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How Does Facial Feedback Modulate Emotional Experience?

Joshua Ian Davis,
Barnard College of Columbia University

Ann Senghas, and
Barnard College of Columbia University

Kevin N. Ochsner
Columbia University

Abstract

Contracting muscles involved in facial expressions (e.g. smiling or frowning) can make emotions more intense, even when unaware one is modifying expression (e.g. Strack, Martin, & Stepper, 1988). However, it is unresolved whether and how inhibiting facial expressions might weaken emotional experience. In the present study, 142 participants watched positive and negative video clips while either inhibiting their facial expressions or not. When hypothesis awareness and effects of distraction were experimentally controlled, inhibiting facial expressions weakened some emotional experiences. These findings provide new insight into ways that inhibition of facial expression can affect emotional experience: the link is not dependent on experimental demand, lay theories about connections between expression and experience, or the distraction involved in inhibiting one's expressions.

Keywords

Affect; Emotion; Emotional Experience; Facial Expression; Facial Feedback; Embodied Emotion; Embodied Cognition; Non-verbal Communication; Expressive Inhibition; Expressive Suppression

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After a stressful day, have you ever become aware of just how tightly you were clenching your jaw, furrowing your brow, or squinting your eyes? Such facial expressions can show the world what we are feeling inside. They are, after all, the result of our emotional states. But is it possible that the reverse is also true – that our emotional states are the result of our facial expressions?

Historically, there has been great interest in this question (Darwin, 1872; Izard, 1971; Laird, 1984; Niedenthal, 2007; Tomkins, 1962). One of the first arguments that expressions influence emotional experience came from William James and Carl Lange. For James and Lange, the direct perception of a particular somatic state (visceral, postural, or facial), was the essence of what it meant to have a particular emotional experience (for review see Fehr & Stern, 1970; James, 1884, 1890, 1894; Lange, 1885/1912). Although the James-Lange theory pertained to expressions throughout the body in addition to facial expressions, their theory anticipated later work on the Facial Feedback Hypothesis (FFH) (Ekman, Levenson, & Friesen, 1983; Izard,

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Correspondence concerning this article should be addressed to Joshua Ian Davis, Department of Psychology, Barnard College of Columbia University, 3009 Broadway, Milbank Hall 415, New York, New York 10027. E-mail: jdavis@barnard.edu.

1971; Tomkins, 1962, 1963; Tourangeau & Ellsworth, 1979) that focused on facial expressions alone and their influence on emotional experience.

Different versions of the FFH make different claims about the relative importance of facial feedback in emotional experience. According to the *necessity hypothesis*, without facial feedback there can be no emotional experience (Keillor, Barrett, Crucian, Kortenkamp, & Heilman, 2002). Keillor et. al. studied a woman with total facial paralysis, who nevertheless demonstrated typical emotional responses to emotionally evocative photographs, effectively ruling out this hypothesis. According to the *sufficiency hypothesis* (e.g. Ekman et al., 1983), facial expressive muscle activity on its own can produce emotional experience. There has been support for this hypothesis; for example, directing people to contract muscles that are associated with facial expressions of emotion can be sufficient to elicit the associated emotions (Levenson & Ekman, 2002). Finally, the *modulation hypothesis* (e.g. Strack, Martin, & Stepper, 1988) holds that facial expression can modulate emotional experiences that have been elicited by some external stimulus, something other than one's own facial actions. It is this modulation hypothesis that is tested in the present study. In particular, we seek to address gaps in existing research that have left this hypothesis unresolved.

There have been two main approaches to examining how changes to facial expression can modulate emotional responses. The most well-studied approach asks participants to generate facial expressions, and records any resulting changes in self-reported emotional experience. This research is perhaps best exemplified by the now classic study by Strack, Martin, and Stepper (1988), which found that asking participants to generate smile-related expressions led them to report enhanced positive affect, whereas having them inhibit smile-related expressions by activating opposing muscles weakened positive affect. Strack et al.'s methods have since been replicated by other researchers, with similar results (e.g. Soussignan, 2002). Other research on how generating facial expressions can modulate emotional experience that is in response to stimuli tends to support these findings (for reviews see Adelman and Zajonc, 1989, Capella, 1993, Laird 1984, Matsumoto, 1987, McIntosh, 1996, and Soussignan, 2004). In general, smiling makes a person feel more positive, and frowning makes a person feel more negative.

A second approach examines the effects of inhibiting facial expression on emotional experience. This approach has been employed by only a handful of studies, in which participants view emotional stimuli and, rather than being asked to generate an expression, are instructed to keep a constant neutral expression on the face, and to not allow emotional expressions to appear. Although the FFH would predict that inhibiting facial expression should decrease the strength of emotional experience, results have been mixed. Studies have variously shown: a) a decrease in negative emotional experience when participants inhibited facial and bodily expressions (Duclos & Laird, 2001), b) a decrease in positive emotional experience when participants inhibited facial expression (Bush, Barr, McHugo, & Lanzetta, 1989), and, with inhibition of micro-expressive changes in facial expression, c) both a decrease in positive and a marginal decrease in negative emotional experience (McCanne & Anderson, 1987). Finally, although Strack et al. did not guide participants to hold a neutral expression, they did find lower positive affect when participants inhibited smile-related activity by activating opposing muscles (Strack et al., 1988).

