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Further evidence for mixed emotions

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Abstract

Emotion theorists have long debated whether valence, which ranges from pleasant to unpleasant states, is an irreducible aspect of the experience of emotion, or whether positivity and negativity are separable in experience. If valence is irreducible, it follows that people cannot feel happy and sad at the same time. Conversely, if positivity and negativity are separable, people may be able to experience such mixed emotions. The authors tested several alternative interpretations for prior evidence that happiness and sadness can co-occur in bittersweet situations (i.e., those containing both pleasant and unpleasant aspects). One alternative interpretation is that subjects who reported mixed emotions merely vacillated between happiness and sadness. The authors tested this hypothesis in Studies 1-3 by asking subjects to complete online continuous measures of happiness and sadness. Subjects reported more simultaneously mixed emotions during a bittersweet film clip than during a control clip. Another alternative interpretation is that subjects in earlier studies only reported mixed emotions because they were explicitly asked whether they felt happy and sad. The authors tested this hypothesis in Studies 4-6 with open-ended measures of emotion. Subjects were more likely to report mixed emotions after the bittersweet clip than the control clip. Both patterns occurred even when subjects were told that they were not expected to report mixed emotions (Studies 2 & 5) and among subjects who did not previously believe that people could simultaneously feel happy and sad (Studies 3 & 6). These results provide further evidence that positivity and negativity are separable in experience.

Keywords: mixed emotions, mixed feelings, ambivalence, bittersweet, circumplex

Further evidence for mixed emotions

Can people feel happy and sad at the same time? If the experience of valence is analogous to the experience of temperature, the answer is no. Imagine a room heated by a heater running at maximum capacity and cooled by an air conditioner running at half capacity (Green, Salovey, & Truax, 1999). If the air flowing from the heater and air conditioner have ample opportunity to mix together, how would the room's occupants feel? Would they feel extremely warm and moderately cold? No. Just as if the heater was running at half capacity and the air conditioner was off, they would feel moderately warm and not at all cold (see Schimmack, 2001). This is because the experience of temperature is irreducible. In other words, the experiences of warm and cold are inseparable such that feelings of warmth preclude feelings of cold and vice versa. A long line of scholars has argued that positivity and negativity are also inseparable in experience and that emotional valence is irreducible (Barrett, 2006; Barrett & Bliss-Moreau, 2009; Bain, 1859; Russell & Carroll, 1999; Titchener, 1908; Wundt, 1896). Bain (1859), for instance, conceptualized pleasure and displeasure as being so antagonistic that, "the presence of the one destroys the property of the other, as an acid neutralizes an alkali [i.e., base]" (Bain, 1859; p. 441) and Barrett has conceptualized valence as a "basic building block" of emotional experience (Barrett, 2006; p. 36). By such accounts, people cannot feel happy and sad at the same time (Barrett & Bliss-Moreau, 2009; Russell & Carroll, 1999), even if the events affecting their emotional state have both pleasant and unpleasant aspects (Russell, 2003). On the other hand, Socrates argued in Plato's *Philebus* that the experience of positivity is separable from that of negativity. Hume (1739/2000), Ebbinghaus (1902; cited in Wolgemuth, 1919), and Cacioppo and Berntson (1994) have taken similar positions. This line of thinking raises the possibility that people can feel mixed emotions of happiness and sadness at the same time.

To the extent that mixed emotions can occur, they may have meaningful consequences. Evidence indicates that individuals with schizophrenia may experience mixed emotions when recalling pleasant memories (Cohen, St-Hilaire, Aakre, & Docherty, 2009), that mixed emotions may foster healthy coping with stressors (Coifman, Bonanno, & Rafaeli, 2007), and that the extent to which advertisements elicit mixed emotions may influence their effectiveness (Williams & Aaker, 2002). As explained below, however, answering the basic question of whether people can feel happy and sad at the same time requires more sophisticated measures of emotion than those employed in these and other studies, including our own (e.g., Larsen, McGraw, & Cacioppo, 2001). As a result, it remains unclear whether people can feel happy and sad at the same time. Our goal is to take steps toward answering that question and the larger question of whether valence is irreducible in experience.

Contemporary theoretical perspectives

A common contemporary approach to identifying the number and nature of the dimensions underlying emotional experience is to ask people to rate the extent to which they currently feel a variety of discrete emotions (e.g., happy, excited, stressed, sad). Factor analyses of the resulting correlation matrices generally reveal a two-factor solution with each emotion falling along the perimeter of a circumplex structure. Most notably, happiness and sadness consistently emerge as polar opposites separated by nearly 180° (for a meta-analysis, see Remington, Fabrigar, & Visser, 2000). What, then, is the relationship between happiness and sadness in experience?

Even though Watson and Tellegen's (1985) Positive Activation/Negative Activation (PA/NA) model contends that highly arousing positive emotions (e.g., excited) and negative emotions (e.g., distressed) are fairly independent, it recognizes that happiness and sadness lie at

opposite ends of a bipolar valence dimension (e.g., Watson, Wiese, Vaidya, & Tellegen, 1999; see Figure 1's left panel). The PA/NA model further contends that polar opposites (e.g., happiness & sadness) should be perfectly negatively correlated. By this account, any increase in happiness comes with a commensurate decrease in sadness and vice versa (see Figure 2, Panel A).

Russell's (1980; Russell & Barrett, 1999; Russell & Carroll, 1999) valence/arousal model highlights a bipolar valence dimension ranging from positive emotions (e.g., happiness) to negative emotions (e.g., sadness) and an orthogonal arousal dimension ranging from emotions low in arousal (e.g., calm) to those high in arousal (e.g., tense; see Figure 1's right panel). As explained by Watson, Weise, Vaidya, & Tellegen (1999) and Russell and Barrett (1999) and illustrated in Figure 1, the PA/NA and valence/arousal models are virtually identical even though they highlight different pairs of dimensions. Perhaps the most prominent difference between the models is that they make different predictions about the relationship between polar opposite emotions. Whereas the PA/NA model contends that polar opposites are perfectly negatively correlated, the valence/arousal model's *bipolarity hypothesis* (Barrett & Russell, 2003, February) echoes Bain (1859), Wundt (1896), and Titchener (1908) by contending that happiness and sadness, like feelings of hot and cold (Schimmack, 2001), are mutually exclusive. As Russell and Carroll (1999) put it, "Bipolarity says that when you are happy, you are not sad and that when you are sad, you are not happy" (p. 25; see Figure 2, Panel B).

At first glance, the PA/NA model's contention that happiness and sadness are perfectly negatively correlated seems reasonable. One plausible implication is that people cannot feel extremely happy and extremely sad at the same time. At least three other implications seem much less plausible. As illustrated in Figure 2's Panel A, to claim that happiness and sadness are

perfectly negatively correlated is to predict that all but the most intense levels of happiness are accompanied by some amount of sadness, that all but the most intense levels of sadness are accompanied by some amount of happiness, and that people cannot feel neutral (i.e., neither happy nor sad). In addition to being implausible, these predictions are inconsistent with the findings of Carroll and Russell (1998; cited in Russell & Carroll, 1999), who asked people in classroom settings to rate their happiness and sadness. Few subjects fell anywhere near the diagonal representing a perfect negative correlation. Most reported varying degrees of happiness, some reported varying degrees of sadness, but only 11% reported feeling both happy and sad. With allowance for measurement error, these data are consistent with the valence/arousal model's contention that happiness and sadness are mutually exclusive.

Though they disagree about whether emotions at opposite ends of the bipolar valence dimension (e.g., happiness & sadness) are perfectly negatively correlated or mutually exclusive, both the PA/NA and valence/arousal models agree that the bipolar valence dimension is irreducible. In contrast, Cacioppo and Berntson's (1994) evaluative space model (ESM) conceptualizes the positive and negative substrates underlying the bipolar valence dimension as separable. Drawing on a variety of findings including evidence that people can have both positive and negative reactions toward attitude objects, the ESM contends that affective reactions can be characterized by any pattern of positivity and negativity. This conceptualization can be extended to the experience of emotion, including such polar opposite emotions as happiness and sadness (Cacioppo, Larsen, N.K. Smith, & Berntson, 2004; Larsen et al. 2001). Whereas the PA/NA and valence/arousal models contend that happiness and sadness are perfectly negatively correlated and mutually exclusive, respectively, the ESM allows for the possibility that people can experience any pattern of happiness and sadness (see Figure 2; Panel C). Because ambivalent

states provide poor behavioral guidance (Cacioppo & Berntson, 1994), the ESM does not contend that polar opposite emotions always or even usually co-occur. Rather, polar opposite emotions should be most likely to co-occur in bittersweet situations, which we conceptualize as those containing both pleasant and unpleasant aspects (Larsen et al., 2001).

Initial evidence for mixed emotions

Some evidence indicates that people can feel happy and sad at the same time. Stanley and Meyer (2009) asked subjects to report their emotions after they watched each of 24 evocative film clips. Parallel factor analyses revealed a two-factor solution with valence and arousal dimensions. Additional analyses revealed a three-factor solution in which the valence dimension split into two separate positivity and negativity factors anchored by happy and sad. Positivity and negativity were only modestly negatively correlated, which suggests that some of the films may have made some subjects feel mixed emotions of happiness and sadness.

Factor analyses are based on correlation matrices, but negative correlation coefficients shed little light on the co-occurrence of two emotions (Russell & Carroll, 1999; Schimmack, 2001). A more direct approach to assessing the co-occurrence of happiness and sadness is to count how many people report feeling both (Russell & Carroll, 1999; see also Diener & Iran-Nejad, 1986). Many early psychologists took this approach and some found evidence for mixed emotions, but, as Beebe-Center (1932) and Schimmack and Colcombe (1999) pointed out, methodological limitations prevent any firm conclusions. In a more rigorous study, Larsen et al. (2001) asked moviegoers whether they felt happy, sad, and other pairs of polar opposite emotions (e.g., calm vs. tense) just before or just after they had watched *Life Is Beautiful* (Benigni, 1997), a tragicomedy set in a World War II concentration camp. Consistent with the valence/arousal model, all pairs of polar opposite emotions rarely co-occurred before the film.

Notably, only 10% of subjects reported feeling both happy and sad. Also consistent with the valence/arousal model, most pairs of polar opposite emotions rarely co-occurred after the film. There was but one exception: 44% of these subjects reported mixed emotions of happiness and sadness. Other studies indicate that meaningful life transitions (e.g., college graduation; Ersner-Hershfield, Mikels, Sullivan, and Carstensen, 2008; Larsen et al., 2001), certain types of music (Hunter, Schellenberg, & Schimmack, 2008), evocative pictures (Schimmack, 2001; 2005), and bittersweet advertisements (Williams & Aaker, 2002) can also make people feel happy and sad at the same time.

