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On the measurement of mixed emotions: A critical review

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Abstract

The Gross Domestic Product (GDP) has typically been used as a measure of a nation's progress and standing in the world. In recent years, economists, psychologists, and policy officials have become increasingly interested in understanding and measuring well-being (both psychological and physical). Yet, as Robert Kennedy noted, measures like GDP ignore many important aspects of daily life, including "the beauty of our poetry or the strength of our marriages, the intelligence of our public debate or the integrity of our public officials." Krueger, Kahneman, Schkade, Schwarz, and Stone (2009) have attempted to rectify this problem by measuring the well-being of individuals and nations through the *U-index*, a measure of the proportion of time an individual spends in an unpleasant state. Although this metric represents a step forward, it focuses on whether people are more experiencing more negative than positive emotions and ignores whether people are experiencing *both* positive and negative emotions. This may be an important oversight because a variety of research in the last decade has demonstrated that such *mixed emotions* represent an important aspect of emotional life and may be associated with healthy outcomes. Mixed emotions researchers have employed a surprisingly disparate array of approaches to measuring mixed emotions. In the present paper, the authors provide a broad, critical review of these approaches and offer recommendations for future researchers who wish to measure mixed emotions.

On the Measurement of Mixed Emotions: A Critical Review

Traditionally, metrics like Gross National Product (GNP) and more recently, Gross Domestic Product (GDP), have been used to evaluate a given nation's progress and compare various countries to each other. Yet, in a 1968 speech at the University of Kansas, Robert Kennedy eloquently noted, "…GNP does not include…the beauty of our poetry or the strength of our marriages, the intelligence of our public debate or the integrity of our public officials…it measures everything, in short, except that which makes life worthwhile" (quoted in Krueger, Kahneman, Schkade, Schwarz, & Stone, 2009). Consequently, recent work in psychology, economics, marketing, and public policy has focused on the concept of psychological well-being as a supplementary way of assessing a nation's progress and overall health. To take a few examples, Krueger et al. (2009), have proposed using a measure of happiness known as the *U-index* to capture the amount of time that the citizens of a nation spend in pleasant or unpleasant states. Along with traditional economic indicators, Diener and Suh (1997) advocate assessing subjective well-being, or an individual's affective and cognitive reactions to his or her life, through the Diener Quality of Life (QOL) scale (Diener, 1995) as a way of evaluating a society. The nation of Bhutan first proposed a global measure of Gross National Happiness (GNH) that has been refined over the years and now comprises seven measures of satisfaction (economic, environmental, physical health, mental health, workplace, social, and political). And, Kramer (2010) has developed an unobtrusive measure of GNH by comparing the difference between positive and negative emotion words for approximately 100 million Facebook users.

Although these metrics collectively represent a step forward in the assessment of a nation's well-being, the majority of this work (e.g., Krueger et al., 2009) has operationalized affective valence as falling along a simple bipolar continuum anchored by pleasant states (e.g.,

happiness) at one end and unpleasant states (e.g., sadness) at the other end. It may be useful instead to conceptualize positive and negative affect as separable dimensions in a bivariate space rather than as opposing poles of a bipolar continuum (Cacioppo & Berntson, 1994; Cacioppo, Gardner, & Berntson, 1997). Supportive findings come from an emerging body of evidence that people sometimes experience mixed emotions (e.g., Ersner-Hershfield, Mikels, Sullivan, & Carstensen, 2008; Larsen & McGraw, 2011; Larsen, McGraw, & Cacioppo, 2001; Williams & Aaker, 2002).

Conceptual and Definitional Distinctions

We define *mixed emotions* broadly as the cooccurrence of positive and negative affect. Mixed emotions therefore represent a subset of *emotion blends*, which refer to the cooccurrence of any two or more same-valence or opposite-valence emotions (Scherer, 1998). Figure 1 illustrates our conceptualization of mixed emotions. By our definition, people experience mixed emotions when their affective state can be characterized as falling into the shaded area, which represents at least some amount of positive affect and negative affect. The absence of mixed emotions is illustrated by the non-shaded, L-shaped area (Russell & Carroll, 1999). The L's horizontal "arm" represents exclusively positive states, its vertical arm represents exclusively negative states, and the intersection of the two represents neutral states (i.e., the complete absence of positive and negative affect).

Additional terms must be defined with the usual caveat that we make no claim that our definitions are any better than anyone else's. We define terms in such a way as to make them most useful in highlighting similarities and distinctions among concepts relevant to the study of mixed emotions. First, we note that the term *affect* can itself refer to a variety of valenced reactions. We focus on affective phenomena that have been characterized as *moods* (i.e., fairly

diffuse pleasant and unpleasant states that can last for hours) and *emotions* (i.e., fairly discrete and usually short-lived states such as anger, fear, sadness, happiness, excitement that are typically far less enduring). Our conceptualization of mixed emotions includes both moods and emotions, so we acknowledge that a term such as *mixed affect* or *ambivalent affect* might be more accurate. We prefer *mixed emotions* in hopes of avoiding jargon (e.g., *ambivalent affect*) that is intended to foster communication but ultimately hinders it.

We also prefer *mixed emotions* because, for the sake of conceptual clarity, our use of the term *mixed emotions* excludes such affective phenomena as *evaluations* (i.e., valenced reactions to some stimulus) including *attitudes* (i.e., enduring valenced reactions to stimuli that can be, but certainly need not be, so stable as to last a lifetime). We acknowledge, of course, that evaluations can influence moods and emotions. For instance, people who experience excitement upon learning that they have just won the lottery are presumably excited because they have a positive attitude toward receiving an almost unimaginably large return on an investment that has a rate of return of -.47 (Haisley, Mostafa, & Loewenstein, 2008; LaFleur & LaFleur, 2003). We also note that mixed emotions are conceptually similar to *ambivalent attitudes* (i.e., attitudes characterized by a mixture of positive and negative evaluative reactions; Cacioppo & Berntson, 1994; Priester & Petty, 1996; Thompson, Zanna, & Griffin, 1995) and that the past decade's work on mixed emotions would not have been possible without the past half-century's conceptual work (e.g., Cacioppo & Berntson, 1994; Cacioppo, Gardner, & Berntson, 1997; Scott, 1968) and empirical work (e.g., Kaplan, 1972; Priester & Petty, 1996) on attitudinal ambivalence.

Most research on mixed emotions involves the subjective experience of affect (i.e., *feelings*) and could therefore be more precisely referred to as research on *mixed feelings* (e.g., Larsen, Hemenover, Norris, & Cacioppo, 2003; Schimmack, 2001), but some research has

involved other aspects of affective reactions (e.g., facial expressions; Griffin & Sayette, 2008; Harris & Alvarado, 2005). In addition, work by Winkielman, Wilbarger, and Berridge (2005) and Leander, Moore, and Chartrand (2009) (2005; see also, Leander, Moore, & Chartrand, 2009) raises the intriguing possibility that some affective states need not be felt (i.e., consciously experienced). Though we are aware of no evidence for such unconscious mixed emotions and do not anticipate any in the near future, we see no reason to limit our definition to consciously-experienced affective states.

The Role of Mixed Emotions in Healthy Coping

Conceptualizing positivity and negativity as distinct raises questions about the antecedents of well-being that bipolar approaches overlook. Fredrickson and Losada (2005) reviewed a variety of evidence that positive emotions lead to greater well-being, but speculated that negative emotions can sometimes be beneficial. There is little evidence to date for the notion that such *appropriate negativity* (Fredrickson & Losada, 2005) can contribute to well-being. Most people experience more positive than negative emotions (Diener & Diener, 1996) and people with a higher ratio of positive emotions to negative emotions typically have higher well-being. In one community sample, people with unusually high ratios had levels of subjective well-being as high as those with merely higher-than-average ratios (Tarlow Friedman, Schwartz, & Haaga, 2002).

In times of stress, however, Larsen, et al.'s (2003) coactivation model of healthy coping contends that negative emotions coupled with positive emotions can foster healthy coping. The model was derived from research on the effects of writing about stressors on well-being. A consistent finding is that those whose who include more emotion-related words in their narratives cope more effectively. Different studies have yielded different conclusions when it

comes to the relationship between the emotional valence of those words and healthy outcomes. Some studies have found that people who used a greater preponderance of positive emotion words showed better outcomes (Pennebaker & Francis, 1996; Stein, Folkman, Trabasso, & Richards, 1997), but at least one study demonstrated that those who used a greater preponderance of *negative* emotion words showed better outcomes (Pennebaker, 1993). To reconcile these seemingly-discrepant findings, Larsen et al. (2003) suggested that effective coping with stressors requires an optimal ratio of positive emotions. In essence, the coactivation model contends that sometimes the best approach is to take the good with the bad. By this account, experiencing positive emotions during stressful times allows people to grapple with their negative emotions and ultimately find meaning in the stressors. In other words, sometimes negativity might be appropriate negativity and intermediate ratios of positive emotions might be more beneficial than extremely high ratios.

Recent findings have provided initial support for the coactivation model of healthy coping. Whereas Tarlow Friedman et al. (2002) investigated the relationship between the ratio of positive affect and well-being in a community sample, Shrira, et al. (2011) studied Israeli cancer patients and hospital employees exposed to missile attacks. They asked participants to indicate how frequently they had experienced several positive affective states and negative affective states during the past week with Bradburn's (1969) Affect Balance Scale. They found a curvilinear relationship between the ratio of positive affect and several measures of well-being. For instance, they found that individuals with the lowest positivity ratios experienced the most psychological distress but that those with the highest ratios showed more distress than those with intermediate ratios. In other words, individuals with intermediate ratios showed the least

psychological distress. Cancer patients with intermediate ratios also showed the highest levels of acceptance and perceived the most benefits from their illness.

The coactivation model contends that intermediate ratios of positive emotions can be beneficial during stressful times because mixed emotions lead to intermediate ratios. As such, Shrira et al.'s (2011) findings are consistent with the coactivation model's contention that mixed emotions can foster healthy coping. Yet Shrira et al. did not mention mixed emotions, perhaps because experiencing mixed emotions is only one of two ways to arrive at an intermediate ratio. Another way is to experience negligible positive and negative emotions. After all, 1/1 = 2/2 = 4/4 = 8/8, and so on. Thus, one possibility is that participants who experienced relatively little emotion, rather than relatively intense mixed emotions, showed the greatest well-being.