The emotional effects of inhibiting facial expression also have been examined in experiments in which participants are instructed to suppress the expression of their emotions as a form of emotion regulation (Gross, 1998a). Although suppression studies direct participants to hide all behavioral expressions of emotion, and not just those on their faces, for present purposes they are informative because the face is likely the dominant channel of emotional expression (Darwin, 1872; Tomkins, 1962, 1963), especially in laboratory experiments. This implies that the expressions that are most inhibited in a suppression study are those that are on the face. To date, studies of suppression have focused primarily on inhibiting expressive responses to negative emotions, again with mixed results. Studies have variously shown: a) a decrease in the strength of various negative emotions for older, but not middle-aged and younger adults (Magai, Consedine, Krivoshekova, Kudadjie-Gyamfi, & McPherson, 2006), b) no effect on negative emotion (Gross, 1998b), c) a significant drop in negative emotion (Goldin, McRae, Ramel, & Gross, 2008), and, in two of only three studies that we are aware of to look at both positive and negative emotion, d) a decrease in positive but not negative emotional experience in one instance (Gross & Levenson, 1997), and no reported differences as compared to spontaneous expression in the other (Zuckerman, Klorman, Larrance, & Spiegel, 1981).

Taken together, this previous work is at least partly consistent with the idea that the inhibition of facial expression decreases the magnitude of emotional experience in response to emotional stimuli. However, at least four important questions remain about the effects of facial expression inhibition on experience that limit the strength of the conclusions that can be drawn from prior work.

First, there is the question of whether inhibition affects positive and negative emotions equally. To date, few studies have considered both positive and negative emotions in the same study. This leaves a critical gap in the logic of the argument, because considering positive or negative emotion alone cannot dissociate an increase or decrease in the strength of emotional experience from a general shift towards feeling more positive or more negative. For example, posing a frown might make one feel more negative, or it might simply disrupt or weaken any emotional experience, positive or negative. Although a few studies have included both positive and negative stimuli (Gross & Levenson, 1997; McCanne & Anderson, 1987; Zuckerman et al., 1981), they have not addressed each of the additional considerations listed below.

Second, there is the question of whether the documented effects of inhibition are indirectly the consequence of the distraction of devoting resources towards inhibiting facial expressions while also attempting to watch video clips or fill in questionnaires related to emotion. Extant experiments on inhibition report changes in emotional experience in terms of overall decreases in emotional experience, which could also be caused by distraction. Indeed, in research on the relative value of different emotion regulation strategies, participants asked to think distracting thoughts rather than ruminate on their depression or anger experienced less negative emotion as a result (e.g. Nolen-Hoeksema & Morrow, 1993; Rusting & Nolen-Hoeksema, 1998). Two studies have addressed the question of how distraction might compare to inhibiting facial expression in response to emotional stimuli (Duclos & Laird, 2001; Richards & Gross, 2006). Richards and Gross (2006) explicitly instructed participants to either distract themselves with “thoughts that have nothing to do with [an emotional video clip]” or to inhibit (specifically to suppress) their emotional expressions while watching video clips. They found that distraction reduced self-reported emotional experience, whereas expressive suppression did not (Richards & Gross, 2006). These data suggest that distraction and inhibition of expression are not identical. Duclos and Laird induced negative affect by having participants in two groups recall sad or angry life experiences. Each group was then asked to perform one of the following tasks: either to sort a deck of cards by suit and order (distraction), or inhibit their emotional expressions. Each group then switched to the other emotion and then performed the task they had not yet performed (distraction or inhibition). The authors found that both distraction and inhibition of expression decreased the strength of negative affect (Duclos & Laird, 2001). Although the reasons for these discrepant results are not immediately apparent, our point here is that these studies included only negative stimuli, and asked participants to inhibit not only their facial expressions but all behavioral manifestations of emotion. Thus, the relative effects of facial inhibition, *per se*, as opposed to distraction, on both positive and negative responses have not yet been examined. Furthermore, the type of attentional control required for facial inhibition is akin to that in a divided attention study in which participants must attend to perceptual stimuli while simultaneously attending to and controlling their facial expressions. This may be importantly different from simply shifting one's attention away from a stimulus, as was done in prior research.

The third question concerns participants' awareness of the experimental hypothesis. In the Strack et al. studies of posing facial expressions, as well as subsequent studies employing variants of those methods, a carefully constructed cover story was used to ensure that participants were not aware that the study pertained to facial expression or emotion. It was thus possible to attribute changes in emotional experience to facial feedback, and not to experimental demand or other effects on self-reports that might follow from participants' holding conscious expectations about how expression and experience should connect. Studies of facial inhibition have not emphasized cover stories to the same degree, however (e.g. Bush et al., 1989; Duclos & Laird, 2001; McCanne & Anderson, 1987). Furthermore, related studies of expressive suppression have explicitly instructed participants to "hide their emotions" so that others could not tell what the participant is feeling, an instruction that could engender expectancies in participants regarding how much their self-reported emotional experience should be independent of their facial expression. Thus, it is not yet clear whether the effects of facial inhibition on experience should be attributable to the lack of feedback *per se*.

A fourth and final question is whether participants who are instructed to inhibit their facial expressions engage in cognitive strategies – such as reappraisal of the stimulus as something less affectively potent – to make it easier to hold their faces still. While a handful of researchers have data that speak to this possibility (e.g. Goldin et al., 2008) it has not been addressed in the majority of work on the topic. The use of such strategies would be problematic, because any observed changes in experience could be attributable to the strategies rather than to changes in facial feedback.

Overview of the present study

The aims of this study were to examine the effects of inhibiting facial expression while (a) investigating both positive and negative emotion, (b) ensuring that participants were not aware of the study's interest in the connection between facial expression and emotional experience, (c) beginning to explore whether alternative cognitive strategies might be at play, and (d) providing a new control for the effects of distraction.