The debate over mixed emotions hinges on the actual experience of emotion (see Russell & Barrett, 1999), which is best indexed with self-reports (e.g., Wilson, 2003), but facial expressions have also provided evidence for mixed emotions. Griffin and Sayette (2008) found that nearly one-quarter of heavy smokers smiled and frowned simultaneously for at least 300 ms while they watched a burning cigarette. Moreover, those who smiled and frowned simultaneously were more likely to be ambivalent about smoking, which was indexed in terms of whether they had had difficulty quitting in the past. These findings provide convergent validity for self-report evidence for mixed emotions.

Alternative Interpretations

Despite considerable research, whether the experience of valence is irreducible (e.g., Russell & Carroll, 1999) or whether positivity and negativity are separable in experience (e.g., Cacioppo & Berntson, 1994) remains unclear because all available evidence that people can feel happy and sad at the same time is open to alternative interpretations. For instance, Griffin and Sayette (2008) did not measure self-reported emotional experience, so it is unclear whether smokers' smiles and frowns reflected mixed emotions of happiness and sadness, as opposed to

other positive and negative emotions. Here we outline several alternative interpretations for studies in which self-reports were collected and explain them in more detail as we present studies designed to address them.

One pair of alternative interpretations involves limitations in how researchers have measured happiness and sadness (e.g., Larsen et al., 2001; Schimmack, 2001; Williams & Aaker, 2002). First, although subjects were asked to report how they felt at one particular moment, they may have instead reported summaries of their emotional experience over time (Barrett & Bliss-Moreau, 2009; Beebe-Center, 1932; Larsen, McGraw, Mellers, & Cacioppo, 2004). If so, they may have reported mixed emotions when they had in fact merely vacillated between happiness and sadness. We addressed this possibility in one set of studies (Studies 1-3) by placing some people in bittersweet situations and collecting continuous, as opposed to static, measures of emotions. Second, subjects in all previous studies completed closed-ended measures of emotion (e.g., "Do you feel happy?"), which raises the possibility that those subjects who reported mixed emotions only because they were explicitly asked whether they felt happy and whether they felt sad. We addressed this possibility in a second set of studies (Studies 4-6) by placing some people in bittersweet situations and asking open-ended questions (e.g., "How do you feel right now?"), as opposed to closed-ended questions.

Another pair of alternative interpretations for evidence for mixed emotions involves subjects' expectancies. First, demand characteristics (Orne, 1962) may have led subjects to report mixed emotions because they thought that we expected them to do so. To address this possibility, we led some subjects to believe that we did *not* expect them to report mixed emotions and collected continuous measures of emotion (Study 2) or open-ended measures of emotion (Study 5). Second, subjects may have only reported mixed emotions because they held the lay

theory that people can feel happy and sad at the same time. To address this possibility, we collected continuous measures (Study 3) or open-ended measures (Study 6) from individuals who did not believe that people can feel happy and sad at the same time.

Subjects in all studies were told that they were participating in a study of foreign language comprehension and then watched one of two clips from the English-subtitled version of *Life Is Beautiful*. The bittersweet clip was 19 min 43 s long (1184 s). During the clip, a character named Guido uses humor to keep his son, Joshua, alive and unaware of their plight while his wife, Dora, is imprisoned elsewhere in the camp. In the final 5 min of the clip, Guido loses his own life to ensure Joshua's survival and Joshua is reunited with Dora. The control clip was 19 min 40 s long (1180 s). It begins with Guido and Dora's lighthearted courtship and joyful scenes from Joshua's childhood. It then transitions abruptly to the family's imprisonment, where it paints an unambiguously dreadful picture of their plight and ends with Dora fearing that Joshua is dead.

Part I: Vacillation

Emotions can be fleeting (e.g., Ekman, 1992). As noted above, this raises the alternative interpretation for earlier evidence for mixed emotions that subjects merely vacillated between happiness and sadness and, when prompted, reported summaries of their emotions (e.g., Barrett & Bliss-Moreau, 2009). Determining whether people can feel happy and sad at the same time and, by extension, whether valence is irreducible, requires tests of this *vacillation hypothesis*.

Schimmack (2005) noted that if people in bittersweet situations merely vacillate between happiness and sadness, they should report less mixed emotions when they rate their happiness and sadness closer together in time. His subjects viewed a series of pleasant and unpleasant pictures and then rated the extent to which they were feeling pleasure, displeasure, and 12 other

emotions, all of which were presented in a unique random order for each subject. Schimmack's finding that the number of items between the pleasure and displeasure items had no influence on the intensity of subjects' reported mixed emotions provides initial evidence against vacillation.

Carrera and Oceja (2007) tested the vacillation hypothesis more directly by collecting continuous measures of subjects' emotional reactions to a bittersweet clip from a film entitled *The Son of the Bride* (Campanella, 2001). The clip depicted a wedding that was both heartwarming and heartbreaking because the elderly bride had Alzheimer's disease and could not recognize anyone, including the groom. After watching the clip, subjects completed static emotion ratings. Those who reported mixed emotions then drew two separate curves to chart their recollection of how the intensity of their happiness and sadness changed over the course of the 6-min clip. Carrera and Oceja quantified simultaneously mixed emotions in terms of whether both curves exceeded zero at any point in time. Subjects who watched the bittersweet clip were more likely to report mixed emotions with static ratings (76%) than they were to recall that their happiness and sadness occurred simultaneously (47%), but they were nonetheless more likely to recall simultaneously mixed emotions than those who watched a control clip intended to elicit happiness and sadness in a sequential, as opposed to a simultaneous, fashion (25%). Taken together, the results indicate that even though some subjects merely vacillated between happiness and sadness, others actually experienced simultaneously mixed emotions.

One limitation of Carrera and Oceja's (2007) study is that retrospective, recall-based measures tend to be less accurate than those collected in real-time as the emotional episode unfolds (i.e., online measures; see Kahneman, 1999; Robinson & Clore, 2002), in part because people can have trouble remembering their experiences of emotion (e.g., Thomas & Diener,

1990). Thus, stronger tests of the vacillation hypothesis require online continuous measures of happiness and sadness. Studies 1a and 1b provided two such tests.

Study 1a: The button press measures

Larsen et al. (2004) developed online continuous measures of positivity and negativity by asking subjects to press one computer mouse button whenever they felt good during a computerized gambling task and another button whenever they felt bad. Subjects were also instructed to press both buttons if they felt both good and bad, and neither button if they felt neither good nor bad. The gambles included several *disappointing wins*, which Larsen et al. defined as good outcomes that could have turned out even better (e.g., smaller-than-expected raises; Kahneman, 1992; Ortony, Clore, & Collins, 1989). Subjects spent more time simultaneously pressing both buttons after receiving disappointing wins than after receiving outright wins, which indicates that disappointing wins can elicit simultaneously mixed emotions. These data do not speak to whether people can experience simultaneously mixed emotions of happiness and sadness, however, because Larsen et al. measured positivity and negativity in general, rather than happiness and sadness in particular. In Study 1a we provided a strong test of the vacillation hypothesis by asking subjects to indicate whether they felt happy and sad with the button press measures as they watched a clip from *Life Is Beautiful.*

Method.

***Subjects*.** Subjects were 47 Texas Tech undergraduates (21 women; 46%). In this and all studies, they received partial course credit for participating.

Procedure. Subjects completed the study individually and watched the bittersweet clip (n = 21) or the control clip (n = 22) by random assignment. After providing the foreign language comprehension cover story, the experimenter asked subjects to hold the mouse in both hands, to

press the left button with their left thumb whenever they felt happy, and to press the right button with their right thumb whenever they felt sad.[1] The experimenter also mentioned that they should not press any buttons if they felt neither happy nor sad, and both buttons if they felt both happy and sad at the same time. Throughout the clip, the experimenter observed subjects on a video monitor. If subjects removed one of their thumbs from the mouse button for more than 30 s, the experimenter asked them over an intercom to keep both thumbs on the buttons. (Data from one subject were discarded because she ignored several such requests.) The computer recorded all changes in the state of the mouse buttons. Offline, we determined whether each button was or was not being pressed every 100 ms.

After subjects completed a film comprehension test, the experimenter conducted a funnel debriefing to determine whether subjects suspected that we were interested in mixed emotions. After explaining that psychology studies are designed to answer questions about how people think, feel, or behave, the experimenter asked subjects what they thought we were interested in. The experimenter then asked about why we might be interested in their emotions and why we asked them to report their happiness and sadness separately and continuously. The experimenter then told subjects that we were only interested in one thing and asked what that one thing might be. Finally, the experimenter told subjects that we were interested in something about their emotions and asked what that one thing might be. No subjects suspected that we were interested in mixed emotions.

The experimenter also asked subjects whether they thought they were allowed to press both buttons at the same time. Data from three subjects (6%) who had watched the control clip were removed because they did not think they were allowed to do so. None of these subjects ever pressed both buttons, so excluding them worked against the hypothesis that people who watched

the control clip would report less mixed emotions. In all, data from four of 47 (8%) subjects were excluded.

Results. The proportion of subjects who reported happiness and who reported sadness at each moment of each clip is shown in Figure 3. People who watched the control clip often reported happiness during the first 11 min and rarely reported sadness. During the final 8 min, they rarely reported happiness and often reported sadness. People who watched the bittersweet clip often reported happiness during the first 3 min and rarely reported sadness. In addition, they often reported happiness at several points during the remaining 17 min even though they often reported sadness throughout that portion, as well.

To further examine how evocative the clips were, we computed how much time each subject pressed each button (see Table 1).[2] We submitted these data to a 2 (clip: control, bittersweet) x 2 (emotion: happiness, sadness) mixed-model ANOVA, where clip was a between-subjects variable.[3] The ANOVA revealed a main effect of clip, such that subjects reported more emotion during the bittersweet clip (M = 10.57 min; SD = 5.27) than during the control clip (M = 7.12 min; SD = 3.38), $F(1, 41) = 6.60$, partial $\eta^2 = .14$, $p = .01$.[4] The main effect of clip was qualified by a clip x emotion interaction, $F(1, 41) = 16.70$, partial $\eta^2 = .29$, $p < .001$. Follow-up t-tests indicated that the bittersweet clip elicited more sadness than the control clip, $t(41) = 4.08$, $d = 1.25$, $p < .001$, but no more happiness, $t(41) = -0.16$, $d = 0.05$, $p = .87$.