Adler and Hershfield (2012) recently addressed this possibility by actually measuring mixed emotions. They asked adults undergoing psychotherapy to write narratives about "their thoughts and feelings associated with being in therapy" (p. 3). Narratives were coded for the presence of eight different emotions (happiness, excitement, surprise, sadness, fear/anxiety, anger, shame and guilt). Not only was the experience of mixed emotions of happiness and sadness associated with improvements in psychological well-being above and beyond the impact of the passage of time, but changes in mixed emotional experience actually preceded improvements in well-being. Taken together with Shrira et al.'s findings (2011), Adler and Hershfield's findings provide evidence for the coactivation model's contention that a combination of positive and negative emotions can foster healthy coping.

Positive and negative affect have also been shown to have unique effects on measures of autonomic nervous system activity. Dowd, Zautra, and Hogan (2010) asked participants to engage in the stressful task of preparing a speech to defend themselves against a hypothetical

false accusation. They obtained separate measures of Positive Activation and Negative Activation (i.e., PA & NA; Watson, Wiese, Vaidya, & Tellegen, 1999) with the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). Positive and Negative Activation comprise high-arousal positive and negative emotions such as *excited* and *nervous*, respectively. Participants who reported high levels of Positive Activation immediately before the speech showed greater systolic blood pressure reactivity during the speech, as did those who reported high levels of Negative Activation. This pair of findings suggests that individuals who experienced mixed emotions composed of Positive Activation and Negative Activation had the highest levels of systolic reactivity. Additional analyses suggested that these individuals also showed the most systolic recovery. Thus, mixed emotions may be associated with short-term optimal cardiovascular functioning, which can have long-term health implications.

More recently, Hershfield, Scheibe, Sims, and Carstensen (in press) assessed the impact of mixed emotions on health outcomes in a 10-year longitudinal experience-sampling study in a sample of adults ranging in age from 18 to 94. At each sampling occasion (5 per day, over the course of 7 days), they asked individuals to report the extent to which they were experiencing each of 19 different emotions (11 negative and 8 positive) on 7-point Likert scales. Hershfield et al. (in press) found that frequent experiences of mixed emotions were strongly associated with better physical health. More important, the researchers discovered that increases of mixed emotions over a ten-year period attenuated typical age-related health declines.

All of these lines of research indicate that capturing mixed emotional experiences is necessary for obtaining a complete picture of well-being. One challenge is that although a host of studies have examined mixed emotions, little consensus has been reached on how best to *measure* mixed emotions. Consider the mere handful of studies reviewed above. Shrira et al.

(2011) calculated a ratio of the amount of positive to negative affect experienced in the past week, Adler and Hershfield (2011) assessed whether individuals mentioned both happiness and sadness in a given narrative, Dowd et al. (2010) investigated whether Positive Activation (cf., happiness) and Negative Activation (cf., sadness) had unique effects on outcome measures, and Hershfield et al. (in press) calculated the intraindividual correlation between average positive emotions and average negative emotions. Such an array of approaches can make it difficult to gain a complete understanding of the nature of mixed emotions in particular and, as a result, the nature of emotion more broadly. It also makes it difficult to gain a complete understanding of the effects of mixed emotions on well-being. Our main goal is to provide a critical review of the approaches that have been used to make inferences about mixed emotions and offer recommendations for future researchers who wish to measure mixed emotions.

A Critical Review of Measurement Strategies

Emotion measures often involve bipolar scales anchored at one end by positive emotions and at the other end by negative emotions. One widely-used example is Lang's (1980) self-assessment manikin which comprises a series of human-like manikins (albeit ones whose bodies contain more right angles than do humans' bodies) expressing different amounts of negative or positive affect. Participants' task is to choose the manikin that best represents their own affective state. A related approach is to simply ask people to rate their emotions on a scale anchored by polar opposite emotions. In a remarkable study, Tokaji (2003) used such bipolar scales to study the Japanese concept of *kandoh*, which can be translated into English as "feeling moved." Undergraduates watched a genuine home video made by a man that comprised photos of his wife and music that she enjoyed. Though the home video they watched was genuine, participants received fictitious background information about the video. After watching the home video,

participants made a number of ratings, including the extent to which they felt happy (1) or sad (7) on a 7-point scale. Participants in a group who had been told that the man had prepared the video for his wife for their anniversary generally indicated that the clip made them very happy (M = 1.8).

In contrast, the average participant in a group who had been told the man had "produced this video with feelings of love for his wife who passed away after an illness" (p. 246) assigned a rating that was quite close to the midpoint of 4 (*M* = 4.4). In light of this finding and the bittersweet background information provided to participants in the love/illness condition, it is tempting to conclude that participants in that condition experienced mixed emotions of happiness and sadness. Indeed, Tokaji (2003) seemed to suggest as much. Unfortunately, it is difficult to make inferences about mixed emotions on the basis of bipolar ratings. Tokaji noted that participants in the love/illness condition showed considerable variance in their happy-sad ratings, which raises the possibility that some people felt exclusively happy and others exclusively sad. Moreover, bipolar ratings of affect are similar to measures of the ratio of positive affect (e.g., Fredrickson & Losada, 2005; Friedman et al., 2002; Shrira et al., 2011) in that they reflect the balance of positive and negative affect (i.e., positive affect - negative affect; Cacioppo, Gardner, & Berntson, 1997) rather than underlying levels of positive and negative affect in their own right. As a result, ratings near the midpoint might reflect mixed emotions of positive and negative affect that cancel one another out, but they might also reflect feelings of neutrality (i.e., the complete absence of both positive and negative affect).

One implication is that bipolar measures offer little opportunity for understanding mixed emotion. As Annas (2004) noted,

> I have seen a survey that asks people to measure the happiness of their lives by assigning it a face from a spectrum with a very smiley face at one end and a very frowny face at the other. Suppose that you have just won the Nobel Prize; this surely merits the smiliest face. But suppose also that you have just lost your family in a car crash; this surely warrants the frowniest face. So, how happy are you? There is no coherent answer–unless you are supposed to combine these points by picking the indifferent face in the middle! (p. 44-45).

We agree with Annas about the potential limitations of bipolar measures, but we still see their value for the study of emotion because the balance of pleasure and pain serves as the conceptual basis of Benthamite utility (Mellers, 2000) and figures heavily in leading models of the structure of affect (e.g., Russell, 1980; Russell & Carroll, 1999). In addition, both theory (Cacioppo & Berntson, 1994) and data (Larsen, et al., 2001; Larsen & Stastny, 2011; MacKerron, 2012) indicate that emotional experience very often falls quite nicely along a bipolar dimension. It is not often that people win a Nobel Prize on the same day that they lose their family in a car crash. We might go so far as to suggest that it has never happened and, for the sake of future Nobel Prize winners and their families, sincerely hope that it never does.

Nonetheless, it appears that less momentous events (e.g., engaging in psychotherapy (Adler & Hershfield, 2011); making a stressful speech (Dowd et al., 2011)) can elicit mixed emotions, so it is necessary to supplement bipolar measures with measures that can shed more light on mixed emotions. Measuring any given emotional experience is difficult (e.g., Heavey, Hurlburt, & Lefforge, 2012). Measuring mixed emotions must be at least as difficult and probably much more so. Below, we review each of several broad strategies for making inferences about mixed emotions. Specifically, researchers have drawn inferences from (a) direct

measures of mixed emotions, (b) the coactivation of positive and negative affect, (c) external correlates of positive and negative affect, and (d) correlations between positive and negative affect (i.e., *emotional complexity*). For each broad strategy, we review several example cases. We then compare the two most commonly used strategies (i.e., the use of cooccurrence-based & correlation-based measures) to each other.

Inferences from Direct Measures of Mixed Emotions

One straightforward approach to measuring mixed emotions is to essentially ask people whether they are experiencing mixed emotions. Attitudes researchers have taken a similar approach to measuring *felt ambivalence* (e.g., Newby-Clark, McGregor, & Zanna, 2002), which refers to the feelings of conflict, tension, and indecision associated with evaluating an attitude object (e.g., capital punishment) as both good and bad (i.e., *potential ambivalence*; Newby-Clark et al., 2002).[1] In their study of mixed emotions, Williams and Aaker (2002) asked participants to rate how conflicted, confused, and uncomfortable they felt about emotionally-evocative advertisements for a fictional moving company. They found that bittersweet ads elicited more felt ambivalence than happy ads and, in one study, marginally more felt ambivalence than sad ads. They also found that bittersweet ads elicited more felt ambivalence among European Americans as opposed to Asian Americans and among older adults as opposed to young adults.

In their study of whether college graduation is associated with mixed emotions, Larsen et al. (2001) asked University of Chicago students to indicate whether they felt bittersweet. They found that students reported feeling more bittersweet on their graduation day than during a typical day on campus. They did not, however, report feeling more ambivalent. Moreover, Ohio State students did not report feeling more bittersweet on the day they moved out of their

[1] Felt ambivalence and potential ambivalence have also been referred to as *objective ambivalence* and *subjective ambivalence*, respectively (Priester & Petty, 1996).

dormitories than during a typical day on campus. Additional data suggested that this may have been because Ohio State freshmen were less likely than Chicago seniors to know what *bittersweet* means, suggesting that one obvious limitation of directly measuring specific experiences of mixed emotions is that the participant population needs to have the same understanding of the given experience as the researchers do.

The use of direct measures of mixed emotions necessarily requires an *a priori* hypothesis about whether the affective state being measured (e.g., conflict; bittersweet) is associated with mixed emotions. For example, Wildschut, Sedikides, Arndt, and Routledge (2006) posited that *nostalgia* is a blend of mostly positive emotions tinged with some sadness that occurs when one looks back on previous events in their lives. Provocative evidence comes from a recent study in which undergraduates were asked to rate their emotional reactions to songs from their youth (F.S. Barrett, Grimm, Robins, Wildschut, Sedikides, & Janata, 2010). Those songs that elicited the most nostalgia were those that elicited the most intense mixed emotions of happiness and sadness.

Despite the findings of Larsen et al. (2001) and F. S. Barrett et al., (2010), many episodes of mixed emotions may not involve feelings of bittersweet and nostalgia. We find it highly unlikely, for instance, that Dowd et al.'s (2011) participants felt particularly bittersweet or nostalgic as they defended themselves against a false accusation. Similarly, correlations between measures of potential ambivalence and felt ambivalence are typically as low as .40 (Priester & Petty, 1996). All of this suggests that direct measures of mixed emotions can only tell us so much about mixed emotions.

Inferences from Measures of the Constituent Positive and Negative Emotions

Not surprisingly, most attempts to measure whether people are experiencing two of more opposite-valence emotions entail measuring whether they are experiencing each of the constituent emotions. The next step is to somehow combine the measures of the component emotions into an index of their cooccurrence on a participant-by-participant basis and even, when necessary, an occasion-by-occasion basis. For instance, Adler and Hershfield (2011) used content coding to identify whether each of the approximately 500 narratives written by their 47 participants made reference to the experience of both positive and negative emotions.