As a cover story, participants were told that we were monitoring brain-wave activity associated with memory and attention. They wore electrodes on their faces for this monitoring, and participants in the critical *no movement* group were told that they must not move at the location of the electrodes because movement would compromise the brain-wave data. We also buried the emotion-related questions within a majority of non-emotional filler questions, included as many neutral video clips as overtly emotional ones, and hid the video camera from view. Finally, we conducted a debriefing interview to determine to what degree participants had inferred that the study pertained to a connection between facial expression and emotional experience. At the end of this interview we also asked participants about the strategies they might have used to comply with the instructions they were given in the *no movement* condition, as some strategies may have relied on recognizing an expression-experience link. We predicted that even under these highly conservative circumstances, inhibiting facial expression (by not moving at the locations of the electrodes) would decrease the strength of emotional experience.

We also attempted to address the potential distraction involved in facial inhibition tasks. We required participants in our distraction condition to count backwards by threes while watching the video clip stimuli. This task was chosen because the distracting effects of arithmetic tasks such as counting backwards are well characterized in dual-task distraction research (e.g. Allen, Baddeley, & Hitch, 2006; Castel, Pratt, & Craik, 2003), and can be performed without directly interfering with the perception of the video or audio portions of the video clips.

Methods

Participants

Participants were 142 members of the Columbia University community, 90 female and 52 male, between the ages of 18 and 57 (M=22.2 yrs, SD =5.3 yrs). Participants were paid at a rate of $10/hour, or received class credit in an Introductory Psychology course. Participants were randomly assigned to one of four groups: (a) *No instructions* (control), (b) *no movement*, (c) *distraction*, and (d) *no instructions & no electrodes*. The groups were defined by the different instructions they were given following the cover story. The data from eight participants were not usable due to equipment malfunction, leaving 35 (M=23.5 yrs, SD=7.3 yrs, 19 female, 16 male) in the *no instructions* group, 34 (M=21.0 yrs, SD=3.6 yrs, 23 female, 11 male) in the *no movement* group, 33 (M=21.8 yrs, SD=4.1 yrs, 25 female, 8 male) in the *distraction* group, and 32 (M=22.3 yrs, SD=5.1 yrs, 18 female, 14 male) in the *no instructions & no electrodes* group.

Stimuli

The stimuli were four video clips, each between 2 and 3 minutes in length (M=2.3 mins), one positive, one negative, and two neutral. The positive video clip was a collection from the television program “America’s Funniest Home Videos,” depicting physical humor, such as a fluffy dog being pushed around like a mop. The negative video clip was composed of footage from the television show “Fear Factor,” depicting a man eating a live-worm sausage. One neutral video clip contained segments from a documentary on Jackson Pollock, and a second neutral video clip was a selection from a documentary entitled “The Way Things Go,” depicting a Rube Goldberg-like chain reaction. Informal pre-testing suggested that it was difficult to select a truly neutral video clip that elicited no emotional responses whatsoever. Seeking comparatively neutral video clips so that participants would not solely be responding to strongly emotional stimuli, we selected mildly positive clips to use in our ‘neutral’ conditions. The neutral clips were included as one means of suggesting to participants that the study did not pertain directly or entirely to emotional experience. The inclusion of these clips also provided additional film clips for which the primary hypotheses could be tested. The video clips were presented on a screen area of approximately 4.5″×6″. Viewing distance was 18 to 24 inches.

Procedures

Group instructions—All participants in the *no instructions*, *no movement*, and *distraction* groups were told that we would be monitoring brain-wave activity related to memory and attention. They were informed that an experimenter would be placing recording electrodes on various locations on their heads in order to monitor brain-wave activity. The experimenter indicated the locations on his or her own face, pointing to the forehead, the area between and just above the eyebrows, the area around the outside of the eyes, and the cheeks. Because participants in the *no instructions & no electrodes group* did not wear electrodes, they were not told that we were monitoring brain-wave activity, but were informed that we were interested in memory and attention. All participants were informed that they were part of a control group in a research study about the effects of general anesthesia on memory and attention. The notion that they were in a control group was meant to further limit the degree to which they were likely to search for ways in which the experimental procedures might be affecting their responses. Participants were then instructed in the procedures for watching the video clips and answering questions on the computer.

Participants in the *no movement* and *distraction* groups then received additional instructions. Participants in the *no movement* group were told that movement of the muscles under the recording disks could interfere with the brain-wave signal and render the data useless. For this reason, they were told they must keep from moving the muscles near the recording disks during the video clips, as that is the time during which we were most concerned about brain-wave activity pertaining to attention and encoding of memories. They could move as they liked between clips.

Participants in the *distraction* group were told that they would be asked to count backwards by threes throughout the duration of each video clip. They would be given a random number between 500 and 1000 at the start of each video clip, and asked to count, for example, down to 997, 994, and so on, and to finally provide the number to which they arrived at the end of the video clip. To guide participants to continue performing the distracting task, participants were instructed to start over from the original given number should they lose track of what number they had counted to.

Following these instructions, participants were seated in front of the stimulus presentation computer, and the facial electrodes (depending on condition) were attached. Finally, they were instructed that we had a large number of stimuli and that the computer randomly picked four or five from among them depending on the time allotted for each participant's session. This was meant to further limit the degree to which participants might search for themes, such as emotional relevance, among the video clips.