To quantify mixed emotions, we measured whether each subject simultaneously pressed both buttons at each point in time. We guarded against the possibility that subjects briefly pressed both buttons inadvertently by excluding those episodes that lasted <1 s. As shown in Figure 4, subjects rarely reported mixed emotions during either clip; the incidence of mixed emotions never exceeded 40% in either clip. This is not surprising because even the ESM

contends that mixed emotions are rare and because the bittersweet clip contains many unambiguously pleasant or unpleasant scenes that were intended to set the stage for bittersweet scenes. Nevertheless, Figure 4 suggests that subjects may have reported more mixed emotions during the bittersweet clip than during the control clip.

To quantify the amount of mixed emotions reported by each subject, we computed how much time each subject pressed both buttons at the same time. These distributions are shown in Figure 5. The overall distribution was J-shaped with a mode of zero and could not be transformed into a normal distribution. Thus, we analyzed the data with the Mann-Whitney test, which is a nonparametric equivalent of a *t*-test and compares distributions of ranked values obtained from two independent samples. The Mann-Whitney test revealed that subjects who watched the bittersweet clip reported more mixed emotions (Mdn = 0.41 min; M_{Rank} = 28.2) than did those who watched the control clip (Mdn = 0.00 min; M_{Rank} = 16.1), Mann-Whitney U = 101.0, z = 3.52, PS_{est} = .22, $p < .001$. This finding provides evidence from online continuous measures against the vacillation hypothesis and for the contention that people can feel happy and sad at the same time.

Study 1b: The continuous evaluative space grid

The goal of Study 1b was to provide a second test of the vacillation hypothesis and extend Study 1a by measuring happiness and sadness with the *continuous evaluative space grid* (ESG; Larsen, Norris, McGraw, Hawkley, & Cacioppo, 2009), which provides continuous online measures of positivity and negativity that are graded, as opposed to dichotomous (cf. the button press measures). With the continuous ESG, subjects move the cursor left and right along a computerized grid's *x*-axis to report changes in their positivity and up and down along its *y*-axis

to report changes in their negativity. The edges of the grid represent the experience of positivity or negativity in isolation; the interior represents coactivation of positivity and negativity.

Duncan, Barrett, and Russell (2006, January) had subjects complete the continuous ESG as they simultaneously viewed emotionally evocative pictures and listened to evocative music. Subjects rarely moved the cursor into the grid's interior when presented with music and pictures of opposite valence, which Duncan et al. interpreted as evidence against the possibility that people can feel mixed emotions of happiness and sadness. If Duncan et al.'s results constitute evidence against mixed emotions, the finding that subjects spend more time in the grid's interior during the bittersweet clip from *Life Is Beautiful* than during the control clip would constitute evidence for mixed emotions. We examined this possibility in Study 1b.

Method.

Subjects. Subjects were 39 University of Colorado, Boulder undergraduates (20 women; 51%).

Procedure. Subjects were seated in separate cubicles and randomly assigned to watch the bittersweet clip (n = 17) or the control clip (n = 22). Computerized instructions provided the cover story and informed subjects how to indicate how happy and how sad they felt by moving the mouse along the x- and y-axes of a 5 x 5 continuous ESG, respectively (for detailed instructions, see Larsen et al., 2009). The left (top), middle (middle), and bottom (right) cells on the x-axis (y-axis) were labeled "not at all," "moderately," and "extremely," respectively. Happiness and sadness ratings ranging from 0 to 4 were collected every 500 ms.

Results. To quantify the degree to which each subject experienced mixed emotions, we computed the minimum of each subject's happiness and sadness ratings during each sample of the clip (i.e., MIN[Happy, Sad]).[5] MIN scores provide a graded index of mixed emotions by

taking on values of 0 when subjects indicate feeling exclusively happy, exclusively sad, or neutral, but higher values when subjects indicate feeling both happy and sad (Schimmack, 2001). To guard against the possibility that subjects briefly crossed through the interior in transit between the exclusively happy and exclusively sad portions of the grid, we set MIN values to 0 if the excursion into the interior lasted <1.5 s. As in Study 1a, a Mann-Whitney test revealed that subjects who watched the bittersweet clip reported more intense mixed emotions (*Mdn* = 0.36; M_{Rank} = 26.6) than did those who watched the control clip (*Mdn* = 0.09; M_{Rank} = 14.9), U = 75.0, z = 3.18, PS_{est} = .20, p = .001.

Discussion. We gave subjects the opportunity to report changes in their experience of happiness and sadness as they occurred with Larsen et al.'s (2004) button press measures (Study 1a) and Larsen et al.'s (2009) continuous ESG (Study 1b). Just as subjects were more likely to report feeling both happy and sad after *Life Is Beautiful* than before (Larsen et al., 2001) and recall feeling both happy and sad during a bittersweet clip than during a control clip from *The Son of the Bride* (Carrera & Oceja, 2007), our subjects who watched the bittersweet clip spent more time reporting simultaneously mixed emotions (Study 1a) and reported more intense simultaneously mixed emotions (Study 1b) than did those who watched the control clip.

These results provide the first evidence from online continuous measures of emotion that people can feel happy and sad at the same time. They extend prior research involving less sophisticated measures of emotion by providing evidence against the vacillation hypothesis, which contends that people can merely vacillate between happiness and sadness. The results do not imply that all events containing pleasant and unpleasant aspects elicit mixed emotions (see Duncan et al., 2006, January), but they do indicate that *Life Is Beautiful* can.

In terms of their implications for contemporary models of the structure of affect, the results of Study 1 are inconsistent with the valence/arousal model, which contends that happiness and sadness are mutually exclusive (Russell & Carroll, 1999), but are consistent with the ESM (Cacioppo & Berntson, 1994), which contends that happiness and sadness can co-occur. More generally, they bear upon an age-old debate over the nature of emotion. Specifically, they provide evidence against the claim that valence is an irreducible aspect of emotional experience (Bain, 1859; Titchener, 1908; Wundt, 1896) and for the rival claim that positivity and negativity are separable in experience (Hume, 1739/2000; Ebbinghaus, 1902).

Study 2: Demand characteristics

One alternative interpretation for the results of Study 1 is that subjects who watched the bittersweet clip inferred that they were expected to report mixed emotions. If so, demand characteristics may have led them to report mixed emotions (see Schimmack, 2005). The fact that Study 1a's subjects reported having no idea that we were interested in mixed emotions provides evidence against the operation of demand characteristics, but studies in which subjects are explicitly told that the researchers' hypothesis was that people could *not* feel both happy and sad at the same time would provide stronger tests.

In Study 2, we told subjects in the bipolarity hypothesis/bittersweet clip group that we had hypothesized that people cannot feel happy and sad at the same time and then showed them the bittersweet clip. We told subject in the no-hypothesis/control clip group that we were indifferent about mixed emotions and then showed them the control clip. All subjects completed the continuous ESG throughout the clip. If Study 1's subjects reported more mixed emotions because they actually experienced more mixed emotions, Study 2's bipolarity hypothesis/bittersweet clip group should report more mixed emotions than the no-

hypothesis/control clip group. On the other hand, if demand characteristics led Study 1's subjects to report more mixed emotions, Study 2's bipolarity hypothesis/bittersweet clip group should report no more or even less mixed emotions than the no-hypothesis/control clip group. The bipolarity hypothesis/bittersweet clip and no-hypothesis/control clip) were sufficient to test our hypothesis, so we intentionally confounded film clip (bittersweet vs. control) with stated hypothesis (bipolarity vs. no-hypothesis).

Method.

Subjects. Subjects were 39 Texas Tech undergraduates (21 women; 54%). Data from two additional subjects were lost due to computer error.

Procedure. Subjects were seated in separate cubicles and randomly assigned to the bipolarity hypothesis/bittersweet clip condition (n = 21) or to the no-hypothesis/control clip condition (n = 18).

Before showing them the bittersweet clip, the experimenter told subjects in the bipolarity hypothesis/bittersweet clip condition that our hypothesis was that people could not experience mixed emotions:

> Some evidence indicates that emotions can also affect language comprehension, so we also need to keep track of how you're feeling during the film. We've also realized that the current study allows us to test a hypothesis we have about emotions. We do not think people can feel both happy and sad at the same time and this study gives us a chance to see whether that's true.

After providing the continuous ESG instructions, the experimenter said,

> As I mentioned a moment ago, we have hypothesized that people cannot feel both happy and sad at the same time, but we'll let the data decide. So if you ever feel both happy and sad at the same time during the movie, then move into the interior of the grid, the portion that indicates that you're feeling both happy and sad to some degree.

Following the clip, subjects were presented with several pairs of statements about what the experimenter had said during the instructions. The final pair of statements was "The

experimenter said that (a) we believe that people cannot feel happy and sad at the same time, or (b) we believe that people can feel happy and sad at the same time." We discarded the data from the 2 subjects who answered incorrectly, leaving 19 subjects in the bipolarity hypothesis/bittersweet clip condition.

To ensure that the question of mixed emotions would be comparably salient for subjects in the no-hypothesis/control clip condition, the experimenter told these subjects that a peripheral aim of the study involved mixed emotions. The experimenter also indicated, however, that we were indifferent about the results:

> Some evidence indicates that emotions can also affect language comprehension, so we also need to keep track of how you're feeling during the film. We've also realized that the current study allows us to settle a debate that other psychologists have been having. Some researchers think that people can feel happy and sad at the same time; others think people cannot feel happy and sad at the same time. We really don't care one way or the other, but this study will allow us to find out.

After the continuous ESG instructions, the experimenter said,

> As I mentioned a moment ago, some researchers think people can feel happy and sad at the same time, but others think that people cannot. We don't care either way, so we'll let the data decide. So if you ever feel both happy and sad at the same time during the movie, then move into the interior of the grid, the portion that indicates that you're feeling both happy and sad to some degree.

These subjects then watched the control clip.

Results and Discussion. To assess whether the two groups reported different amounts of mixed emotions, we computed the minimum of each subject's happiness and sadness ratings during each moment of the clip. A Mann-Whitney test on the MIN data revealed that subjects in the bipolarity hypothesis/bittersweet clip condition reported more intense mixed emotions (*Mdn* = 0.19) than those in the no-hypothesis/control clip condition (*Mdn* = 0.06), U = 73.0, $z = 2.64$, $PS_{est} = .20$, $p = .008$. Thus, subjects who watched the bittersweet clip reported more intense mixed emotions even though we explicitly told them that we thought people could not feel happy

and sad at the same time. In addition to providing additional evidence against the vacillation hypothesis, these results provide evidence against the notion that subjects in earlier studies only reported mixed emotions because they thought the researchers expected them to (Schimmack, 2005).