Unfortunately, determining how best to combine the measures is not terribly straightforward. Scherer and Ceschi (1997) investigated the emotional experience of airline passengers who had just reported to an airline agent that their luggage was missing. They asked the passengers to rate the extent to which they felt angry, resigned, worried, and in good humor. The vast majority of participants reported emotion blends comprising the experience of two or more emotions with at least some intensity. Many reported mixed emotions of, for instance, good humor coupled with resignation or worry. As Scherer and Ceschi noted, however, "Given the wide variability of these blends, it is difficult to report these data in the form of simple indices" (p. 220) and cluster analyses of passengers' emotion profiles yielded an unwieldy number of clusters. Scherer and Ceschi instead resorted to illustrating the variety of blends with a figure.

Other studies have also yielded insight into mixed emotions but little insight into how to quantify mixed emotions. In an early use of experience sampling to study emotional experience in everyday life, Diener and Iran-Nejad (1986) asked undergraduates to make a variety of emotion ratings when they found themselves experiencing an emotional episode over the course of a 6-week period. For each episode, they calculated a measure of positive emotions by averaging the ratings of a variety of positive emotions (e.g., happy, fun/enjoyment) and a

measure of negative emotions by averaging the ratings of a variety of negative emotions (e.g., depressed/blue, angry/hostile). Diener and Iran-Nejad provided a 9 (intensity of positive emotion) x 9 (intensity of negative emotion) contingency table to illustrate how frequently participants reported various combinations of positive and negative emotions. They noted that participants typically reported a combination of positive and negative emotions, but that intense positive emotions appeared to preclude intense negative emotions and vice versa. Though Diener and Iran-Nejad provided suggestive evidence that mixed emotions can occur fairly regularly in everyday life, they made no attempt to provide a simple index of mixed emotions. Subsequent researchers have spent considerable effort developing indices of mixed emotions.

Absolute difference. One fairly simple approach suggested by Hui, Fok, and Bond (2009) might be to calculate the absolute value of the differences in positive and negative affect:

$$\text{Absolute Difference} = |\text{Positive Affect} - \text{Negative Affect}|$$

The thinking is that smaller absolute differences in positive and negative affect reflect greater mixed emotions. Unfortunately, such an index is no better than bipolar rating scales for indexing mixed emotions. The absolute difference between positive and negative affect will approach 0 when someone is experiencing mixed emotions comprised of comparably intense positive and negative emotions, but it will also approach 0 when someone is experiencing neither positive nor negative emotions. This might help explain why Hui et al. merely suggested the absolute differences approach and did not actually employ it.

Dichotomous cooccurrence. A better approach to quantifying mixed emotions is to simply determine whether a given participant experienced both of the constituent emotions at a particular moment. We refer to this as the *dichotomous cooccurrence index.* Folkman and Lazarus (1985) investigated students' experience of threat-related emotions (e.g., *worried*,

fearful) and challenge-related emotions (e.g., *confident*, *hopeful*) as an exam loomed two days ahead. They found that some 94% of participants reported at least some amount of both threat and challenge emotions. In a similar study, Smith and Ellsworth (1987) asked students to report how they were feeling immediately before an exam or immediately after students learned how well they had done. Before the exam, more students were at or above the midpoint of the scale for both threat-related emotions (e.g., fear) and challenge-related emotions (e.g., hope) (24%) than for any other pair of emotions, including same-valence emotions (e.g., hope-related emotions & happiness, threat-related emotions & anger). After the exam, however, positive emotions (including challenge-related emotions) "rarely or never combined" (p. 483) with negative emotions (including threat-related emotions).

One challenge in applying the dichotomous cooccurrence index to graded measures (e.g., rating scales) is that it requires researchers to set a threshold for dichotomizing the measures of each of the constituent emotions. Folkman and Lazarus (1985) presumably observed a higher incidence of mixed emotions than did Smith and Ellsworth (1987) in part because they set a less conservative threshold. Visual inspection of Diener and Iran-Nejad's (1986) contingency table indicates that applying Folkman and Lazarus's liberal threshold yields an incidence of mixed emotions of 60%. Applying Smith and Ellsworth's more conservative threshold leads that incidence to plummet to 0.07%.

One way to avoid the vagaries of dichotomizing non-dichotomous data is to simply collect dichotomous data. Russell and Carroll (1999) essentially took this approach in order to study mixed emotions of happiness and sadness. In a classroom setting, they asked people whether they felt happy and whether they felt sad. (Those who answered "yes" to either question were subsequently asked to rate the intensity of the emotion on 5-point scales, but Russell &

Carroll, 1999, made inferences about mixed emotions solely on the basis of people's answers to the dichotomous questions.) Most participants reported feeling happy and some reported feeling sad. Only 10% reported feeling both happy and sad, which suggests that the incidence of mixed emotions was very low. This finding is theoretically important because it is quite consistent with the circumplex model of affect's claim that happiness and sadness are mutually exclusive (Russell & Carroll, 1999). According to this model, at any moment in time people's affective state can be characterized in terms of two fairly orthogonal dimensions: valence and activation. Moreover, polar opposite emotions such as happiness and sadness (which fall near the opposite ends of the valence dimension) should be mutually exclusive in experience.

Larsen et al. (2001) used similar measures to test the generalizability of Russell and Carroll's (1999) findings to more bittersweet situations. They found that 11% of filmgoers reported mixed emotions of happiness and sadness before watching the tragicomedy *Life Is Beautiful*. The more novel finding was that 44% of filmgoers reported mixed emotions after the film. Larsen et al.'s (2001) findings are consistent with the evaluative space model's notion that the positive and negative substrates of the affective system are separable (Cacioppo & Berntson, 1994; Cacioppo, et al., 1997). The results are difficult to reconcile with the circumplex model's contention that happiness and sadness are mutually exclusive, but the circumplex model could accommodate the findings if participants merely vacillated between happiness and sadness (Barrett & Bliss-Moreau, 2009; Larsen, McGraw, Mellers, & Cacioppo, 2004).

To address this alternative interpretation, subsequent researchers have calculated dichotomous cooccurrence indices on the basis of moment-to-moment measures of happiness and sadness, which possess greater greater temporal resolution than Larsen et al.'s (2001) static measures. After watching a 6-min film clip, Carrera and Oceja (2007) asked participants to chart

how the intensity of their happiness and sadness changed over the course of the clip. Carrera and Oceja quantified simultaneously mixed emotions in terms of whether both curves exceeded zero at any point in time. Participants who watched a bittersweet clip were nearly twice as likely to report simultaneously mixed emotions as those who watched a control clip, which provided evidence for simultaneously mixed emotions.

One limitation of Carrera and Oceja's (2007) measurement strategy 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). Larsen and McGraw (2011; Studies 1a & 3) derived dichotomous cooccurrence indices of mixed emotions on the basis of moment-to-moment measures of happiness and sadness collected in the moment, rather than retrospectively. Specifically, they showed participants clips from *Life is Beautiful* and asked participants to press the left mouse button whenever they felt happy and the right mouse button whenever they felt sad. Participants spent more time pressing both buttons at the same time (and thereby reporting the cooccurrence of happiness and sadness) while watching a clip containing bittersweet scenes than while watching a control clip. Taken together, the results from Carrera and Oceja's study and those of Larsen and McGraw's button press study extended Larsen et al.'s (2001) evidence that people can feel happy and sad at the same time.

Dichotomous cooccurrence indices can also be derived from open-ended self-report measures of emotion. Larsen and McGraw (2011; Study 5) asked participants to write about how they were feeling immediately after watching clips from *Life Is Beautiful*. They found that participants were more likely to write that they felt both happy and sad after watching a clip

containing bittersweet scenes. Larsen, To, and Fireman (2007) interviewed children after they watched a bittersweet clip from an animated film (e.g., “How do you feel right now?”) and found that older children were more likely to report both happiness and sadness than younger children

In order to test the hypothesis that events are funny when they are in some sense wrong but also benign, McGraw and Warren (2010) used the dichotomous cooccurrence index to measure mixed emotions of amusement and disgust. They asked undergraduates to indicate whether they felt amused and whether they felt disgusted after reading a hypothetical scenario about a man engaging in frottage with a kitten. The man's action violates the proscription against bestiality, so it is not surprising that most participants indicated that they were disgusted. Despite finding the man's action disgusting, approximately half of the participants also found it amusing if the scenario mentioned that the kitten purred during the contact. By way of comparison, only a quarter of participants found it amusing if the kitten whined. Thus, the more benign violation was more likely to elicit mixed emotions.

The dichotomous cooccurrence index is most often derived from self-report data, but it can be derived from any index of opposite-valence emotions. Harris and Alvarado (2005) used Ekman and Friesen’s (1978) Facial Action Coding System (FACS) to explore people's emotional reactions to being tickled. They found that some people showed pure Duchenne smiles, which are suggestive of positive affect. Other people showed "mixed smiles" comprising Duchenne smiles coupled with expressions of negative affect (e.g., furrowed brows). In a similar study, Griffin and Sayette (2008) found that many smokers, particularly those who had recently tried and failed to quit, often showed mixed smiles as they watched a burning cigarette.

MIN. Mixed emotions may vary in intensity, so graded indices of mixed emotions can be more useful than dichotomous indices. Indeed, it seems reasonable to suggest that the handful of

observations in Diener and Iran-Nejad's (1986) study in which the respondents' mean positive and mean negative rating was 3 (on a scale from 0-6) reflects more mixed emotions than those in which the respondents' mean positive and mean negative rating was only 1. The most straightforward graded index is the MIN score. MIN was originally introduced to the attitudes literature by Kaplan (1972) as a measure of what has since been referred to as *potential ambivalence* (Newby-Clark, et al., 2002; cf. *objective ambivalence*, Priester & Petty, 1996). The idea is that having positive and negative reactions to the same attitude object (e.g., capital punishment) increases the potential to experience feelings of conflict, tension, and indecision (i.e., *felt ambivalence*). To calculate the MIN score as an index of mixed emotions (cf., attitudinal ambivalence), researchers measure positive emotions and negative emotions and calculate the smaller (i.e., minimum) of the two values:

$$\text{MIN} = \text{minimum}(\text{positive}, \text{negative})$$

For instance, if an individual reports feeling extremely happy (e.g., 5 on a 0-5 scale) but not at all sad (i.e., 0), then MIN (happy, sad) = MIN (5, 0) = 0. If the individual reports feeling increasingly sad, MIN will rise accordingly. Note that MIN will only reach the ceiling if both positive *and* negative emotions are at maximum intensity. Note also that dichotomous cooccurrence measures indicate a special case of MIN, one in which participants who meet threshold for reporting both positive and negative emotions receive a MIN score of 1 and all others a score of 0.