Electrode placement—Using a method similar to that used by Bush et al. (1989), dummy electrodes were placed on the faces of all participants (excepting those in the *no instructions & no electrodes* group), and participants were told that these were the electrodes through which we were monitoring brain-wave activity. For the purposes of this study, it was important that the locations of the electrodes be over key muscle groups whose activity has been correlated with emotional experience (Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000; Ekman, Friesen, & Ancoli, 2001). These muscle groups included the zygomatic muscles (smiling), the orbicularis oculi (laugh lines), the corrugator supercilii (frowning, furrowing the brow), and the frontalis (raising the brow). Locating the appropriate placement for the electrodes was done according to Fridlund and Cacioppo (1986).

Following dummy facial electrode placement, participants were reminded of the cover story and the specific instructions for their group, as well as of the instructions for use of the computer. Participants in the *no movement* group were also "shown" the effects of moving one of the wires attached to the electrodes on a recording of what participants had been led to believe was brain-wave activity, to convince them that the brain-wave signal could be easily overwhelmed with movement.

Stimulus presentation order—A neutral video clip always came first, in order to: (a) allow participants to become familiar with the types of questions they would answer and their format; (b) allow participants to become accustomed to having electrodes on their face; and (c) give a first impression that the study was not about emotion. For these reasons the data for this first neutral video clip, which was the same video clip for all participants ("The Way Things Go"), were not analyzed. However, participants were led to believe that this first video clip was no different from the others.

Self-report measures—After each video clip, participants completed a series of self-report measures, a majority of which were non-emotional filler questions, and one of which was to provide ratings of emotional experience as a result of the video on the dimension of *valence* (how positive or negative a person felt). They responded on a nine point Likert scale from −4 to 4, anchored with “Very negative” at −4, “Neutral” at 0, and “Very positive” at 4.

Following the self-ratings, participants were asked to speak aloud into a microphone for approximately one minute and to relate as much as they could remember. They were told that this free-recall question was one of our primary memory questions.

Distracter tasks—Following the self-report and spoken responses, participants completed word and math puzzles intended to reduce emotional carryover from one stimulus to the next. These included simple to moderate difficulty arithmetic problems and fill-in-the-blank word puzzles. These tasks had the further effect, as we later confirmed from our participants, of helping to lead many of them to believe that the study pertained to something other than emotion.

Iterations—After completing the distracter tasks following the first video clip, participants then watched the next video clip, completed the self-report questions, the spoken memory question, and the distracter tasks, repeating the process for each of the three remaining video clips (one negative, one neutral, and one positive), whose order was counterbalanced within and between groups. Timing was self-paced at each stage. Participants were reminded of their specific group instructions prior to beginning each video clip. (See Figure 1 for an illustration of the methods).

Debriefing interview—Following the distracter tasks after the final (fourth) video clip, participants completed a series of questions regarding their beliefs about the study that were modeled after the “funnel” debriefing interviews conducted by Bargh and colleagues (Bargh, Chen, & Burrows, 1996). Participants were not explicitly given the hypothesis during this period; they were only asked about what they already believed. For this debriefing interview, the computer prompted participants to answer seven successive questions that progressively hinted at the hypothesis and encouraged participants to figure it out. Questions began as open-ended regarding the experiment, and later encouraged participants to find themes, to report on what they believed the study was about, and to search for potential alternative hypotheses besides what had been explained by the experimenters. Participants were scored according to the question at which two independent judges, who were blind to experimental condition, determined that the participant guessed that the study pertained to facial expression and/or to emotional experience. So as to have a conservative bias when scoring responses for hypothesis awareness, participants did not need to reveal that they had understood that the study pertained to the connection between facial expression and emotional experience, but simply that they suspected that the study’s goals might pertain to each topic in some way.

Three participants were identified, by at least one of the two judges, as having guessed that the hypotheses pertained in some way to both facial expression and emotional experience. Those three participants were excluded from all subsequent analyses. Debriefing interview data were not available for one participant, who was treated neither as having guessed the hypothesis, nor as having never guessed it. That participant’s data, however, were later excluded due to failure to comply with instructions as determined by the manipulation check (described below). Inter-rater reliability coefficients between the two judges were r = .576 regarding “at what question participants guessed that the hypothesis pertained to emotion,” and r = .661 regarding “at what question they guessed that the hypothesis pertained to facial expression.” One judge reported that 37 percent did not ever guess (a score of eight) that the study pertained to emotion even when asked to search for alternative purposes for the study besides memory and attention, and 85 percent never guessed it pertained to facial expression. The second judge reported 36 percent and 91 percent, respectively.

Strategies used—Participants in the *no movement* condition were asked at the completion of the debriefing interview to offer percentages representing the degree to which they felt that they used each of several strategies to keep the face from moving. The strategies that were probed were derived from the common themes that emerged in free reports during pilot testing. These included physical restriction (I just kept my muscles from moving), reappraisal (I changed the impact of what I was watching by reframing it as something else; for example, I reminded myself that this is only television and television can be fake), and distraction (I thought about something else so that I wouldn't be thinking about what I was watching). Participants could also specify strategies not listed.

In order to be able to treat all four groups equally during the video clip watching and debriefing phases of the study, additional questions that pertained only to specific groups were held until after the interviews. Participants who had been given a second task (*no movement* and *distraction* participants) were asked at this point to rate how distracting their task was. Ratings were made for each video clip individually. Participants were prompted to respond regarding the first video clip they saw, then the second, and so on. Distraction ratings were not completed by four participants (two from the *no movement* and two from the *distraction* groups).