Study 3: Lay theories of mixed emotions

Study 2 helped rule out the notion that prior evidence for mixed emotions is a result of subjects' beliefs about the experimenters' expectations, but no studies of mixed emotions have addressed the role of the expectations that subjects have before entering the laboratory. Most undergraduates think that people can feel happy and sad at the same time (Larsen & McGraw, 2000, February), but lay theories about emotion can be inaccurate (Robinson & Clore, 2002). For instance, most people think that women are more emotional than men, but experience sampling studies reveals little evidence for gender differences in emotional experience (Barrett, Robin, Pietromonaco, & Eyssell, 1998). In the case of mixed emotions, people's lay theories may lead them to think they are experiencing simultaneously mixed emotions even when they are not (E. Harmon-Jones, personal communication; April, 2004). We investigated this possibility in Study 3 by conducting another test of the vacillation hypothesis and including a group of subjects who did *not* hold the lay theory that happiness and sadness can co-occur.

Method.

Prescreening. Two weeks before data collection began, 631 introductory psychology students at Texas Tech University completed a mass survey. One questionnaire contained the question, "Do you think people can feel happy and sad at the same time?" embedded among five similar questions (e.g., "Do you think dreams can provide insight into your unconscious mind?"). Subjects responded to each question by selecting "yes," "no," or "I don't know." Subjects who

thought people could experience mixed emotions were classified as endorsers (n = 540; 86%). Those who did not know (n = 65; 10%) and who did not think so (n = 26; 4%) were classified as non-endorsers.

Subjects. A subset of endorsers and non-endorsers (n = 52; 25 women; 48%) were invited to participate. Data from an additional endorser were removed because she did not know she could press both buttons.

Procedure. The subject pool contained few non-endorsers and we thought it unlikely that they would report mixed emotions after watching the control clip, so all non-endorsers watched the bittersweet clip; all endorsers watched the control clip. As in Study 2, this intentional confound provided a stronger test of mixed emotions. The procedure was otherwise identical to that of Study 1a, in which subjects completed the button press measures.

Results and Discussion. As in Study 1a, we quantified mixed emotions by measuring the total amount of time that subjects pressed both buttons after excluding those episodes that lasted <1 s. Though the median subject in both groups reported no mixed emotions, a Mann-Whitney test revealed that non-endorsers, all of whom watched the bittersweet clip, reported more mixed emotions (M_{Rank} = 30.0) than did endorsers, all of whom watched the control clip (M_{Rank} = 22.6), Mann-Whitney U = 241.5, z = 1.98, PS_{est} = .36, p = .048.

These results indicate that even people who did not know whether (or did not think that) people can feel happy and sad at the same time reported more simultaneously mixed emotions while watching the bittersweet clip than did people who watched the control clip. The results do not imply that lay theories have no effect on self-reported emotions, but they do make it difficult to attribute available evidence for mixed emotions to the belief that people can experience mixed emotions.

Implications. Studies 1-3 provide evidence against the vacillation hypothesis, which holds that previous studies have only yielded evidence for mixed emotions because subjects vacillated between happiness and sadness more quickly than those studies' static measures could detect. They also provide evidence against the notion that people only report mixed emotions because they think the researchers want them to (Study 2) or because they hold the lay belief that people can experience mixed emotions (Study 3). Taken together, the results of Studies 1-3 provide evidence for the ESM's contention that happiness and sadness can co-occur and against the valence/arousal model's contention that happiness and sadness are mutually exclusive. More broadly, in contrast to Bain's (1859) assertion that valence is irreducible to the experience of emotion and that pleasantness and unpleasantness "destroy" one another, our results indicate that positivity and negativity are separable in experience (Hume, 1739/2000; Ebbinghaus, 1902)

Part II: Reactive Measurement

In Studies 1-3 we explicitly asked people whether they felt happy and whether they felt sad. Such closed-ended questions are commonly used to measure emotions (R. J. Larsen & Fredrickson, 1999), but they may have unwelcome consequences. People generally test hypotheses by seeking confirmatory evidence (e.g., Klayman & Ha, 1987), so asking people whether they are experiencing a particular emotion may prompt them to seek evidence that they are feeling that emotion. Sandberg and Conner (2009) found that women asked to indicate how much they would regret not getting a cervical smear were more likely to get a cervical smear within 4 months than those in a control group. This finding suggests that simply asking about anticipatory regret can elicit anticipatory regret.

Sandberg and Conner's (2009) findings give rise to a potential alternative interpretation for prior evidence for mixed emotions. For example, By asking them whether they felt happy

after *Life Is Beautiful*, Larsen et al. (2001) may have inadvertently elicited happiness by prompting subjects to think about the pleasant events that occurred near the end of the film (e.g., the boy's reunion with his mother). Similarly, by asking them whether they felt sad, we may have elicited sadness by prompting subjects to think about the unpleasant events that occurred near the end (e.g., the father's death). According to this *reactive measurement hypothesis,* Larsen et al.'s subjects only experienced mixed emotions because we asked them whether they felt happy and sad. We tested this alternative interpretation in Studies 4-6 by asking subjects open-ended questions about their emotions (e.g., "How do you feel?") rather than closed-ended questions (e.g., "Do you feel happy?").

Study 4: Emotion listings

In Study 4, we asked subjects to list the emotions they were experiencing immediately after watching one of the two clips from *Life is Beautiful.* We reasoned that if people can feel happy and sad at the same time, they would be more likely to spontaneously report experiencing mixed emotions after watching the bittersweet clip than after watching the control clip. The control clip ends on an especially sad note, so its ending might be especially unlikely to elicit mixed emotions. Thus, we included a group of subjects who watched no clip at all. Because the emotion listings were insensitive to the time course of emotions, we supplemented the emotion listings with a retrospective measure of the time course of subjects' positive and negative emotions.

Method.

Subjects. Subjects were 116 University of Colorado, Boulder undergraduates (54 women; 47%).

Procedure. Subjects were seated in separate cubicles and randomly assigned to watch the bittersweet clip (n = 33), the control clip (n = 34), or neither clip (n = 49). Computerized instructions provided the cover story but made no mention of emotions. For subjects who watched either the control or bittersweet clip, the computer provided the following prompt immediately after the clip ended: "Emotions can affect language comprehension, so before we go on we need to know what—if any—emotions you are feeling right now, at this very moment. Are you feeling any emotions right now?" Those who selected "yes" were instructed to "list ONE emotion that you are feeling right now, then press 'Enter.'" After entering an emotion, they were asked, "Are you feeling any other emotions right now?" Those who selected "yes" were instructed to list another emotion. These steps were repeated until subjects indicated that they did not feel any other emotions.

In order to collect a retrospective measure of the time course of subjects' positive and negative emotions, the computer next told subjects that,

> "Some people mention feeling both happy and sad after the movie. If you mentioned feeling both happy and sad (or some other pair of positive and negative emotions), we're interested in how your feelings played out over time during the last few moments of the movie and up until now if the movie is still affecting your emotions."

The computer then displayed a figure with four panels, each plotting different patterns of happiness and sadness across time (see Figure 6). Panels A, B, C, and D depicted happiness and sadness as nonadjacent, adjacent, partially overlapping, and completely overlapping, respectively. Subjects were then asked which panel best captured the time course of their emotions at the end of the clip. Subjects were also given the option to indicate that they had not "mention[ed] feeling positive and negative emotions."

Subjects who were assigned to watch neither of the clips received the cover story and completed the emotion listing task immediately thereafter. For these subjects, the instructions for the retrospective time course measure made no mention of the clip.

Results and Discussion. Subjects generated a variety of words to describe their emotions. The percentage of subjects in each condition who reported happiness or its synonyms (i.e., glad, happy, joy, overjoyed, "feel rejoiced") and sadness or its synonyms (i.e., depressed, despair, sad, saddened, sadness, sorrow) is shown in Table 2. A chi-square test on the happiness data revealed an effect of condition, $\chi^2(2, N = 116) = 55.97$, Cramer's V = .69, $p < .001$.[6] To examine the nature of this effect, we conducted a pair of follow-up Fisher's exact tests (which yield *p*-values, but no test statistic). We corrected for familywise error rate in all follow-up tests in this study and Studies 5 and 6 by setting α to .025 (i.e., .05 / 2). These tests indicated that people who watched the bittersweet clip were more likely to report happiness than those who watched the control clip, $\varphi = .71$, $p < 001$, or neither clip, $\varphi = .65$, $p < .001$. There was also an effect of condition on sadness, $\chi^2(2, N = 116) = 57.38$, Cramer's V = .70, $p < .001$. Fisher's exact tests revealed that people who watched the bittersweet clip were less likely to report sadness than those who watched the control clip, $\varphi = -.29$, $p = .02$, but more likely to report sadness than those who watched neither clip, $\varphi = .62$, $p < .001$.

To meet criteria for reporting mixed emotions, subjects in this study and Studies 5 and 6 had to report feeling happiness (or one of its synonyms) and sadness (or one of its synonyms). To meet criteria for experiencing simultaneously mixed emotions, subjects had to meet criteria for experiencing mixed emotions and report that one of the panels in which happiness and sadness overlapped (i.e., Panels C or D) best captured the time course of their emotions. The percentage of subjects in each group who reported mixed emotions and simultaneously mixed emotions is

shown in Table 3. Chi-square tests revealed an effect of condition on reports of mixed emotions and simultaneously mixed emotions, $\chi^2(2, N = 116) = 30.56$ and 21.61, Cramer's V = .51 and .43, respectively, both *p*s < .001. Follow-up Fisher's exact tests revealed that subjects who watched the bittersweet clip were more likely than those who watched the control clip to report mixed emotions, $\varphi = .45$, $p < .001$, and simultaneously mixed emotions, $\varphi = .37$, $p = .002$. Subjects who watched the bittersweet clip were also more likely to report mixed than those who watched the control clip, $\varphi = .48$, $p < .001$, or neither clip, $\varphi = .40$, $p < .001$.