Potential ambivalence (e.g., "I feel both good and bad about capital punishment) is very similar to mixed emotions (e.g., "I feel happy and sad"), so it makes sense that Schimmack (2001) imported MIN from the attitudes literature to index mixed emotions. He had participants rate how pleasant and unpleasant they felt after viewing a series of pictures. After viewing

pleasant pictures, people reported a great deal of positive affect and little negative affect, which resulted in modest MIN scores. After viewing unpleasant pictures, however, people reported moderate amounts of both positive and negative affect, which resulted in relatively large MIN scores.

MIN has since become the most commonly used cooccurrence-based measure of mixed emotions. As indexed by MIN, for instance, participants have reported more mixed emotions of good and bad feelings after winning the smaller of two amounts of money in a lottery (e.g., $5 instead of $12) as opposed to the larger of two amounts ($5 instead of $3; Larsen, et al., 2004), more mixed emotions of pleasure and displeasure after viewing rapidly-alternating pairs of opposite-valence, as opposed to same-valence, pictures (Schimmack & Colcombe, 2007), and more mixed emotions of disgust and amusement after watching a disgusting film clip from the perspective of a dispassionate observer, as opposed to that of the protagonist (Hemenover & Schimmack, 2007). Ersner-Hershfield et al. (2008) have used MIN to investigate the effect of limited time on feelings of poignancy, which they operationalized as mixed emotions of happiness and sadness. In one study, they had participants across the life span undergo a guided imagery induction in which they repeatedly imagined visiting a meaningful location. Compared to a control group, participants who imagined visiting this location for the final time showed an increase in MIN scores. In a follow-up study, Ersner-Hershfield et al. asked Stanford students to report the intensity of the emotions they were feeling on their graduation day, and highlighted the salience of the ending of college for one group of students. They found that MIN ratings were higher for students who had been reminded that this was their last day as Stanford undergraduates than for students who simply completed the emotion questionnaire.

MIN ratings have also been derived from the *continuous evaluative space grid* (Larsen, Norris, McGraw, Hawkley, & Cacioppo, 2009), which provides graded moment-to-moment measures of positive and negative affect. To complete the evaluative space grid, participants move the cursor left and right along a computerized grid's x-axis to report changes in positive affect and up and down along its y-axis to report changes in negative affect. The bottom edge represents exclusive positive affect, the left edge represents exclusive negative affect, and the interior represents coactivation of positive and negative. Larsen and McGraw (2011; Studies 1b & 2) asked participants to complete a 5 x 5 version of the continuous evaluative space grid as they watched either a bittersweet or control clip from *Life Is Beautiful*. The computer recorded which cell the cursor was in every 500 msec, thereby yielding moment-to-moment measures of happiness and sadness, as well as MIN scores. For each participant, Larsen and McGraw collapsed across time to compute a mean MIN score. They found that participants who watched the bittersweet clip had higher mean MIN scores than those watched a control clip, which extended evidence from Larsen and McGraw's button press study that the bittersweet clip elicited more simultaneous mixed emotions.

Other cooccurrence-based measures. Some researchers have imported Thompson et al.'s (1995) measure of ambivalence, which Priester and Petty (1996) later dubbed the *similarity-intensity measure*, from the attitudes literature to serve as measures of mixed emotions. Though Thompson et al. (1995) expressed their measure with a fairly complex formula, Priester and Petty (1996) noted that it can be expressed most simply as:

$$SIM = 3 * MIN(positive, negative) – MAX(positive, negative)$$

SIM is strongly associated with MIN. It only differs from MIN in that it decreases with increases in the larger of the positive and negative ratings (i.e., MAX). In other words, it increases as

positive and negative ratings become more comparable. To take an example, if an individual is experiencing an 8 on happiness (on an 8-point scale) and a 8 on sadness (again, on an 8-point scale), then Ambivalence = 3 * 8 – 8 = 16. This is a case when emotions are both similar and intense, and consequently, the resulting ambivalence score is a maximum of 16. A situation in which negative emotions equal 2 and positive emotions equal 8 would elicit a considerably lower ambivalence score: 3*2 – 8 = -2. Fong and Tiedens (2002) found that women who were assigned a high status position in a role-play task experienced subsequently higher amounts of mixed emotions compared to women assigned a low-status position, as indexed by SIM. Williams and Aaker (2002) used SIM scores to confirm that an ostensibly bittersweet ad for a hypothetical moving company elicited more mixed emotions than ostensibly happy and ostensibly sad ads.

The most sophisticated measure of subjective attitudinal ambivalence, which follows from Priester and Petty's (1996) gradual threshold model (GTM), was recently employed as a measure of mixed emotions by Podoynitsyna, Van der Bij, and Song (2012). The GTM can be expressed as:

$$GTM = 5 * MIN(positive, negative)^{0.5} - MAX(positive, negative)^{1/MIN(positive, negative)}$$

The GTM measure is closely related to SIM, and by extension, to MIN. The main difference is that the effect of MIN on the GTM measure decreases (and that of MAX increases) as MIN increases. Podoynitsyna et al. (2012) asked entrepreneurs to rate the extent to which reading about a retailer's opportunity to open a new outlet made them feel a variety of positive and negative emotions. They took the innovative approach of assessing mixed emotions in terms of the *number* of opposite-valence emotions that participants reported, as opposed to the *intensity* of those emotions. Specifically, they counted the number of positive emotions and negative

emotions for which each participant's rating exceeded that of the average participant, and they used the smaller and larger of these numbers as indices of MIN and MAX, respectively. They found that those entrepreneurs who experienced more mixed emotions, as indexed by the GTM measure, also perceived opening the new outlet as riskier.

Choosing among cooccurrence-based measures. Dichotomous cooccurrence measures, MIN, and the other cooccurrence-measures are conceptually very similar. Whereas the dichotomous cooccurrence measure indexes the mere presence of mixed emotions, MIN indexes the presence and intensity of mixed emotions, and the other cooccurrence-measures index the presence, intensity, and similarity of mixed emotions. As a result, we would expect them to be highly correlated with one another. We conducted a Monte Carlo simulation of 100 samples of 50 hypothetical people with uniform distributions of sadness (on 1-7 scale) and happiness (on a 1-7 scale). As seen in Table 1, the average correlations among dichotomous cooccurrence, MIN, SIM, and GTM were quite high, suggesting that these measures are virtually interchangeable.

Of course, positive emotions, negative emotions, and mixed emotions need not be uniformly distributed (as assumed in the Monte Carlo simulation). Negative emotions tend to be positively skewed and mixed emotions even more so. We therefore re-analyzed the data from Ersner-Hershfield et al. (2008, Study 1) to investigate the relationships among dichotomous cooccurrence, MIN, SIM, and GTM indices of mixed emotions. As mentioned above, Ersner-Hershfield et al. (2008) had participants undergo guided imagery inductions in which they imagined being at meaningful locations, and then reported the extent to which they were experiencing each of 19 different emotions on 7-point scales. In the third guided imagery induction, half of the participants imagined being at their chosen location for the final time. The researchers operationalized poignancy as the minimum amount of happiness and sadness that

was experienced. Here, we re-analyzed the data to compute three additional measures: 1) dichotomous cooccurrence (i.e., "1" if participants reported feeling greater than a 1 on both happiness and sadness, "0" if participants reported feeling a 1 on either happiness or sadness), 2) SIM (i.e., 3*MIN(happiness, sadness) – MAX(happiness, sadness)), and 3) GTM (i.e., GTM = 5 * MIN(happiness, sadness)$^{0.5}$ – MAX(happiness, sadness)$^{1/MIN(happiness, sadness)}$). As shown in Table 2, the correlations among the various measures of cooccurrence are extremely high, even in this sample where the distribution of emotion scores are distributed in a more skewed, rather than uniform way. Note that although we computed these measures specifically for the third guided imagery induction, correlations among the cooccurrence measures for the first and second guided imagery inductions show similar patterns. In sum, although SIM and GTM provide information about the relative similarity between positive and negative emotions, they still nonetheless correlate extremely highly with the more parsimonious MIN measure.

Inferences from External Correlates of Positive and Negative affect

Rather than combining measures of positive and negative affect in some way, Brehm and Miron (2006) contended that investigating the external correlates of positive and negative affect can shed light on mixed emotions. Specifically, they argued that demonstrating that some independent variable has opposite effects on happiness and sadness would provide evidence against mixed emotions. Brehm, Brummett, and Harvey (1999) gave people a gift of $1, $2, or $3 after they had a read a sad story. Larger gifts made people both less happy and more sad, which Brehm et al. interpreted as evidence that happiness and sadness were mutually exclusive. This conclusion is premature. The participants who received a $1 gift reported, on average, moderate levels of happiness and moderate levels of sadness. If half of these participants felt extremely and exclusively happy and the others felt extremely and exclusively sad, Brehm et al.'s

findings would provide evidence that happiness and sadness are mutually exclusive. Another possibility, however, is that the average participant felt moderately happy and moderately sad because a number of participants felt both moderately happy and moderately sad. The implication is that demonstrating that some independent variable has opposite effects on opposite-valence emotions sheds little light on the cooccurrence of those emotions.

A related possibility is that demonstrating that some independent variable increases one emotion but has no effect on an opposite-valence emotion does provide evidence for mixed emotions. Combs, Powell, Schurtz, and Smith (2009) investigated the effects of ingroup identification on *schadenfreude* (i.e., experiencing positive affect in response to others' suffering). In an illustrative study conducted in early fall 2006, they had U.S. college students read about a rise in the death of U.S. troops during the war in Iraq, which threatened the Republicans' prospects in the upcoming election. Democrats found the report no less distressing than did Republicans, but they did acknowledge experiencing greater *schadenfreude*. According to Combs et al., such results suggest that "*schadenfreude* may be an example of an emotion that can be felt alongside a countering emotion" (p. 645). Though we are sympathetic to Combs et al.'s (2008) interpretation of this pattern of findings as evidence that Democrats experienced more mixed emotions of distress and *schadenfreude*, there are other plausible explanations. As in the case of emotional reactions to receiving $1 after listening to a sad story, it may be that half the Democrats experienced exclusive distress and the other half experienced exclusive *schadenfreude*. Thus, demonstrating that some independent variable selectively increases positive or negative emotions provides little evidence for mixed emotions.