Video Coding

Because a visible camera might have caused participants to become self-conscious of their facial expressions, and how they were coming across to an observer, the camera was hidden from view. Of course, all participants consented at the outset of the study to be videotaped, and likely expected to be videotaped at some point during the study. However, they were not told that the videotaping would take place specifically while they were watching the video clips.

We coded amount of expression. A trained judge, blind to the experimental hypothesis and to participant condition, coded the videos. The judge made ratings of expression with sliding knobs that sent continuous output in the form of a changing voltage signal, with end points representing a range from *no expression* to *a lot of expression*. The continuously changing voltage values were recorded on a BIOPAC Systems MP150 module. The integral of the area under the curve produced by this continuous recording provided a measure, in units of Volts × Seconds, of the amount of overall expression shown during the video clip. All ratings were made with the sound off so as to ensure that the soundtrack of the video clip could not be used to determine whether the participants were watching a negative, neutral, or positive video clip. The judge instructions were to code only what was visible on the screen, and not to attempt to infer what the participant was feeling. Rather than instruct the judge to search for particular muscle movements, we asked that he code any visible expressions that could be considered a positive or negative expression. Our measure was thus a sum of amounts of positive and negative expression. Prior to beginning, he was coached regarding how to use the equipment by allowing him to practice with a full range of photographs that had been edited to form a continuum from neutral to either strongly negative expressions or strongly positive expressions.[1]

To provide inter-rater reliability, a second judge coded 30% of the video clips. We computed z-scores for each judge to account for differential use of the scales. Inter-rater reliability for

[1]This coding method was chosen over alternatives, such as FACS (Ekman & Friesen, 1978) that focus on micro-expressive changes, for two reasons. First, although methods such as FACS are very good for picking up micro-expressions, simpler methods of coding expression have proved useful in this type of work (see e.g. Gross & Levenson, 1993, 1997), and the question of how micro-expressions interact with emotional experience is beyond the scope of this study. Secondly, the type of expressions that we were intending to investigate were the everyday expressions that people make. For such expressions, another socially capable person must be able to detect them if they are to be considered effectively expressive.

amount of expression was then calculated two ways. Pearson's r=.805, and the intraclass correlation was .782 (King, 2004).

Eight of our video recordings were not usable for coding, due either to equipment failure or participants' inadvertently blocking a clear view of their faces by turning their heads, or leaning their faces in their hands. One of those eight, a participant in the *no movement* group, did have usable video for both the positive and negative video clips, but not the neutral video clip; that participant's videos could be evaluated using the manipulation check described below.

Manipulation Check

Participants in the *no movement* condition who showed facial expressions that were indistinguishable from an average member of the *no instructions* group were considered to have not followed instructions to refrain from moving. The 95 percent confidence interval for the *no instructions* group was used as the criterion for whether a participant in the *no movement* group was indistinguishable from those in the *no instructions* group. Because the manipulation involved refraining from any movement, we compared participants on our measure of overall amount of expression. Eight participants were found not to have followed instructions by these criteria and their data were excluded from all subsequent analyses. Of these eight, three were excluded due to expressing excessively in response to the negative video clip, two in response to the positive video clip, and three in response to both the negative and the positive video clips. Conservatively (that is, potentially increasing the noise in the data), the two participants in the *no movement* group whose video was unusable for the manipulation check were treated as though they had followed instructions, and included in all analyses.

Results

Self-Report

In order to compare valence scores for all three video clips on a single metric, the scores for the negative video clip were multiplied by negative one. This made the group means positive for all video clips, and created a scale representing strength of emotional experience, whether positive or negative, with higher values indicating stronger emotional experience. A 4 (Group) × 3 (Video clip) mixed design omnibus analysis of variance (ANOVA) revealed a significant main effect of Video clip, $F(2,238) = 13.981$, $p<.001$, *partial* η^2=.105.

A linear contrast of the *no movement* group vs. the other three groups combined yielded a significant main effect in which the *no movement* group reported weaker emotions than the other groups, $F(1,119)=4.704$, $p=.032$, $d=.501$. This contrast was significant at both the negative, $F(1,119)=18.801$, $p<.001$, $d=1.003$, and neutral video clips, $F(1,119)=6.122$, $p=.015$, $d=.572$, but was not significant at the positive video clip.

Our principle hypothesis concerned the comparison of the *no movement* group with the *no instructions* group. In that contrast, the *no movement* group reported significantly weaker emotional experience than did the *no instructions* group, $F(1,119)=5.979$, $p=.016$, $d=.657$ (see Figure 2 and Table 1). Additional planned contrasts at each level of video clip compared affect ratings for the *no movement* and *no instructions* groups. These analyses revealed significantly weaker emotional experience for the *no movement* group for the negative video clip, $F(1,56)=4.330$, $p=.040$, $d=.559$, and marginally significantly weaker emotional experience for the *no movement* group for the neutral video clip, $F(1,56)=3.701$, $p=.057$, $d=.516$, along with a non-significant trend in the same direction for the positive video clip. Note that when including the eight participants who did not follow instructions, the difference between the *no movement* and *no instructions* groups was still significant, $p=.050$. Also note that when the two participants from the *no movement* group who had no video that could be evaluated in the manipulation check were removed from the analysis, this effect of Group was still significant, p=.026. Similarly, when all participants from all groups who were missing video data were removed from the analysis, this effect was again still significant, p=.027.