The results of Study 4 indicate that simply asking people in bittersweet situations how they feel is sufficient to elicit reports of mixed emotions; it is not necessary to ask them whether they feel happy and sad. These findings are inconsistent with the reactive measurement hypothesis, which holds that people in bittersweet situations will only report mixed emotions when they are asked whether they feel happy and whether they feel sad. These data thereby provide additional evidence that people can feel happy and sad at the same time (Larsen et al., 2001) and that positivity and negativity are separable in experience.

Study 5: Demand characteristics revisited

Like Study 1's evidence against the vacillation hypothesis, Study 4's evidence against the reactive measurement hypothesis may have been a result of demand characteristics. That is, subjects who watched the bittersweet clip may have reported mixed emotions only because they thought we expected them to do so. To address this alternative interpretation, we conducted a study similar to Study 2 in which we told some subjects that our hypothesis was that people could not feel happy and sad at the same time. In addition, we asked subjects to write about emotions rather than list them. None of the subjects in Study 4 who watched neither clip reported sadness and only 6% reported happiness, so we dropped that condition from Study 5.

Method.

Subjects. Subjects were 94 University of Colorado, Boulder undergraduates (48 women; 51%).

Procedure. Subjects were seated in separate cubicles. Some were randomly assigned to the bipolarity hypothesis/bittersweet clip condition (n = 33) and others to the no-hypothesis/control clip condition (n = 30). Because Study 5 featured a novel open-ended measure, other subjects were randomly assigned to a no-hypothesis/bittersweet clip condition (n = 31). After they watched the bittersweet film, subjects in the bipolarity hypothesis/bittersweet clip condition were asked to describe their emotions. Specifically, the computer provided subjects with the following prompt: "Emotions can affect language comprehension, so please tell us how you feel right now. Type in how you are feeling and why." The prompt was accompanied by a field with a capacity of approximately 300 words. We gave subjects up to 4 min to respond, but, to prevent confabulation, gave them the option to finish early. Subjects then read that we were interested in how any positive and negative emotions they felt "played out over time" and that, "What we're really interested in is whether people can feel happy and sad at the same time. Two groups of researchers have spent several years debating whether people can feel happy and sad at the same time." They then read that one group's prediction is that people can feel happy and sad at the same time but that,

> "Our own group, the Boulder Group, predicts that people CANNOT feel happy and sad at the same time. So we have predicted that people CANNOT feel both happy and sad at the same time, but evidence for or against our prediction would be interesting so we'll let the data decide."

These subjects were then asked to indicate which of Figure 6's panels best captured the time course of their emotions. Finally, they were asked whether they had been told that our hypothesis was or was not that people could feel both happy and sad at the same time. Data from the four

subjects (12%) who incorrectly thought they had been told that our hypothesis was that people could feel both happy and sad were removed from all analyses.

Subjects in the no-hypothesis/bittersweet clip condition went through the same procedure except they were neither told nor asked about our hypothesis. Subjects in the no-hypothesis/control clip condition also went through the same procedure except that they watched the control clip and were neither told nor asked about our hypothesis.

Results and Discussion. The percentage of subjects in each group who reported mixed emotions and simultaneously mixed emotions is shown in Table 4.[7] Chi-square tests revealed effects of condition on both measures, $\chi^2(2, N = 90) = 19.57$ and 16.58, Cramer's V = .47 and .43, respectively, both *p*s < .001. Follow-up Fisher's exact tests indicated that subjects who watched the bittersweet clip and were told nothing about our hypotheses were more likely than subjects who watched the control clip to report mixed emotions, $\varphi = .51$, $p < .001$, and simultaneously mixed emotions, $\varphi = .41$, $p = .002$. Additional tests indicated that subjects who watched the bittersweet clip and were told that we doubted that people can feel happy and sad at the same time were also more likely than subjects who watched the control clip to report mixed emotions, $\varphi = .57$, $p < .001$, and simultaneously mixed emotions, $\varphi = .54$, $p < .001$.

In sum, individuals who watched the bittersweet clip reported more mixed emotions than those who watched the control clip whether or not they were led to believe that we doubted the existence of mixed emotions. Thus, these data replicate Study 4's evidence for mixed emotions and extend them by indicating that subjects pay more attention to reporting their emotions than to speculating about our hypotheses.

Study 6: Lay theories revisited

As in Studies 1 and 2, subjects in Studies 4 and 5 may have simply reported feeling both happy and sad because they believed that people can feel happy and sad at the same time. To test this hypothesis, we conducted another study that included subjects who did not endorse the belief that happiness and sadness can co-occur. Rather than asking subjects to write about their emotions, we had an interviewer ask them to describe their emotions verbally (Larsen, To, & Fireman, 2007).

Method.

Prescreening. Three weeks before the study began, 852 University of Colorado, Boulder undergraduates enrolled in introductory psychology courses completed a mass survey. One questionnaire contained the yes/no question, "Do you think people can feel happy and sad at the same time?" embedded among similar questions about psychological phenomena. Those who said "yes" and "no" were classified as endorsers (n = 789; 93%) and non-endorsers (n = 63; 7%), respectively.

Subjects. A subset of endorsers and non-endorsers were invited to participate in the study (n = 74; 38 women; 51%). Data from an additional subject were lost because the voice recorder malfunctioned.

Procedure. Subjects completed the study individually. Because few non-endorsers were available and we thought it unlikely that they would report mixed emotions after watching the control clip, all non-endorsers (n = 28) watched the bittersweet clip. Endorsers watched either the bittersweet *Life Is Beautiful* clip (n = 22) or the control clip (n = 24) by random assignment. After providing the cover story, the experimenter left and subjects watched the clip. After the clip, the experimenter told subjects she needed to ask a few questions about their emotional reactions to the film because emotions can affect language comprehension. She first asked,

"How do you feel right now?" Throughout, whenever subjects mentioned an emotion, the experimenter asked them to explain why they felt that way if they had not spontaneously done so. If they only mentioned positive or negative emotions in response to the first question, she asked, "Do you feel anything else?"[8] At this point, the experimenter confirmed any reports of mixed emotions by asking, "So you feel happy and sad?" (When applicable, the experimenter replaced "happy" and "sad" with the positive and negative emotions mentioned by the subject.) No subjects who initially reported mixed emotions subsequently denied them.

Results and Discussion. We distinguished between subjects who reported mixed emotions spontaneously after being asked "How do you feel right now?" and those who only reported mixed emotions after being asked, "Do you feel anything else?" The percentage of subjects in each group who reported mixed emotions, reported mixed emotions spontaneously, and reported simultaneously mixed emotions is shown in Table 5. Chi-square tests revealed effects of condition on all three measures, $\chi^2(2, N = 90) = 14.69$, 7.85, and 7.86, Cramer's V = .45, .33, and .33, respectively, all ps < .03. Follow-up Fisher's exact tests indicated that endorsers who watched the bittersweet clip were more likely than endorsers to report mixed emotions, $\varphi = .48$, $p = .001$, and report simultaneously mixed emotions, $\varphi = .36$, $p = .02$, after correcting for familywise error rate. Endorsers who watched the bittersweet clip were also marginally more likely to spontaneously report mixed emotions, $\varphi = .32$, $p = .04$. Non-endorsers, all of whom watched the bittersweet clip, were more likely than endorsers who watched the control clip to report mixed emotions, $\varphi = .54$, $p < .001$, spontaneously report mixed emotions, $\varphi = .40$, $p = .005$, and report simultaneously mixed emotions, $\varphi = .40$, $p = .005$.[9]

Thus, whether or not they initially endorsed the notion that people could feel happy and sad at the same time, individuals who watched the bittersweet clip were more likely to report

mixed emotions than those who watched the control clip. These results provide further evidence against the contention that people only report mixed emotions in bittersweet situations because they think that people can feel happy and sad at the same time. More generally, Study 6's results, like those of Studies 4 and 5, provide evidence against the reactive measurement hypothesis and for the contention that happiness and sadness can co-occur.

General Discussion

When it comes to the experience of emotion, is valence irreducible or are positivity and negativity separable? We addressed this question with six studies designed to test whether people can feel happy and sad at the same time. Subjects reported their emotions during (Studies 1-3) or after clips (Studies 4-6) from a tragicomic film containing bittersweet scenes or a combination of unambiguously pleasant and unpleasant scenes. At first glance, the results of all six studies indicate that the incidence of mixed emotions is low. In Studies 1b and 3, for instance, the majority of subjects never reported mixed emotions for so much as a second over the course of a nearly 20 min film clip. In Studies 4-6, 84% did not report experiencing simultaneously mixed emotions after the clips. Thus, our data may provide the strongest evidence to date that people cannot feel happy and sad at the same time.

A closer look at the data, however, provides even stronger evidence for a more nuanced conclusion. Compared to those who watched the control clip, people who watched the bittersweet clip spent more time pressing the happy and sad buttons simultaneously in Studies 1a and 3, moved further into the interior of the continuous ESG in Studies 1b and 2, were more likely to list mixed emotions in Study 4, were more likely to describe feeling mixed emotions in Study 5, and were more likely to tell an interviewer that they felt mixed emotions in Study 6.

Thus, the data indicate that people do not often feel happy and sad at the same time but can do so in bittersweet situations.

Taken together, the data extend prior evidence against the contention of Bain (1859), Wundt (1896), and Titchener (1908) that valence is an irreducible aspect of the experience of emotion. In contrast, the findings provide evidence for the contention of Socrates, Hume (1739/2000), and Ebbinghaus (1902) that positivity and negativity are separable in experience. In terms of their implications for contemporary models of the structure of affect, the data are inconsistent with Russell's (1980; Russell & Carroll, 1999) valence/arousal model but consistent with Cacioppo and Berntson's (1994; Cacioppo et al., 2004) ESM.

A lingering alternative interpretation

The current studies indicate that prior evidence that people can feel happy and sad at the same time is not a result of vacillation, reactive measurement, demand characteristics, or lay theories about mixed emotions, but Russell (2003) has raised another alternative interpretation. Like appraisal theorists of emotion (see Roseman & C. A. Smith, 2001), Russell distinguished between the experience of emotion, which he termed *core affect*, and appraisals of stimuli as pleasant or unpleasant, which he termed *perceptions of affective quality.* Perceptions of affective quality do not necessarily influence core affect, as when an individual with depression appreciates the beauty of a sunset, but remains utterly depressed (Russell, 2003). By extension, people may perceive an object as having ambivalent affective qualities without actually experiencing mixed emotions. Thus, Russell suggested that research subjects may erroneously report feeling happy and sad when they merely intended to report that ongoing events contained both pleasant and unpleasant aspects.