It is even the case that some independent variable could increase both positive and negative affect without increasing mixed emotions. Imagine, if you can, that New York

University revived its long-dormant football program and somehow managed to upend the Texas Tech Red Raiders before a stunned crowd comprised of equal numbers of NYU Violet and Texas Tech Red Raider fans. We suspect that the average fan would be both more joyful and more outraged after the game than before the game, but we also suspect that few fans would experience mixed emotions of joy and outrage. Rather, the Violet fans would be exclusively joyful and the Red Raider fans would be exclusively outraged. Clearly, then, it is far more difficult to make inferences about mixed emotions from the external correlates of positive and negative affect than from cooccurrence-based measures, which probably helps explain why few researchers have adopted the former strategy. For both of these reasons, we have little more to say on the topic.

Inferences from the Correlation Between Positive and Negative Affect (i.e., Emotional Complexity)

More researchers have attempted to make inferences about mixed emotions by assessing emotional complexity, which refers here to the relationship between positive and negative affect.[2] The idea is that strongly negative relationships between positive and negative affect indicate scarce mixed emotions and that weaker relationships indicate greater mixed emotions. Ready, Carvalho, and Weinberger, for instance, (2008) suggested that, "Low covariation suggests the capacity to experience affects as independent yet potentially *co-occurring*" (p. 928; emphasis added).

Emotional complexity has frequently been used to assess cultural differences in mixed emotions. Whereas Westerners typically ascribe to the Aristotelian notion that opposing

[2] The term *emotional complexity* has also been used to refer to the ability to experience a range of emotions and verbalize subtle distinctions among similar (e.g., same-valence) affective states. By this conceptualization, low emotional complexity is synonymous with alexythymia (e.g., Kang & Shaver, 2004). For a review of different conceptualizations of emotional complexity, see Lindquist & Barrett (2008).

propositions cannot both be true, Asians are more likely to ascribe to the Confucian notion that opposing propositions can both be true (Peng & Nisbett, 1999). Tolerating or even welcoming contradiction represents one aspect of *dialectical thinking* (Peng & Nisbett, 1999) so it makes sense that *dialectical emotions* have been defined as "simultaneous reports of positive and negative feelings (i.e., feeling both happy and sad)" (Leu, Wang, & Koo, 2011, p. 994) (see also Goetz, Spencer-Rodgers, & Peng, 2008).

Bagozzi, Wong, and Yi (1999) assessed American and Chinese undergraduates' emotional complexity by asking them to rate the extent to which they experience 72 different emotions covering an extensive range of positive and negative emotions. They found that feelings of love were negatively correlated with a broad measure of negative affect among American undergraduates, but not among Chinese undergraduates. Indeed, feelings of love and negative affect were actually positively correlated among Chinese women, which suggests a considerable amount of mixed emotions. Bagozzi et al. did not use terms such as *mixed emotions*, but they clearly had mixed emotions in mind. To introduce cultural differences in conceptualization of emotion, for example, they contrasted a quotation from the Talmud in which the Judeo-Christian God appears incapable of experiencing mixed emotions with Confucius' suggestion that, "When a person feels happiest, he or she will inevitably feel sad at the same time" (Bagozzi et al., 1999; p. 644). They also suggest that, in the Aristotelian's mind, "PA and NA [i.e., positive and negative affect; cf. Positive and Negative Activation, Watson et al. (1999)] are conceived as oppositional categories. One is either happy or sad but not both" (p. 646).

Others who have investigated cultural differences in emotion have explicitly equated emotional complexity with greater mixed emotions. Shiota, Campos, Gonzaga, Keltner, and

Peng (2010) asked European and Asian American heterosexual romantic couples to discuss four potentially bittersweet topics (e.g., past romantic partners) then indicate the extent to which they were experiencing feelings of love and a specific negative target emotions particular to each topic (e.g., anger). Not surprisingly, love and negative emotions tended to be negatively correlated. The more interesting finding was that those correlations tended to be weaker among Asian Americans than among European Americans. Thus, Asian Americans showed greater emotional complexity. Shiota et al. interpreted these findings as evidence that, "Asian-American participants were more likely to report both love and negative emotion, whereas European-American participants tended to report either love or the target negative emotion" (p. 795). Goetz, Spencer-Rodgers, and Peng (2008), Leu et al. (2010), and Larsen and McGraw (2011) have also interpreted cultural differences in emotional complexity as evidence for cultural differences in mixed emotions.

Note that both Bagozzi et al. (1999) and Shiota et al. (2010) used measures of emotional complexity to index emotional complexity in single-shot examinations (i.e., situations in which data were collected at a single point in time). In these situations, correlations between positive and negative emotions are calculated *across* participants. Other researchers have tracked the relationship between positive and negative emotions over time for particular individuals with the use of intraindividual correlation coefficients (e.g., Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Hershfield, et al., in press) or hierarchical linear modeling approaches (e.g., Rafaeli, Rogers, & Revelle, 2007).

Rafaeli et al. (2007) investigated whether there are stable individual differences in emotional complexity, which they termed *affective synchrony*. In several studies, they asked participants to rate the extent to which they were experiencing a series of positive and negative

emotions numerous times over the course of up to 14 days. Ratings of high-arousal positive emotions (e.g., *energetic*) and reverse-scored ratings of low-arousal negative emotions (e.g., *tired*) were used to index energetic arousal (Thayer, 1986) which is conceptually similar to the more well-known construct of Positive Activation (Watson et al., 1999). Ratings of high-arousal negative emotions (e.g., *tense*) and reverse-scored ratings of low-arousal positive emotions (e.g., *calm*) were used to index tense arousal (cf., Negative Activation, Watson et al., 1999).

Within-subjects correlations revealed striking individual differences in the relationship between energetic arousal and tense arousal, with some correlations ranging from -.50 to .50. Rafaeli et al. demonstrated that greater emotional complexity was associated with high levels of evaluative integration [i.e., the extent to which people evaluate aspects of their self-concept (e.g., *ambitious*) as both good and bad (Showers, 1992)] and low levels of valence focus [i.e., the extent to which people use same-valence emotion terms varying in arousal (e.g., calm, excited) interchangeably to describe their affective state (Feldman, 1995)]. In contrast, emotional complexity was unrelated to neuroticism and extraversion.

Hershfield et al. (in press) assessed the impact of emotional complexity on health outcomes in a 10-year longitudinal experience-sampling study in a sample of adults ranging in age from 18 to 94. At each sampling occasion (5 per day, over the course of 7 days), they asked individuals to report the extent to which they were experiencing each of 19 different emotions (11 negative and 8 positive) on 7-point Likert scales. Hershfield et al. (in press) found that individuals who experienced more emotional complexity (i.e., those who showed fairly weak relationships between positive and negative emotions) also had better physical health. More important, the researchers discovered that increases in the correlation between positive and negative emotions over a ten-year period attenuated typical age-related health declines.

Hershfield et al. (in press) interpreted these findings as evidence for the role of mixed emotions in healthy coping.

Interest in emotional complexity came long before interest in mixed emotions (e.g., Watson & Tellegen, 1985) so it is not surprising that many researchers have not made inferences about mixed emotions from measures of emotional complexity (Coifman, Bonanno, & Rafaeli, 2007; Zautra, Reich, Davis, & Potter, 2000). Following earlier evidence that stress reduces emotional complexity (e.g., Zautra et al., 2000), Coifman et al. (2007) studied emotional complexity among individuals who had recently lost a spouse or child. They found that individuals who showed greater resilience also showed greater emotional complexity. Though Coifman et al. made no mention of mixed emotions, Larsen and McGraw (2011) interpreted Coifman et al.'s findings as evidence that "mixed emotions may foster healthy coping" (p. 1095).

A Comparison of Cooccurrence-Based Measures of Mixed Emotions and Measures of Emotional Complexity

Mathematical considerations. Cooccurrence-based measures of mixed emotions have become increasingly common in the last decade or so, but our review indicates that measures of emotional complexity also remain fairly common for assessing mixed emotions. The fact that both appear to be used to assess the same phenomenon is noteworthy because they are conceptually quite distinct and calculated quite differently.

One serious cause for concern about this state of affairs is that Diener and Iran-Nejad (1986), Russell and Carroll (1999), and Schimmack (2001) have suggested there is little reason to expect measures of emotional complexity to index mixed emotions. As noted above, the logic underlying the use of measures of emotional complexity to index mixed emotions is that increasingly negative correlations between positive and negative affect indicate increasingly

scarce mixed emotions. By this account, there should be a perfectly negative correlation between positive and negative affect (i.e., $r = -1$) when the incidence of mixed emotions is 0. One potential problem with this claim is that the correlation between positive and negative affect will approach -1 if and only if all observations fall in the region surrounding a straight line extending from some degree of exclusive negative affect to some degree of exclusive positive affect (see Figure 2a). Note that vast portions of that region represent states comprised of some degree of *both* positive and negative affect (i.e., some degree of mixed emotions). As a result, correlations approaching -1 can actually reflect a great deal of mixed emotions (Russell & Carroll, 1999; Schimmack, 2001). The precise amount of mixed emotions will depend upon the distribution of points within the shaded region. Greater concentrations near the middle of the shaded region will be indicative of greater mixed emotions. Greater concentrations at the top left and bottom right portion of the shaded region of Figure 2a will be indicative of less mixed emotions. Whatever the case, the presence of a strongly negative correlation need not imply the absence of mixed emotions.

Also critical to the logic underlying the use of measures of emotional complexity to index mixed emotions is the related contention that the absence of mixed emotions implies a strongly negative correlation. This contention has also been challenged (Russell & Carroll, 1999; Schimmack, 2001). Consider an individual who never experienced mixed emotions. In other words, this individual's affective state always falls within the shaded region of Figure 2b. As long as there is at least some variance in both positive and negative affect, this L-shaped pattern (Russell & Carroll, 1999) will yield a negative correlation, but the magnitude of that correlation may range from -1 to very nearly 0. The exact magnitude of the negative correlation will depend entirely on the distribution of the points within the L-shaped region. If one subset of observations

fall into a cluster in one of the L's two "arms" and another subset falls into another cluster in the other of the L's arms, the correlation will approach -1. If, however, the observations are uniformly distributed, the correlation will be approximately -.6 (Schimmack, 2001), which is quite strong, but considerably weaker than -1. Several patterns will yield correlations that are far weaker than -1 or even -.6 (for mathematical details, see Russell & Carroll, 1999). Due to restriction in range, for instance, negligible amounts of variance in positive and/or negative affect can result in correlations approaching 0.