The no movement group did not significantly differ from the *distraction* group or the *no movement & no electrodes* group. Contrasts at each level of video clip, revealed that the *no movement* group reported marginally weaker emotion in response to the negative video clip than did the *distraction* group, $F(1,54)=3.465$, $p=.065$, $d=.506$.

Omnibus 2 (Group) × 3 (Video clip) ANOVAs were also conducted on self-ratings of distraction, producing a significant main effect of Group, $F(1,50)= 19.070$, $p<.001$, $d=1.234$, as well as a main effect of Video clip, $F(2,100)= 3.446$, $p=.036$, *partial* $\eta^2=.064$ (see Table 1). The *no movement* group rated their task as less distracting than did those in the *distraction* group. Planned group contrasts at each level of Video clip revealed that the *no movement* group was significantly less distracted than the *distraction* group for the negative, $F(1,50)=5.749$, $p=.020$, $d=.678$, and the neutral video clips, $F(1,50)=21.916$, $p<.001$, $d=1.323$, and showed a non-significant trend in the same direction for the positive video clip.

Strategies Used

Participants in the *no movement* group reported a mean of 74.4 percent use of physical restriction, 5.0 percent distraction, 7.2 percent reappraisal, and 13.3 percent other in an effort to refrain from moving. Looking at each participant individually, we found that 90.5 percent of those in the *no movement* group reported that they used physical restriction at least half of the time. Two participants did not provide strategy estimates adding to 100 percent, and were therefore treated as not having provided strategy estimates.

Video Coding

The data for amount of expression were subjected to a 4 (Group) by 3 (Video clip) omnibus mixed design ANOVA. There was a main effect of Video clip, $F(2,224)=34.972$, $p<.001$, *partial* $\eta^2=.238$, of Group, $F(3,112)=6.731$, $p<.001$, *partial* $\eta^2=.153$, and of the interaction of Video clip by Group, $F(6,224)=5.064$, $p<.001$, *partial* $\eta^2=.119$. Planned group comparisons, conducted to check that the *no movement* group produced less expression than the other groups, revealed that the *no movement* group showed less expression than the *no instructions* group, $F(1,112) = 9.031$, $p=.003$, $d=.839$, the *distraction* group, $F(1,112) = 9.889$, $p=.002$, $d=.883$, and the *no instructions & no electrodes* group, $F(1,112) = 19.773$, $p<.001$, $d=1.265$. Inspection of the means suggests that the interaction was due to substantial differences between the groups during the negative and positive video clips, but not during the neutral. Indeed, significant simple main effects of Group were seen for the negative, $F(3,112)=8.865$, $p<.001$, *partial* $\eta^2=.192$, and positive video clips, $F(3,112)=4.553$, $p=.005$, *partial* $\eta^2=.109$, but not for the neutral video clip.

Discussion

This study sought to examine whether inhibiting facial expression influences emotional experience, particularly when participants are unaware that their facial expressions are being manipulated. Moreover, we sought to examine this relationship while controlling for the potential role of distraction due to a cognitively demanding secondary task. Overall, we found that *no movement* instructions, to inhibit facial expression, led participants to both show less emotion on their faces and to experience weaker emotions, whereas *distraction* instructions did not. This pattern held more clearly for our negative and neutral video clips, but was less clear for our positive video clip. Importantly, post-test debriefings and questionnaires indicated that participants were not aware of the experimental hypothesis, and that by a substantial margin, when asked to inhibit their expressions, participants reported attempting to physically keep their faces still rather than using some other type of regulatory strategy.

Limitations

Taken together, these results suggest that inhibiting facial expressions weakens at least some emotional experiences. In particular, this influence was most robust for the negative video clip, and less so for the neutral video clip - which itself elicited mild positive emotions. In response to our positive video clip, there were no significant differences between any of the groups. However, non-significant trends were seen in which inhibiting facial expression led to a slight decrease relative to the *no instructions* control group, but a slight increase as compared to both the *distraction* and the *no instructions & no electrodes* groups. Additional research is warranted examining whether the effects of inhibition of facial expression on emotional experience depends on the type or intensity of the emotion examined.

The different patterns found for the *no movement* and *distraction* groups are intriguing findings, as we might have expected a significant decrement in emotional experience as a result of the *distraction* instructions. The failure to find such an effect may suggest that, in at least some circumstances, a verbal secondary task does not interfere with emotional responses elicited by visual-auditory stimuli, even if it does demand attentional resources. In contrast, the *no movement* task specifically does interfere with the processing of at least some emotions, suggesting that processing of the type of information (e.g. verbal, visual, interoceptive, etc.) interfered with by the *no movement* instruction was integral to eliciting emotional responses. Testing the boundaries of this hypothesis would be an interesting direction for future research.

A second caveat in the interpretation of this study is that the non-significant results for the valence measure in the *distraction* condition might lead some readers to wonder whether participants were not fully engaging in the task of counting backwards. This seems unlikely, however, because the task for the *distraction* group was rated as more distracting than the task for the *no movement* group.

Conclusions & Future Directions

The research presented here provides some evidence in favor of the hypothesis that changing one's facial expressions, in particular, inhibiting one's facial expressions, can influence one's emotional experience. However, this study raises at least three additional questions about the expression-experience connection that might be addressed in future work.

First, there is the issue of how well the present findings will generalize to other situations in which one might want to regulate emotion, aside from the class of situations tested. The present study examined participants' emotional response to external stimuli, when they inhibited their facial expression as their emotional experience was developing. There may be different effects of inhibiting facial expression, for example, when changes to one's facial expressions are attempted after one is already in an affective state, or when the emotion-eliciting stimulus is internally generated (Duclos & Laird, 2001). Addressing these alternatives will help to characterize the value of inhibiting facial expression for purposes of emotion regulation.