It is widely acknowledged that films are can elicit intense emotions (e.g., Gerrards-Hesse, Spies, & Hesse, 2004; Gross & Levenson, 1995; Russell, 2003), so our data are less susceptible to Russell's concern than other data are. It is especially unlikely that subjects in a recent study of mixed emotions by Andrade and Cohen (2007) reported their perceptions of affective quality. In that study, continuous ESG ratings indicated that fans of horror films experienced mixed emotions of happiness and fear while they watched horror clips. The horror clips were terrifying and contained no happy material, so it is doubtful that subjects merely reported their appraisals of the clips' emotional content. A more plausible explanation is that subjects genuinely experienced happiness and, by extension, mixed emotions of happiness and fear. Thus, the most parsimonious interpretation for our studies is that subjects who watched the bittersweet *Life Is Beautiful* clip reported mixed emotions of happiness and sadness because they genuinely experienced mixed emotions of happiness and sadness.

Future directions

Some people may experience mixed emotions more often than others. The tendency for Asians to experience more mixed emotions than Westerners (e.g., Bagozzi, Wong, and Yi, 1999; Schimmack, 2009; Williams & Aaker, 2002; for a review, see Goetz, Spencer-Rodgers, & Peng, 2008) has been attributed to the tendency for Asians to show greater *dialectical thinking* (Peng & Nisbett, 1999). One aspect of dialectical thinking is the belief that two contradictory propositions can both be true. Experiencing positive and negative emotions can be seen as contradictory, so it makes sense that cultural differences in mixed emotions are a result of cultural differences in perceptions of contradiction. Another aspect of dialectical thinking is the belief that things change. The extant evidence for cultural differences in mixed emotions comes from static measures, which leaves open the possibility that Asians report more mixed emotions not because

they spend more time experiencing simultaneously mixed emotions than Westerners, but because they spend more time vacillating between positive and negative emotions (cf. Goetz et al., 2008). Future research with continuous measures of positivity and negativity (e.g., the continuous ESG) can test these competing hypotheses.

Future research with continuous unipolar measures might also shed light on emotional disturbances associated with bipolar disorder. Personality inventories indicate that individuals with bipolar disorder show greater emotion lability (e.g., "My mood often changes from happiness to sadness, without my knowing why" Benazzi & Akiskal, 2005) and emotion ratings indicate that some individuals with bipolar disorder vacillate between intense positive and negative emotions within the course of a single day (Kramlinger and Post, 1996), but researchers in this area have not employed continuous measures or separate measures of positivity and negativity. Such measures may indicate that what appear to be episodes of vacillation are actually episodes of simultaneously mixed emotions and that individuals with bipolar disorder experience more mixed emotions than others do.

Final Thoughts

Our data and others' (e.g., Remington et al., 2000) indicate that emotional experience generally conforms to the valence/arousal model's predictions. Yet even the most robust models in psychology have boundary conditions (e.g., McGuire, 1989), so it should come as no surprise that the valence/arousal model cannot account for every person's experience in every situation. Our evidence for mixed emotions indicates that a more complete understanding of emotional experience in bittersweet situations requires conceptualizing positivity and negativity as separable.

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Footnotes

[1] To address the potential role of experimenter expectancy effects (Rosenthal & Rosnow, 1991), we told the experimenters that we anticipated that subjects would not press both buttons simultaneously in either condition. We also showed them fabricated time series figures from 12 fictitious subjects who had ostensibly watched the bittersweet clip, none of whom had pressed both buttons simultaneously for more than a fraction of a second. After the study's completion, Larsen conducted separate funnel debriefings with each experimenter. Neither experimenter reported any suspicions and both appeared and reported being surprised upon hearing that they had been misinformed.

[2] To correct for the slight difference in the two clips' length, we multiplied duration data for subjects who watched the control clip in Studies 1a and 3 by 1.003 (1184 s / 1180 s).

[3] Initial analyses on data from all dependent variables in Studies 1-3 revealed isolated gender effects, but only two were obtained in more than one study. In Studies 1 and 3, a significant main effect of gender was qualified by a significant interaction with emotion such that women reported more sadness, but no more happiness, than men.

[4] We used a variety of effect size estimates depending on the nature of the data. Consistent with standard practice, we report partial μ^2 for ANOVA effects, Cohen's (*d* for comparisons of two means, Cramer's V for 2 x 3 contingency tables, and φ (which is mathematically equivalent to Pearson's *r*) for 2 x 2 contingency tables. Parametric measures (e.g., *d*) are invalid when assumptions associated with parametric statistical tests are violated, so we report the estimated probability of superiority (PS_{est}) for Mann-Whitney U's (Erceg-Hurn & Mirosevich, 2008).

[5] The Supplemental Material contains analyses of the happy and sad data from Studies 1b - 3.

[6] We report Fisher's exact tests for all paired comparisons in Studies 4-6 because many expected frequencies were <5, which renders Pearson's chi-square test invalid (see Agresti, 1992). Any concerns about the validity of the results of the chi-square tests involving three groups (for which there is no exact test) should be alleviated by the finding that all significant tests were significant at the .001 level.

To test for gender effects in Studies 4-6, we conducted additional Fisher's exact tests on the happiness, sadness, and mixed emotion data from each condition. Only one test revealed a significant gender effect: In Study 4, women who watched the control clip were more likely to report sadness (100%) than men who watched the control clip (63%).

[7] The Supplemental Material contains analyses of the percentage of subjects who reported happiness and who reported sadness in Studies 5 and 6.

[8] If subjects had not mentioned happiness or other moderately-arousing positive emotions in response to the open-ended questions, the experimenter asked the closed-ended question, "Do you feel happy?" If they had not mentioned sadness or other moderately-arousing negative emotions, she asked, "Do you feel sad?" To avoid relying on closed-ended questions, we focused our analyses on responses from the earlier, open-ended questions.

[9] Table 5 indicates that non-endorsers tended to be more likely to report mixed emotions than endorsers who watched the bittersweet clip, but none of these differences approached significance (all *p*s > .5).

Table 1

Number of minutes that Study 1a's subjects reported happiness and sadness during the control and bittersweet clips

	Clip			
	Control		Bittersweet	
Emotion	Mean	*SD*	Mean	*SD*
Happy	4.25	2.58	4.14	2.24
Sad	2.87	1.65	6.44	3.74

Table 2

Percentage of subjects in Study 4's three groups who reported happiness and who reported sadness

	Clip		
Emotion	None	Control	Bittersweet
Happy	6%	0%	67%
Sad	0%	79%	52%

Table 3

Percentage of subjects in Study 4's three groups who reported mixed emotions and simultaneously mixed emotions

	Group		
Measure	None	Control	Bittersweet
Reported mixed emotions	0%	0%	34%
Reported simultaneously mixed emotions	0%	0%	24%

Table 4

Percentage of subjects in Study 5's three groups who reported mixed emotions and simultaneously mixed emotions

	Group		
Measure	No-hypothesis / control clip	No-hypothesis / bittersweet clip	Bipolarity hypothesis / bittersweet clip
Reported mixed emotions	0%	42%	48%
Reported simultaneously mixed emotions	0%	29%	45%

Table 5

Percentage of subjects in Study 6's three groups who reported mixed emotions, spontaneously reported mixed emotions, and reported simultaneously mixed emotions

	Group		
Measure	Endorsers / control clip	Endorsers / bittersweet clip	Non-endorsers / bittersweet clip
Reported mixed emotions	0%	36%	46%
Spontaneously reported mixed emotions	0%	18%	29%
Reported simultaneously mixed emotions	0%	23%	29%

Figure Captions

Figure 1. Watson and Tellegen's (1985; Watson et al., 1999) Positive Activation/Negative Activation (PA/NA) model (left panel) and Russell's (1980; Russell and Barrett, 1999; Russell & Carroll, 1999) valence/arousal model (right panel). Arrows indicate the pair of dimensions highlighted by the respective models. These depictions are intended to highlight the models' similarities, particularly their conceptualization of happiness and sadness as falling at opposite ends of a bipolar valence dimension. *Note:* Adapted from "Toward a Consensual Structure of Mood," by D. Watson and A. Tellegen, 1985, *Psychological Bulletin, 98*, p. 221 and "The structure of current affect: Controversies and emerging consensus," by L. F. Barrett and J. A. Russell, 1999, *Current Directions in Psychological Science, 8*, p. 11. Copyright 1985 by the American Psychological Society and 1999 by the American Psychological Association, respectively.

Figure 2. Competing predictions about the theoretic relationship between happiness and sadness. Gray and white areas in each panel represent configurations of happiness and sadness that theoretically can and cannot occur. Panel A: Predictions of Watson and Tellegen's (1985) PA/NA, which contends that happiness and sadness are perfectly negatively correlated. Panel B: Predictions of Russell and Carroll's (1999) valence/arousal model, which contends that happiness and sadness are mutually exclusive. Panel C: Predictions of the evaluative space model (Cacioppo & Berntson, 1994), which allows any configuration of happiness and sadness.

Figure 3. Percentage of subjects who pressed the happy button and the sad button at each point during the control clip (top two panels) and the bittersweet clip (bottom two panels) in Study 1a.

Figure 4. Proportion of subjects who pressed both buttons at each point during the control clip (top two panels) and the bittersweet clip (bottom two panels) in Study 1a.

Figure 5. Number of minutes that each subject who watched the control clip (left panel) and bittersweet clip (right panel) spent pressing both buttons (Study 1a).

Figure 6. Hypothetical time courses of happiness and sadness. Subjects in Studies 4-6 were asked to indicate which one best represented the time course of their happiness and sadness. Panels A, B, C, and D represent nonadjacent, adjacent, partially overlapping, and completing overlapping episodes of happiness and sadness, respectively.