In sum, strong negative correlations between positive and negative affect do not imply the absence of mixed emotions and the absence of mixed emotions does not imply a strong negative correlation. Both issues call into question the utility of assessing mixed emotions with measures of emotional complexity (Diener & Iran-Nejad, 1986; Russell & Carroll, 1999; Schimmack, 2001), be they simple Pearson correlations, beta weights, or parameters derived from hierarchical linear models. There is one small caveat: a positive correlation between positive and negative affect does imply that the individual experienced some amount of mixed emotions. This caveat ends up being something of a *non sequitur*, however. As shown in Figure 3, a distribution that yields a perfectly positive correlation may contain less intense mixed emotions, on average, than a distribution that yields a perfectly *negative* correlation.

We have long found the analyses by Schimmack (2001) and others compelling demonstrations that cooccurrence-based measures provided superior indices of mixed emotions than did measures of emotional complexity (e.g., Ersner-Hershfield et al., 2008; Adler & Hershfield, 2012; Larsen et al., 2001), but have assumed that emotional complexity measures could still serve as proxy measures of mixed emotions (Hershfield et al., in press; Larsen & McGraw, 2011). That is, we have assumed that most individuals with low MIN scores (e.g.,

those whose patterns approximated Russell and Carroll's L-shaped pattern) would have fairly low emotional complexity scores and that most individuals with high MIN scores would have fairly high emotional complexity scores. As it turns out, this is an empirical question. To the extent that emotional complexity measures are associated with mixed emotions, they should be correlated with cooccurrence-based measures of mixed emotions.

Prior empirical comparisons. All datasets that can yield cooccurrence-based measures of mixed emotions can also yield measures of emotional complexity (and vice versa), but researchers who rely upon cooccurrence-based measures of mixed emotions have rarely reported measures of emotional complexity (and, again, vice versa). Thus, a review of literature provides few opportunities to investigate whether cooccurrence-based measures of mixed emotions are highly correlated with measures of emotional complexity.

There are a handful of exceptions. Scollon, Diener, Oishi, and Biswas-Diener (2005) reported average levels of MIN scores and emotional complexity for samples from five different cultural groups (e.g., European Americans, Asian Americans, Hispanic Americans). Unlike other researchers, they found little in the way of cultural differences in MIN scores or emotional complexity. On its own, this finding represents absence of evidence that cooccurrence-based measures of mixed emotions and measures of emotional complexity are dissociated. Such a comparison involving group as the unit of analysis is limited in part by the small number of groups. More informative would be analyses in which participant is the unit of analysis. That is, it would be useful to assess the correlation between MIN and emotional complexity among, for instance, the 61 Indian participants in Scollon et al.'s (2005) study.

Larsen et al. (2001) found that many participants reported feeling both happy and sad after watching *Life Is Beautiful* (44%), moving out of their dormitories (54%), and graduating

from college (50%). Thus, if measures of emotional complexity can serve as proxy indices of mixed emotions, we would not expect particularly strong negative correlations between happiness and sadness in those samples. Consistent with this possibility, happiness and sadness were not significantly correlated among undergraduates who had just moved out of their dormitories (r = -.02) and graduated (r = -.16). In contrast, the negative correlation between happiness and sadness was fairly strong after *Life Is Beautiful* (r = -.43). It would be useful to know whether the happiness and sadness were more strongly negatively correlated in each of the three studies' typical situations (e.g., typical days on campus), but Larsen et al. did not report these correlations.

Smith and Ellsworth (1987) and Folkman and Lazarus (1985) found that threat- and challenge-related emotions frequently co-occurred among individuals who faced an upcoming exam. In addition, threat- and challenge-related emotions were not significantly correlated with one another in Smith and Ellsworth's study (r = .15) or in Folkman and Lazarus's study (r = -.05). Smith and Ellsworth also reported (and Folkman and Lazarus intimated) that the cooccurrence of threat- and challenge-related emotions declined in the days after the exam. As such, we might also expect these emotions to become more strongly negatively correlated after the exam. Nonetheless, threat- and challenge-related emotions remained uncorrelated several days after students took the exams but before they learned their grades (Smith & Ellsworth, 1987: r = .01; Folkman & Lazarus: .03) and, in Folkman and Lazarus's study, several days after students learned their grades (r = -.15). On balance, the extant literature provides little evidence bearing on the coherence of cooccurrence-based measures of mixed emotions and measures of emotional complexity and what little evidence there is provides little indication of much coherence.

A more direct empirical comparison. An unpublished dataset that we have recently collected allows us to more directly investigate the relationship between cooccurrence-based measures of mixed emotions and measures of emotional complexity (Larsen, Hershfield, Hester, & Stastny, 2012). Undergraduates (n = 103) watched a 23-min clip from *Life Is Beautiful* that contained a variety of happy, sad, and bittersweet scenes. As they watched the clip, participants reported moment-to-moment changes in their happiness and sadness with the continuous evaluative space grid (Larsen et al., 2009). The computer recorded the location of the mouse every 500 msec, yielding a total of 2786 samples per participant. Whereas earlier studies employed a 5 x 5 version of the evaluative space grid (e.g., Larsen & McGraw, 2011; Larsen et al., 2009), Larsen et al. (2012) used a 251 x 251 version, thereby allowing participants to report more fine-grained changes in their emotions. To compute cooccurrence-based measure of mixed emotions, we (a) computed the minimum (MIN) of each participant's happiness and sadness ratings during each moment of the clip, then (b) averaged those MIN ratings to get an overall index of the intensity of that participant's mixed emotions (i.e., mean MIN). To compute measures of emotional complexity, we (a) calculated the correlation between each participant's happiness and sadness ratings, then (b) submitted the raw correlations to the Fisher r-to-z transformation. A scatterplot showing the relationship between the mean MIN values (on the x-axis) and the non-transformed correlations (on the y-axis) is shown in Figure 4. As is typically the case, Figure 4 reveals that the intraindividual correlations between happiness and sadness tended to be negative (M = -.61, SD = 0.33) and that MIN values tended to be fairly low (M = 17.42, SD = 17.62) and positively skewed, as evidenced by the fact that the median (12.82) fell well below the mean. The most striking pattern shown in Figure 4 is that the cooccurrence-based measures and measures of emotional complexity were completely unrelated to one another (r = -

.04). This finding corroborates earlier conceptual analyses that measures of emotional complexity cannot be used to index mixed emotions, *per se*. Some of those earlier conceptual analyses used hypothetical, idealized data to illustrate the potential separability of cooccurrence-based measures of mixed emotions and measures of emotional complexity (Russell & Carroll, 1999). We can extend those analyses by using actual data from four illustrative participants from Larsen et al.'s (2012) dataset. Scatterplots showing the relationship between happiness and sadness for each of these four participants are shown in Figure 5. We hasten to note that we did not select these four participants at random. Rather, they are illustrative of participants who were relatively high and low in terms of emotional complexity and MIN.

We (Hershfield et al., in press; Larsen & McGraw, 2011) have had participants like #2049 (see the bottom left panel of Figure 5) and #2060 (see the top right panel of Figure 5) in mind when interpreting weak correlations as indicative of fairly intense mixed emotions and moderate or strong negative correlations as indicative of negligible mixed emotions. Participant #2049 (bottom left panel) spent most of his time reporting fairly intense levels of exclusive happiness or exclusive sadness. As a result, his MIN scores were exceptionally low ($M = 1.6$) and happiness and sadness were highly negatively correlated, $r = -.84$. Participant #2060 spent quite a bit of time reporting fairly modest levels of exclusive happiness or exclusive sadness. She also made numerous long-lived excursions into the interior of the grid. As a result, her MIN scores were quite high ($M = 25.4$). On some occasions, she ventured to the top right portion of the grid in order to report intense simultaneously mixed emotions of happiness and sadness. This pattern resulted in a mildly positive correlation between happiness and sadness, $r = .13$.

If a sizable minority of participants showed patterns like that of #2049 and another sizable minority showed patterns like that of #2060, MIN and emotional complexity would be

positively correlated and emotional complexity could be used to measure mixed emotions. As demonstrated by Figure 4 and illustrated by the top left and bottom right panels of Figure 5, however, any number of other participants showed markedly different patterns of happiness and sadness. Participant #2120 (top left panel), for example, spent most of his time in the grid's bottom left corner, reporting fairly modest levels of exclusive happiness or exclusive sadness, so his MIN scores were very low ($M = 4.6$). Though he rarely reported intense levels of exclusive happiness and sadness, he occasionally ventured well into the interior of the grid. These excursions lasted long enough to result in a positive correlation between happiness and sadness, $r = .19$, but did not last long enough to elevate his MIN score considerably.

Participant #2142 spent quite a bit of time near the middle of the grid, which resulted in fairly high MIN scores ($M = 25.8$). She spent quite a bit of time near the middle because she spent most of her time traversing the diagonal running from intense levels of exclusive happiness to intense levels of exclusive sadness. In other words, she showed *reciprocal activation* (Cacioppo & Berntson, 1994), which resulted in a very strong negative correlation between happiness and sadness, $r = -.84$. This participant nicely (albeit somewhat anecdotally) demonstrates that reciprocal activation can yield nearly perfect negative correlations without precluding mixed emotions (Diener & Iran-Nejad, 1986; Schimmack, 2001). Indeed, a comparison of this participant's data with that of the one above indicates that this participant's mixed emotions *strengthened,* rather than attenuated, her negative correlation. Schimmack (2001) noted that William McDougall (1905) anticipated such a pattern just over a century ago when he described pleasure and displeasure as "antagonistic, [but] not absolutely incompatible and mutually exclusive" (McDougall, 1905; p. 80).

None of the four participants highlighted here were particularly anomalous. Figure 2 suggests that they were each joined by many others with similar patterns of happiness and sadness ratings. As a result, MIN and measures of emotional complexity were completely uncorrelated among a sample of American undergraduates reporting moment-to-moment levels of happiness and sadness as they watch scenes from *Life Is Beautiful*. The extent to which these findings generalize across populations, measures, and stimuli remains to be seen. Based on the compelling conceptual analyses provided by Diener and Iran-Nejad (1986), Russell and Carroll (1999), and Schimmack (2001), we will go so far as to speculate that our results will generalize quite well.

Further considerations. Earlier researchers have delineated a list of factors that can lead to a dissociation between cooccurrence-based measures of mixed emotions and measures of emotional complexity. To this list we would like to add a couple factors based largely on well-known principles of correlational analysis.