Second, one could explore further the role of participants' expectations regarding facial manipulations and how they might affect emotional experience. For example, researchers could explicitly provide a group of participants with a hypothesis about the effect of expressions, and investigate how doing so influences their emotional experience. Rather than probing whether facial expression, *per se*, can influence emotional experience, even when participants are unaware of the hypothesis, researchers could examine what happens when participants are driven towards specific beliefs regarding the process. This would further illuminate the roles cognitive processes may play in the link between expression and emotional experience.

Third, several alternative mechanisms may be at play, such as potential differences in effort, familiarity, or cultural display rules pertaining to posing or inhibiting the various facial expressions pertinent to the conditions of these studies (Levenson & Ekman, 2002; Matsumoto, 2006). Future research can help to build on the present findings by examining whether, when, and how each of these variables might play a part.

On the whole, the present study lends support to William James and others who argued that expressions can influence emotional experience, and are not exclusively products of it. This work builds on the existing literature on the inhibition of facial expression by addressing gaps that have previously limited the interpretation of results. Until now, shifts in valence have been conflated with reductions in the magnitude of emotional experience, distraction has not been satisfactorily controlled, participants' alternative strategies were not typically considered, and, participants may have been aware of the hypothesized effect of their own expressions. With all of these factors controlled in the present study, an impact of emotional expressions on at least some emotional experiences seems difficult to dispute.

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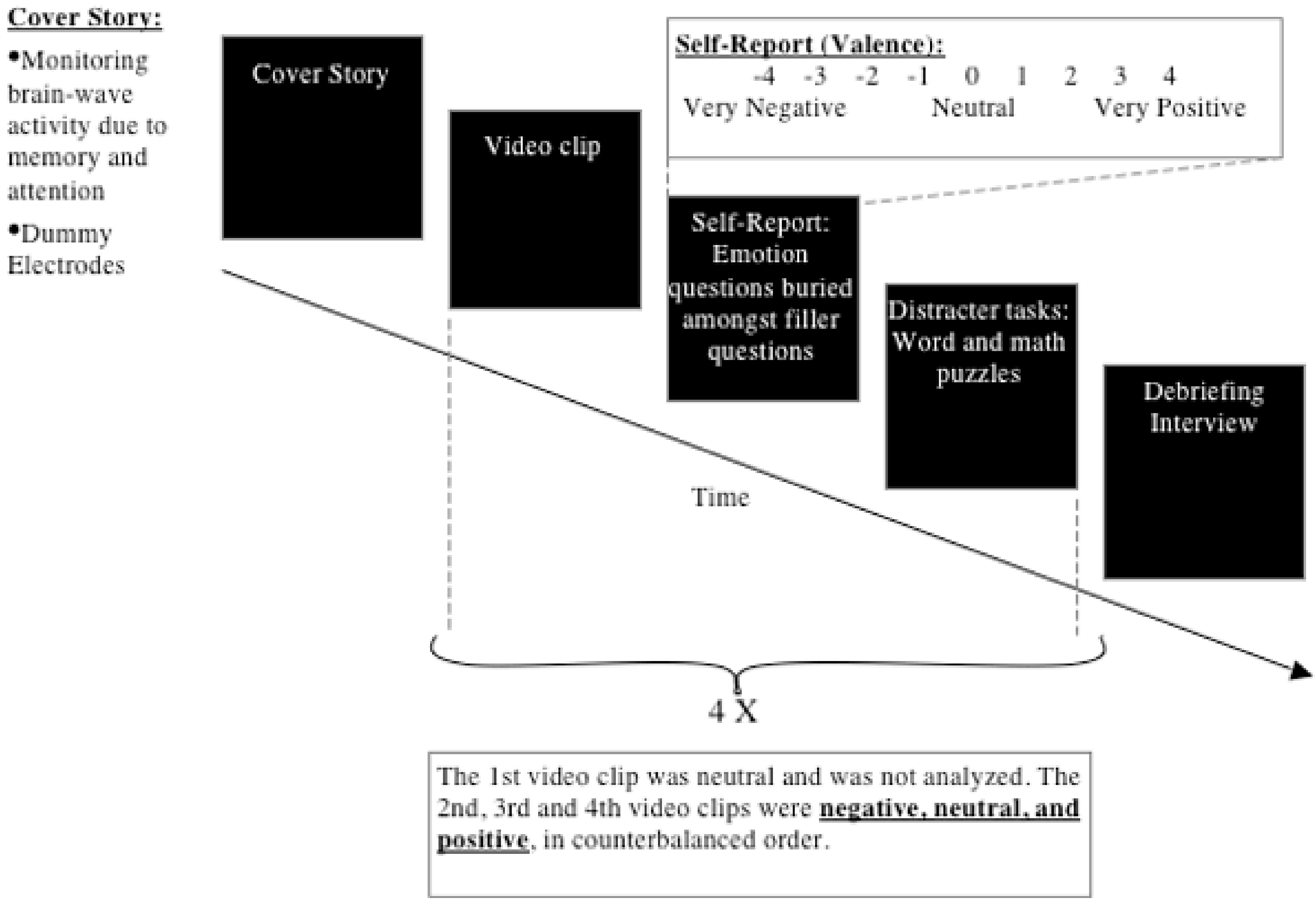

Figure 1.
Graphical depiction of methods.