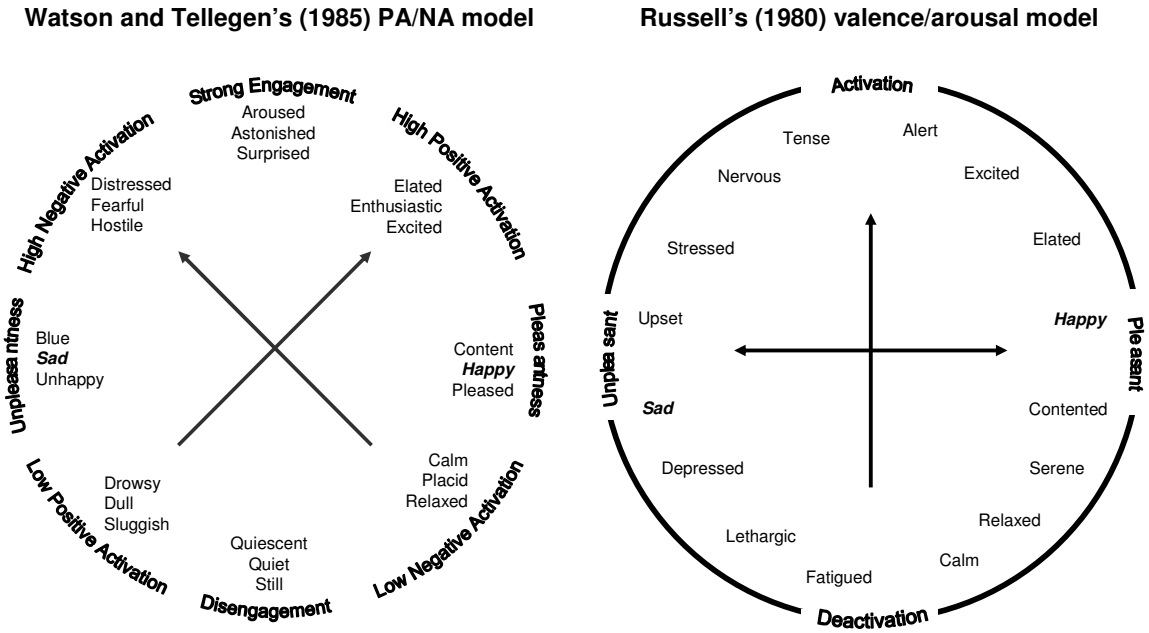
Watson and Tellegen's (1985) PA/NA model
Strong Engagement
Aroused
Astonished
Surprised
High Positive Activation
Elated
Enthusiastic
Excited
Pleasantness
Content
Happy
Pleased
Low Negative Activation
Calm
Placid
Relaxed
Disengagement
Quiescent
Quiet
Still
Low Positive Activation
Drowsy
Dull
Sluggish
Unpleasantness
Blue
Sad
Unhappy
High Negative Activation
Distressed
Fearful
Hostile
Russell's (1980) valence/arousal model
Activation
Tense
Alert
Nervous
Excited
Stressed
Elated
Upset
Happy
Unpleasant
Pleasant
Sad
Contented
Depressed
Serene
Relaxed
Lethargic
Calm
Fatigued
Deactivation

Figure 1

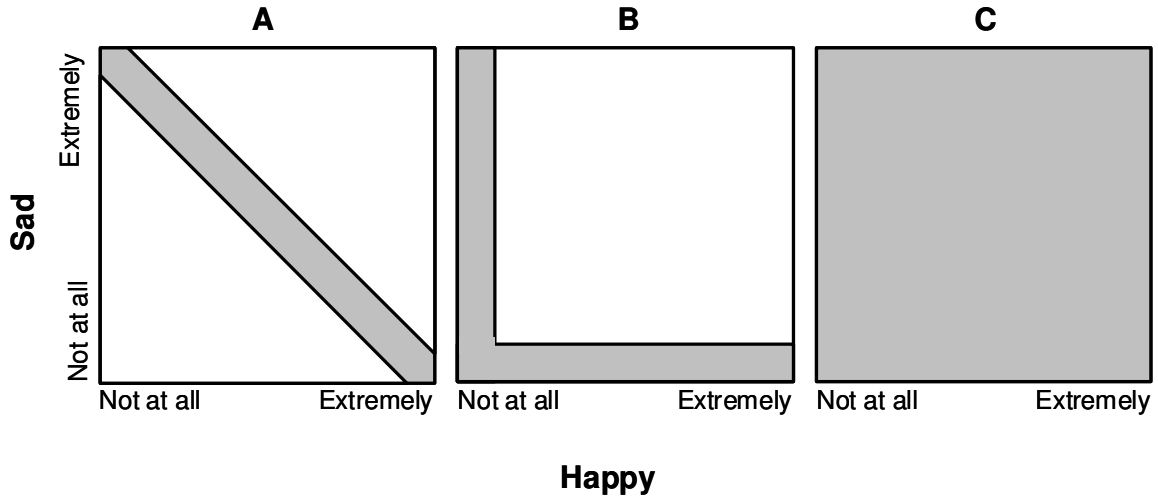
A
B
C
Sad
Extremely
Not at all
Not at all
Extremely
Not at all
Extremely
Not at all
Extremely
Happy

Figure 2

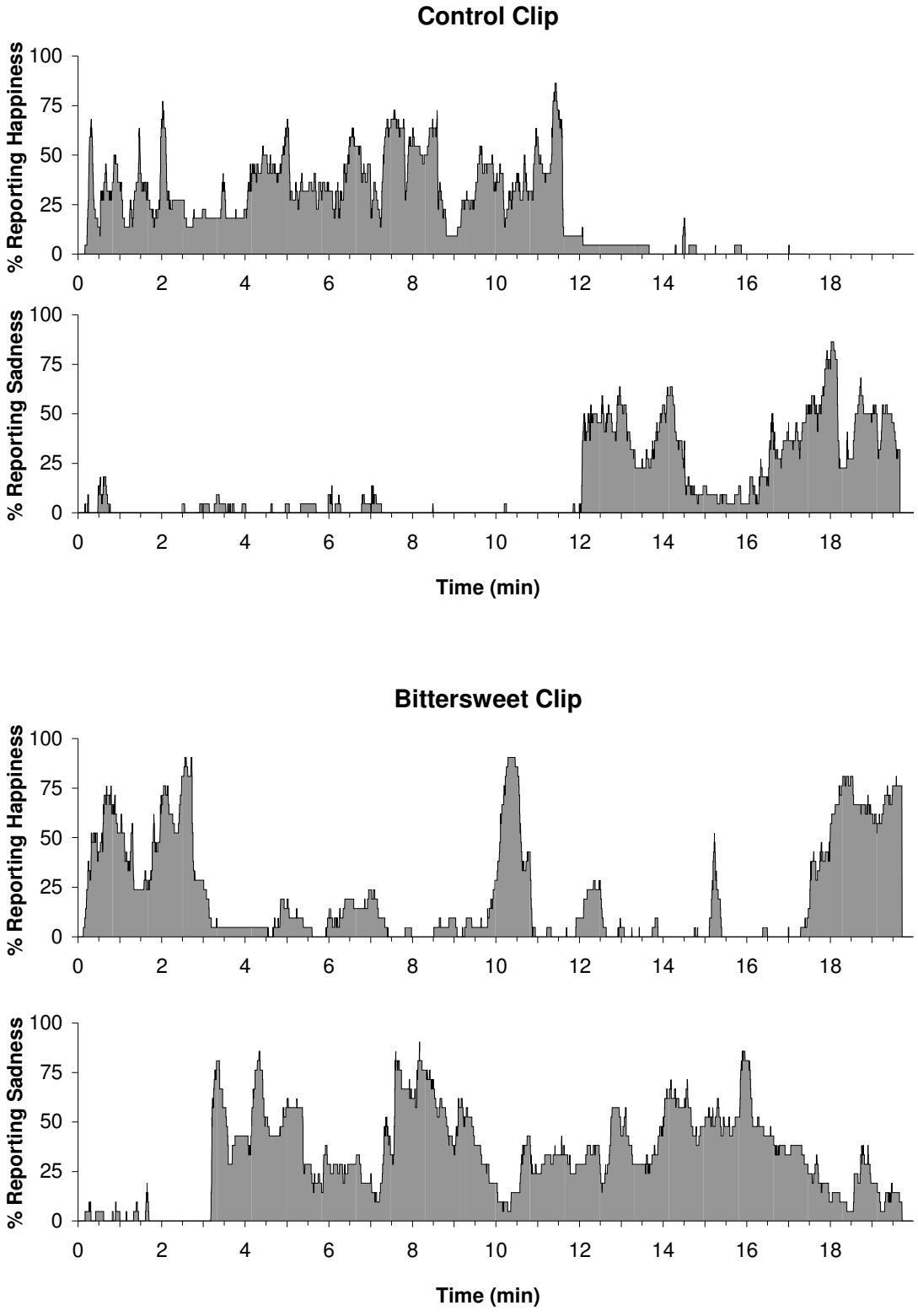
Control Clip
% Reporting Happiness
% Reporting Sadness
Time (min)
Bittersweet Clip
% Reporting Happiness
% Reporting Sadness
Time (min)

Figure 3

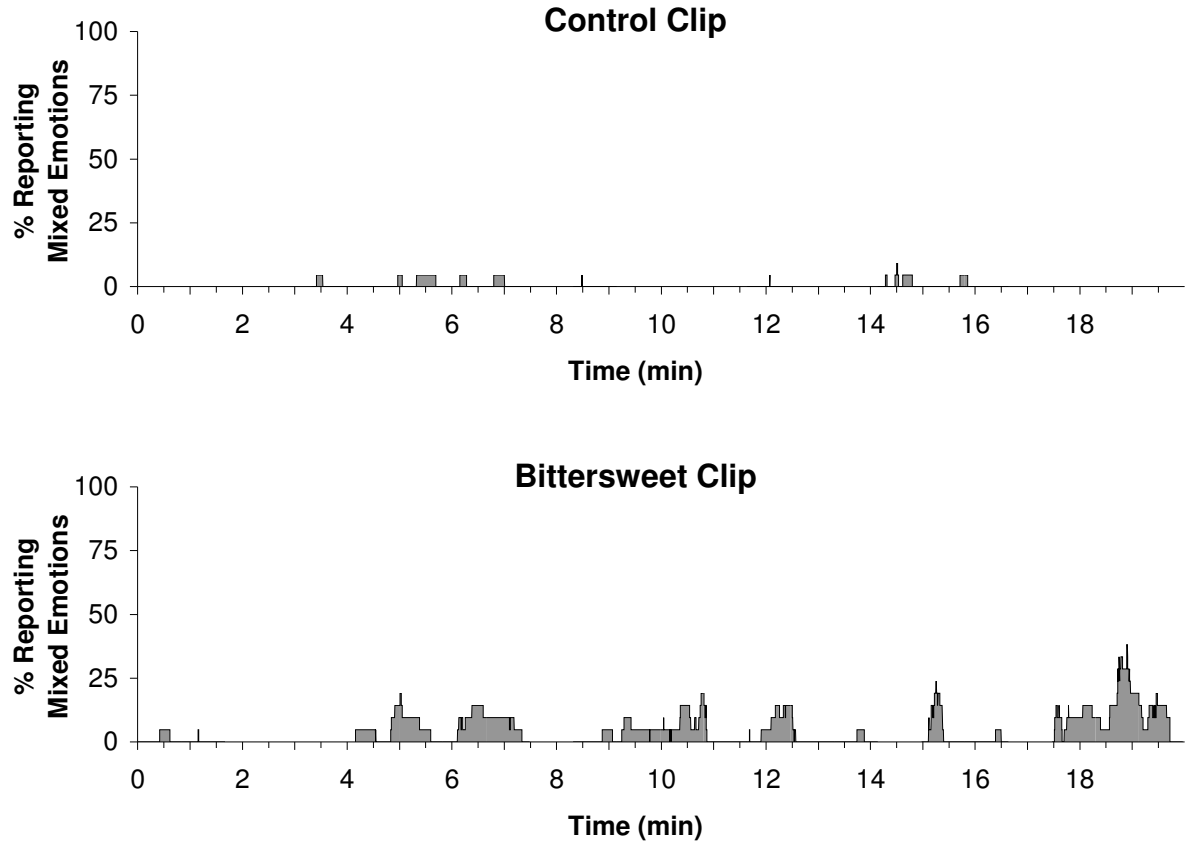
Control Clip
% Reporting Mixed Emotions
100
75
50
25
0
0
2
4
6
8
10
12
14
16
18
Time (min)
Bittersweet Clip
% Reporting Mixed Emotions
100
75
50
25
0
0
2
4
6
8
10
12
14
16
18
Time (min)