First, in situations in which a pre-stimulus to post-stimulus emotional experiences are examined, it is possible that although a person may be experiencing mixed emotions, the correlation efficient could actually be negative (suggesting that mixed emotions are not present, even though one would expect a positive correlation between positive and negative emotion if one had an *a priori* hypothesis that mixed emotions would be present). To illustrate, consider a case in which research participants are exposed to a moving advertisement that should theoretically give rise to a mixed emotional experience. Using 7-point scales, before watching the ad, a given participant may score a 1 on sadness and a 6 on happiness: a decidedly unmixed, and relatively normative, emotional profile that would generate a MIN score of 1. After viewing the ad, however, a person may score a 4 on sadness and a 5 on happiness, creating a more mixed

experience and a MIN score of 4. Note that although the post-stimulus experience is more mixed, happiness and sadness in this example moved in opposite directions of one another, which across a group of people, would suggest a negative correlation. Although this is obviously a stylized example, it points to the idea that correlation-based measures of mixed emotions may not be ideal for single-shot examinations of mixed emotions. A measure of emotional complexity in this setting (i.e., a single-shot examination of mixed emotions) necessarily measures the correlation between positive and negative emotion *across* participants. Such a measure taps into a fundamentally different experience than the average cooccurrence of oppositely-valenced emotions across participants.

Second, all else held constant, increasing mean levels of positive and/or negative affect will have no effect on emotional complexity but may increase cooccurrence-based measures of mixed emotions. Third, all else held constant, the introduction of error variance into measures of positive and/or negative affect will weaken the relationship between positive and negative affect but will have little effect (and even less systematic effect) on cooccurrence-based measures of mixed emotions. With these factors in mind, it may be tempting to index mixed emotions with emotional complexity after controlling for mean levels of positive and negative affect, as well as measures of variance around those means. We fear that this essentially amounts to statistical alchemy: no number of control variables will uncover the relationship between emotional complexity and mixed emotions because there is little relationship between emotional complexity and mixed emotions. Furthermore, there is little need for such statistical alchemy. Unlike gold, MIN and other cooccurrence-based measures of mixed emotions are readily available.

None of this is to say that cooccurrence-based measures are as valuable as gold or can capture mixed emotions in their entirety. For instance, cooccurrence-based measures are insensitive to whether mixed emotions are characterized by more intense positive emotions or more intense negative emotions. They also cannot tell us about how it *feels* to feel mixed emotions beyond telling us that it involves a combination of positive and negative affect. Fortunately, direct measures of mixed emotions such as measures of felt ambivalence (Williams & Aaker, 2002) and bittersweet (Larsen et al., 2001) may shed additional light on how feeling mixed emotions feels.

Nor is any of this is to say that measures of emotional complexity are mathematically or psychologically meaningless. To the contrary, evidence that there are cultural differences in emotional complexity (e.g., Shiota et al., 2010), that there are stable individual differences in emotional complexity (e.g., Rafaeli et al., 2007), and that such individual differences predict health outcomes (e.g., Coifman et al., 2007; Hershfield et al., in press) indicate that emotional complexity is quite meaningful. Our point is only that there is little reason to use measures of emotional complexity to assess mixed emotions, and that researchers should avoid making inferences about mixed emotions on the basis of measures of emotional complexity.

One concern is that the use of measures of emotional complexity have led to inaccurate conclusions about mixed emotions. For instance, most inferences about cultural differences in mixed emotions have come from evidence for cultural differences in emotional complexity. Until recently, researchers have reported little in the way of cultural differences in cooccurrence-based measures of mixed emotions, perhaps because they have not calculated cooccurrence-based measures. As mentioned above, however, Scollon et al. (2005) found no cultural differences in MIN scores in their experience sampling study of emotions in everyday life. More recently,

Miyamoto, Uchida, and Ellsworth (2010) asked American and Japanese students to write about the thoughts and feelings they had during times in which they had succeeded, failed, and gone through a transition. Content coding revealed some cultural differences. Specifically, Japanese mentioned experiencing more mixed emotions than Americans while discussing a success. They did not, however, mention more mixed emotions about a failure or about a transition.

Whatever the case, we wish to reiterate that we do not think that measures of emotional complexity are useless. Rather, they tap into different aspects of emotional experience than do cooccurrence-based measures of mixed emotions. Researchers thus need to think carefully about the emotional phenomena that they wish to examine (mixed emotions or emotional complexity).

A Broader Set of Recommendations

In addition to making recommendations about how to assess mixed emotions with measures of positive and negative measures after the data have been gathered, we have a broader set of recommendations for researchers interested in mixed emotions. A general recommendation is that, as is virtually always the case, it is a good idea to start with a conceptual question. Mixed emotions might be sufficiently rare in a given context that asking about questions about those mixed emotions will be of no more value than asking about how many angels can dance on the head of a pin. Assessing mixed emotions can actually be counterproductive because doing so generally requires multiple measures and measurements can disrupt the processes they are intended to index. Nonetheless, the very occurrence of mixed emotions sheds light on the structure of affect (e.g., Larsen & McGraw, 2011) and mixed emotions have been shown to (a) play a role in healthy coping (Adler & Hershfield, 2012), (b) influence creativity (Fong, 2006), (c) memory for emotions (Aaker, Drolet, & Griffin, 2008), and (d) advertisements' effectiveness

(Williams & Aaker, 2002), so we are quite optimistic that the study of mixed emotions will continue to shed light on the nature of emotion more generally.

Measurement Issues

Which emotions to measure? Researchers should keep in mind that there are a variety of different positive emotions and an even larger variety of negative emotions. A particular measure of emotion may not be sensitive to the particular emotion that a particular individual is experiencing. Consider the widely-used Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). It is sometimes used as a measure of global positive affect and negative affect, but it was only designed to index high-arousal positive affective states (e.g., "excited") and negative affective states (e.g., "nervous"). The PANAS would be well-suited for assessing mixed emotions of (say) "nervous excitement", but it is not well-suited for assessing mixed emotions involving states that are low or moderate in arousal.

In that different measures assess different emotions, researchers must therefore think carefully about which opposite-valence emotions to measure. Some researchers have focused on measuring polar opposite emotions such as happiness and sadness because different models of the structure of affect make competing predictions about whether polar opposite emotions can co-occur (Larsen & McGraw, 2011; Larsen et al., 2001; Russell & Carroll, 1999; Schimmack, 2001). By way of comparison, Hemenover and Schimmack (2007) had the very different goal of simply understanding people's emotional reactions to other people's disgusting actions. It therefore made much more sense for Hemenover and Schimmack to assess mixed emotions of humor and disgust as opposed to mixed emotions of happiness and sadness. In many cases, assessing discrete emotions may not be critical. In their study of emotional reactions to lottery

outcomes, for instance, Larsen et al. (2004) simply asked people to indicate whether they felt "good" and "bad" about each lottery.

How to measure constituent emotions? Having identified which emotions to measure, researchers must determine how to measure them most effectively. Any measure of mixed emotions can only be as reliable and as valid as the measures of the component opposite-valence emotions used to assess those mixed emotions. Consider Harris and Alvarado's (2005) finding that people often showed mixed smiles suggestive of mixed emotions while being tickled. Even though smiling can be used to index positive affect, not all smiles are a result of positive affect. Indeed, Harris and Alvarado suggested that people may have smiled while being tickled not to express positive affect but to mask their negative affective reactions to being tickled (see Ekman, Friesen, & O'Sullivan, 1988). As a result, participants may have expressed mixed smiles even though they found the experience of being tickled entirely unpleasant and not at all pleasant. Similarly, the mixed smiles expressed by smokers in Griffin and Sayette's (2008) study may merely have been masking smiles.

Even when variance in a measure of emotion is due to variance in the target emotion, that measure might overestimate the incidence of the emotion. Any such overestimates run the risk of leading researchers to overestimate the incidence of mixed emotions. People may be more apt to think of positive and negative affect as opposite ends of the bipolar valence dimension than as separable unipolar dimensions. As a result, they might misinterpret unipolar measures of positive affect (e.g., "How happy are you?") and negative affect (e.g., "How sad are you?") as bipolar measures of valence (Russell & Carroll, 1999). When asked, "How happy are you?" on a scale from "not at all" to "extremely," they might treat "not at all happy" as synonymous with "extremely sad." When asked, "How sad are you?" in a comparable fashion, they might treat

"not at all sad" as synonymous with "extremely happy." In the event, participants who are feeling neutral (i.e., neither happy nor sad) would avoid both scales' endpoints, all of which seemingly represent intense happiness or sadness, and instead select middling response options (e.g., "moderately happy", "moderately sad"). The researcher would erroneously conclude that these participants are experiencing mixed emotions comprised of moderate happiness and moderate sadness, when in fact they were unsuccessfully trying to communicate that they were feeling neither happy nor sad.

Russell and Carroll (1999) found that one way to minimize the likelihood that participants misinterpret unipolar measures as bipolar measures is to first ask individuals a dichotomous question about whether they are feeling a particular emotion (e.g., "Do you feel happy?"). Only if participants responded in the affirmative were they subsequently asked to rate the intensity of the emotion. When they measured happiness and sadness with such dichotomous-then-unipolar measures, as opposed to more standard unipolar measures, the reported incidence of mixed emotions dropped from approximately 50% to approximately 10% (see Russell & Carroll, 1999, Figure 5).

Schimmack (2001) has developed a simpler approach to prevent participants from misinterpreting unipolar measures as bipolar measures. Prior to completing the questionnaire, participants were explicitly instructed to, "Please consider first whether you feel the experience. If you do not experience this feeling, respond with 0. If you experience this feeling, respond with 1 to 6'' (p. 88). In addition, the lowest response option was phrased differently ("0 = I do *not* experience this feeling") than all the others (e.g., "1 = I do experience this feeling *very mildly*," "2 = I do experience this feeling *mildly*," etc.).

Timeframe. To experience mixed emotions is to experience positive and negative emotions at the same time, so researchers who are interested in measuring mixed emotions must consider the temporal resolution of their measures of emotion. Measures with greater temporal resolution provide stronger tests of competing hypotheses about whether polar opposite emotions can co-occur at the same moment in time, so some researchers have gone to great lengths to develop measures with superior temporal resolution (Carrera & Oceja, 2007; Larsen & McGraw, 2011; Larsen et al., 2004). Unfortunately, going to such lengths is rarely practical. Fortunately, measures with far less temporal resolution can still shed light on worthwhile questions about mixed emotions. No matter whether people undergoing psychotherapy had mixed emotions that occurred at the same time or merely close together in time, Adler and Hershfield's (2012) findings indicate that mixed emotions had beneficial consequences.

One useful strategy for understanding individual differences in emotional experience is to ask participants to indicate the extent to which they have experienced positive emotions and negative emotions over the course of extended time periods (e.g., a week or more), but this is not the most useful strategy for investigating mixed emotions. Consider the case of individuals who experienced a great deal of exclusively positive emotions during the first two weeks of the previous month but a great deal of exclusively negative emotions during the last two weeks of the week. When asked to report on their emotions during the previous month, they will presumably indicate experiencing quite a bit of positive and negative emotions. Such reports would be valid. Any inference that they had experienced mixed emotions would be far less valid.