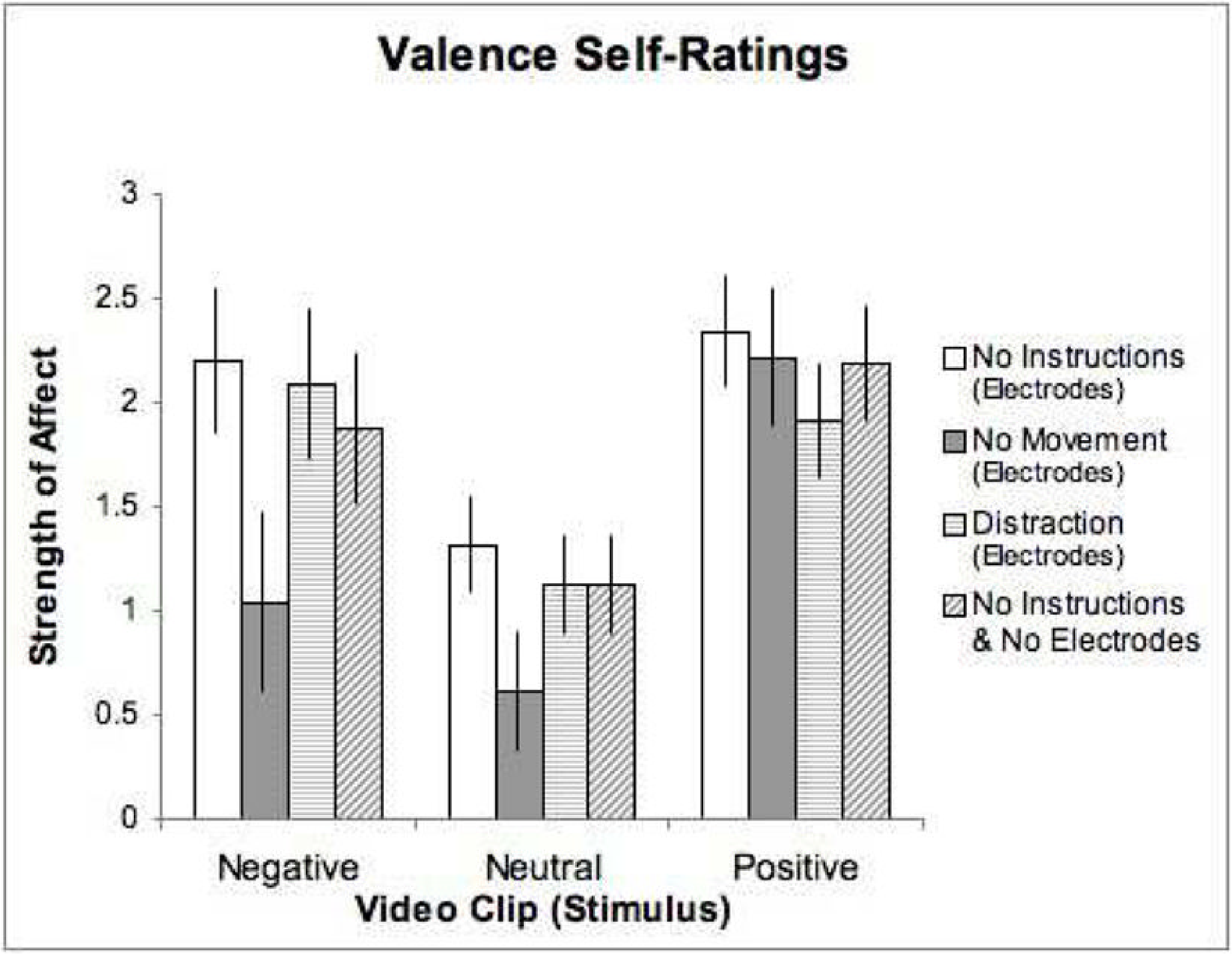

Figure 2.

Average self-reported strength of emotional experience. Valence scores (how positive or negative a person felt) for the negative video clip were multiplied by −1 in order to place all video clips on the same scale, and therefore be able to test for the hypothesized main effect of an overall reduction in the strength of emotional experience.

Table 1

Means and (SE) for Dependent Measures

	Negative				Neutral				Positive			
	No Instructions	No Movement	Distraction	No Instr. & No electrodes	No Instructions	No Movement	Distraction	No Instr. & No electrodes	No Instructions	No Movement	Distraction	No Instr. & No electrodes
Self-Report												
Valence	2.20 (.35)	1.04 (.43)	2.09 (.36)	1.88 (.37)	1.31 (.23)	.61 (.29)	1.12 (.24)	1.13 (.24)	2.34 (.27)	2.22 (.33)	1.91 (.28)	2.19 (.28)
Distraction		3.43 (.52)	5.03 (.43)			2.14 (.49)	5.10 (.40)			4.24 (.54)	5.32 (.45)	
Video Coding												
Expression	16.47 (5.00)	1.62 (6.26)	32.70 (5.07)	39.39 (5.24)	1.15 (1.01)	0.64 (1.26)	2.52 (1.02)	2.74 (1.06)	40.95 (7.15)	4.42 (8.97)	26.09 (7.26)	42.82 (7.50)

Note. Self-Report measures are derived from 9 point Likert Scales (Valence ranging from −4 to 4, Distraction from 0 to 8). Valence scores for the negative video clip are multiplied by minus 1 so as to put them on the same scale as valence scores for the other video clips and create a measure of the strength of the emotional experience. Expression units are volts × seconds.