Figure 4

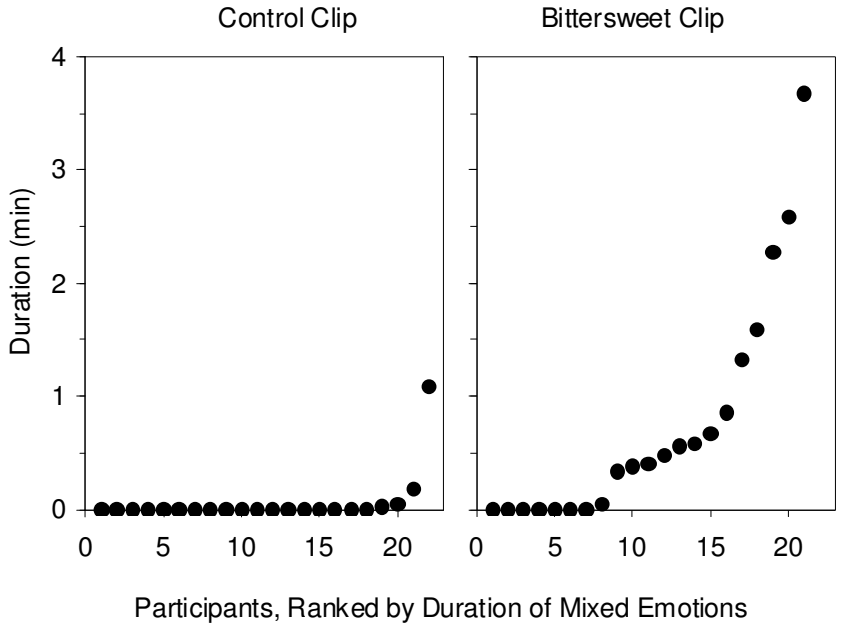
Control Clip
Bittersweet Clip
Duration (min)
0
1
2
3
4
0
5
10
15
20
Participants, Ranked by Duration of Mixed Emotions

Figure 5

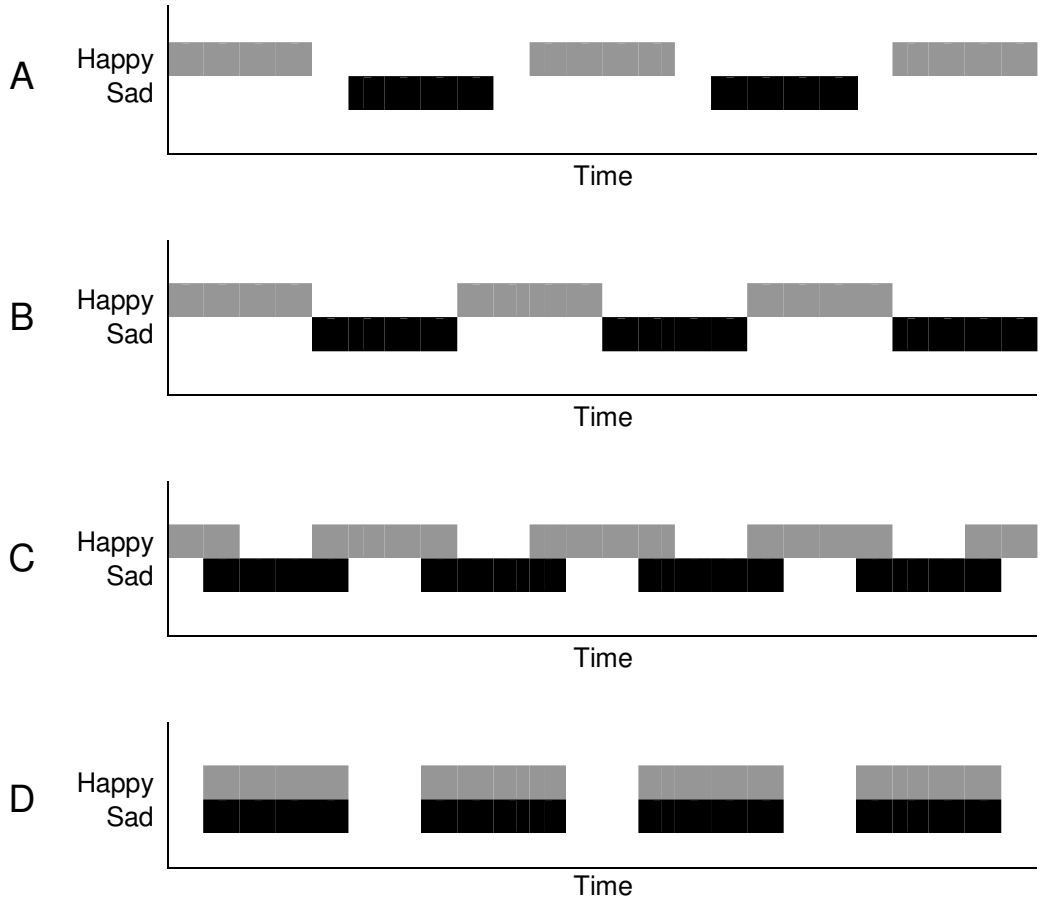
A
Happy
Sad
Time
B
Happy
Sad
Time
C
Happy
Sad
Time
D
Happy
Sad
Time

Figure 6

Supplemental Material

Happy and Sad Results

Study 1b

To examine how emotionally evocative the clips were, we averaged each subject's happiness and sadness ratings across the entire clip (see Table S1). These data were submitted to a 2 (clip: control, bittersweet) x 2 (emotion: happiness, sadness) mixed-model ANOVA, where clip was a between-subjects variable. The only significant effect was a clip x emotion interaction, partial $\eta^2 = .51$. Follow-up between-subjects *t*-tests indicated that the bittersweet clip elicited less happiness than the control clip, $d = 1.14$, but more sadness, $d = 1.05$.

Table S1
Happiness and sadness ratings in Study 1b

	Clip			
	Control		Bittersweet	
Emotion	Mean	*SD*	Mean	*SD*
Happy	1.46	0.55	0.88	0.44
Sad	1.02	0.45	1.63	0.72

Study 2

We averaged each subject's happiness and sadness ratings across the entire clip (see Table S2) and submitted these data to a 2 (condition: no-hypothesis/control clip, bipolarity hypothesis/bittersweet clip) x 2 (emotion: happiness, sadness) mixed-model ANOVA, where condition was a between-subjects variable. The only significant effect was a condition x emotion interaction, partial $\eta^2 = .28$. Follow-up between-subjects *t*-tests indicated that subjects in the bipolarity hypothesis/bittersweet clip group experienced more sadness than those in the no-

hypothesis/control clip group, d = .54; the two groups experienced comparable levels of happiness, $p > .1$.

Table S2
Happiness and sadness ratings in Study 2

	Condition			
	No-hypothesis / control		Bipolarity hypothesis / bittersweet	
Emotion	Mean	*SD*	Mean	*SD*
Happy	1.27	0.67	0.96	0.42
Sad	0.69	0.46	1.28	0.87

Study 3

As in Study 1a, we computed the total amount of time that subjects pressed each button. These data, which are shown in Table S3, were submitted to a 2 (condition: control clip/endorsers, bittersweet clip/non-endorsers) x 2 (emotion: happiness, sadness) mixed-model ANOVA, where condition was a between-subjects variable. The only significant effect was a main effect of emotion, such that subjects experienced more sadness than happiness, partial η^2 = .08.

Table S3
Number of minutes that Study 3's subjects reported happiness and reported sadness

	Condition			
	Control clip / endorsers		Bittersweet clip / non-endorsers	
Emotion	Mean	*SD*	Mean	*SD*
Happy	3.42	2.40	3.54	2.07
Sad	3.94	2.67	4.92	4.39

Study 5

The percentage of subjects in each condition who reported happiness and sadness is shown in Table S4. A chi-square test on the happiness data revealed an effect of condition and a pair of follow-up Fisher's exact tests revealed that both groups of subjects who watched the bittersweet clip were more likely to report happiness than those who watched the control clip. A chi-square test on the sadness data revealed no effect of condition, $p > .7$.

Table S4
Percentage of subjects in Study 5 who reported happiness and sadness

Measure	Condition		
	No-hypothesis / control Clip	No-hypothesis / bittersweet Clip	Bipolarity hypothesis / bittersweet Clip
Reported Happiness	0%	61%	62%
Reported Sadness	67%	58%	59%

Study 6

The percentages of subjects in each condition who reported happiness and sadness are shown in Table S5. A chi-square test on the happiness data revealed an effect of condition and a pair of follow-up Fisher's exact tests revealed that both groups of subjects who watched the bittersweet clip were more likely to report happiness than those who watched the control clip. A chi-square test on the sadness data revealed effect of condition, $p > .3$.

Table S5
Percentage of subjects in Study 6 who reported happiness and who reported sadness

Measure	Condition		
	Proponents / control clip	Proponents / bittersweet clip	Non-proponents / bittersweet clip
Reported Happiness	0%	59%	57%
Reported Sadness	83%	64%	75%