, H. Aarts, *J. Pers. Soc. Psychol.* **89**, 129 (2005).
- S2. In an independent test of the conscious perception of the primed exertion words, an additional sample of student-participants (N=36) was subjected to the priming and priming-plus-reward treatments. Specifically, for each of the 50 trials participants were asked to indicate whether they saw a word related to physical exertion or not. The mean percentage of correct responses was 50.8 ($SD = 5.3$), which did not differ significantly from chance, $t < 1$. Furthermore, the two conditions did not differ as well, $t < 1$. In short, the post-masked subliminal primes of exertion were attended to but not reportable.
- S3. H. Forssberg et al. *Exp. Brain Res.* **90**, 393 (1992).