Miyamoto and Ryff (2011) asked American and Japanese adults to rate how frequently they had experienced several positive emotions and negative emotions during the past month. On the basis of these data, they categorized individuals in terms of whether they experienced mostly

positive emotions, mostly negative emotions, or some balance of the two. Those who experienced a balance of positive and negative emotions were seen as experiencing dialectical emotions and were further divided into those who had experienced positive and negative emotions frequently (high dialectical), moderately often (moderate dialectical), or infrequently (low dialectical) during the month.[3] Japanese were more likely to be classified as moderate dialectical than Americans were. Moreover, after controlling for overall cultural differences in physical health-related symptoms, moderate dialectical Japanese reported fewer physical health-related symptoms than did moderate dialectical Americans.

Miyamoto and Ryff's (2011) findings add to our understanding of cultural differences in emotion and in the relationships between emotion and health. As they were careful to note, however, these findings do not allow inferences about "the *simultaneous* experience of both positive and negative emotion *in the moment*" (p. 23; emphasis in original). One question for future research is whether those individuals who frequently experience positive emotions and negative emotions in general also experience more mixed emotions in the moment.

Considering demand characteristics. Researchers should also consider the potential role of demand characteristics. Peterson and Janssen (2007) have studied mixed emotional responses to pornography, which is a particularly evocative category of stimulus, but also one for which viewers' responses are particularly sensitive to social desirability concerns (Dovidio & Fazio, 1992). They asked men and women to view excerpts from several pornographic films and then to rate their experience of a variety of emotions on 7-point scales. They operationalized mixed emotions in terms of whether participants reported experiencing at least one of four

[3] Miyamoto and Ryff's (2011) typology highlights that they conceptualize dialectical emotions more broadly than other researchers do. They conceptualize dialectical emotions as a balance of positive and negative emotions, whether that balance reflects mixed emotions or no emotions. Others equate dialectical emotions with mixed emotions in particular (e.g., Goetz et al., 2008, Leu et al., 2011).

positive emotions (e.g., interested, passionate) to at least some degree and at least one of seven negative emotions (e.g., repulsed, guilty) to at least some degree. By this metric, some 70% of men and 70% of women reported mixed emotions after each of the excerpts. Demand characteristics may have inflated the reported incidence of negative emotions and deflated the reported incidence of positive emotions. As a result, demand characteristics may have either inflated *or* deflated the reported incidence of mixed emotions.

Questions for Future Research: Beyond Health to Overall Well-Being

From an applied perspective, quantifying mixed emotions is only worthwhile if mixed emotions have meaningful consequences. Larsen et al. (2003) have suggested and Adler and Hershfield (2012) have demonstrated that mixed emotions can contribute to healthy coping, which raises the possibility that mixed emotions can also influence well-being more globally.

Bipolar Approaches

Most research on emotional influences on well-being involves bipolar measures of emotion. One bipolar measure of daily emotional experience that has been shown to predict well-being is Krueger et al.'s (2009) U-index. The U-index has been calculated on the basis of participants' reports about the amount of time they spent during the previous day in unpleasant activities. In such Day Reconstruction Method (DRM) studies, participants report what they did throughout the day and rate the positive feelings (e.g., "happy," "friendly") and the negative feelings (e.g.,. "depressed," "angry") they experienced during each activity. To calculate the U-index, (a) activities are operationalized as unpleasant if the most intense negative feeling was more intense than the most intense positive feeling and (b) the proportion of time that individuals spent in unpleasant activities is computed. This operationalization has a number of advantages (Krueger et al., 2009). For instance, it reduces a potentially overwhelming number of

observations into a manageable index. It also provides a cardinal metric of emotional experience. That is, one can reasonably infer that unfortunate people with a U-index of (say) .40 spent twice as long engaged in unpleasant activities than people with a U-index of .20. By way of comparison, one cannot infer that people who assign themselves a rating of 4 on a negative affect scale ranging from 0 (not at all sad) to 5 (extremely sad) are twice as sad as those who assign themselves a rating of 2. Most important, the U-index has remarkable predictive validity, in that individuals with higher U-indices report lower subjective well-being.

Despite its many strengths and demonstrated utility, the U-index is insensitive to the experience of mixed emotions and its influence on well-being. Consider two hypothetical individuals who, like most people, find their morning commutes predominantly unpleasant and their lunch-breaks predominantly pleasant. Suppose further that one of the individuals finds some pleasure in the commute (e.g., by taking the opportunity to listen to an enjoyable radio program) but also some displeasure in their lunch-break (e.g., by having little choice but to listen to a tedious colleague). As a result, one individual experiences more mixed emotions than the other despite spending comparable amounts of time engaged in predominantly unpleasant and predominantly pleasant activities.

Beyond Bipolar Measures

Krueger et al.'s (2009) approach can be modified in fairly straightforward ways to allow for a quantification of mixed emotions, which would permit investigation of the influence of mixed emotions on well-being. Several approaches do not even require modifying the types of data that are gathered and could therefore be applied to existing datasets. Based on our review, one obvious approach would be to compute the minimum of the mean positive emotion ratings and mean negative emotion ratings at each point in time:

Mixed emotions = MIN[mean positive affect, mean negative affect]).

Krueger et al. (2009) suggested that the dominant negative emotion is more important than the average negative emotion (e.g., the absence of sadness may do nothing to minimize the unpleasantness and consequences of intense anger), so another approach would be to first identify the highest-rated emotion and then quantify mixed emotions as the highest-rated opposite-valence emotion. This formula can be expressed as:

Mixed emotions = MIN[MAX(positive affect), MAX(negative affect)].

Both of these approaches lose a useful property of the U-index, which is that it provides an ordinal index of emotional experience. A third approach that would potentially yield a cardinal index of mixed emotions involves simply measuring the proportion of positive emotions and the proportion of negative emotions that participants experienced to at least some degree during a given measurement occasion. Following Podoynitsyna et al.(2012), the smaller of those two proportions would constitute an index of mixed emotions:

Mixed emotions = MIN(proportion positive emotions, proportion negative emotions)

One complicating factor with all of these indices of mixed emotions is that they will be highly correlated with measures of positive or negative emotions whenever levels of one affect are generally higher than the other. For instance, most graduates report far more intense happiness than sadness (Ersner-Hershfield et al., 2008; Larsen et al., 2001). For all those participants, MIN(Happy, Sad) = Sad. As a result, MIN scores end up being highly correlated with sadness. This does nothing to invalidate MIN ratings, but it does make it difficult to disentangle any effects of mixed emotions on subsequent outcomes from effects of negative emotions. People also tend to experience more positive than negative affect in the course of daily life (Diener & Diener, 1996) and the participants in Hershfield et al.'s (in press) study were no

exception. Thus, MIN scores were highly correlated with negative affect. In fact, it is for this reason that Hershfield et al. (in press) relied upon emotional complexity as an ostensibly purer measure of mixed emotions than MIN.

A fourth approach to measuring mixed emotions will require gathering somewhat different data than Krueger et al. (2009) have used to calculate the U-index. In Steps 1 and 2, people will simply be asked whether they feel pleasant and whether they feel unpleasant (cf. Larsen & McGraw, 2011; Larsen et al., 2001; Russell & Carroll, 1999). If they indicate feeling both pleasant and unpleasant, they would then be asked to indicate whether they felt more pleasant than unpleasant or vice versa (Step 3). Mixed emotions can be operationalized in terms of whether a given participant indicated feeling both pleasant and unpleasant at the same time. Moreover, just as the U-index provides a cardinal metric of unpleasant affect, this approach would yield a cardinal metric of mixed emotions.

In addition to providing indices of mixed emotions, all four of these approaches will yield indices of negative affect, positive affect, and neutrality. By providing this array of measures, they have the potential to extend previous investigations of how well-being is influenced by negative emotions (e.g., Krueger et al., 2009) and positive emotions (e.g., Fredrickson, Tugade, Waugh, & Larkin, 2003). Compare Krueger et al.'s (2009) U-index with similar indices that can be derived from our 3-step approach. The U-index essentially constitutes the proportion of time that individuals experienced more intense negative emotions than positive emotions. Our 3-step approach would allow that proportion to be decomposed into those proportions of time that individuals experienced (a) exclusively negative emotions (i.e. negative emotions unaccompanied by positive emotions) and (b) predominantly negative mixed emotions (i..e. negative emotions accompanied by weaker positive emotions). Taken together, these indices will

shed light on the deleterious effect of negative emotions on subjective well-being (Krueger et al., 2009). One possibility is that only periods of exclusively negative emotions contribute to lower well-being; periods of negative emotions tempered by positive emotions may not be deleterious. According to the coactivation model of healthy coping (Larsen et al., 2003), it is even possible that predominantly negative mixed emotions will be associated with *greater* well-being in times of severe stress.

Challenges to Valid Measurement

The DRM requires individuals to reconstruct their day from memory. It is therefore worth noting that people have trouble recalling mixed emotions. Aaker et al. (2008) for example, asked students to rate how happy and sad they felt immediately after receiving their midterm exam grades. Two weeks later, they asked those students to recall how happy and sad they had felt when they received their grades. Even though the average participant accurately recalled how happy and how sad they had felt, the average student also recalled experiencing less intense mixed emotions than they actually had experienced. These findings demonstrate that mixed emotions can render retrospective measures of emotion less valid than in-the-moment measures.

Aaker et al.'s (2008) findings may help explain noteworthy discrepancies between people's ratings of how much they generally enjoy various daily activities and their previous-day ratings of those same activities. For most daily events, people's previous-day enjoyment ratings cohere quite nicely with their ratings of how much they generally enjoy those activities (Krueger et al., 2009). For instance, both previous-day and general enjoyment ratings indicate that people enjoyed relaxing more than lunch more than working more than commuting. There are some interesting exceptions. People report that they generally enjoy taking care of their children more than eating lunch and dinner, socializing at and after work, watching television, and talking on

the phone. Their previous-day ratings, however, indicate that they find taking care of their children *less* enjoyable than all of those activities. On the other hand, socializing after work is much more enjoyable according to previous-day ratings than general ratings. In other words, people's theories about how much they enjoy some activities may not always be accurate (Krueger et al., 2009).

One possibility is that difficulty recalling mixed emotions makes people's theories about their enjoyment of events that elicit mixed emotions especially inaccurate. For instance, people may experience relatively intense mixed emotions while taking care of their children, but they forget those mixed emotions as time passes, thereby reducing the validity of retrospective reports. If so, it would highlight the need to consider the extent to which daily activities elicit mixed emotions and how those mixed emotions influence the relationship between daily affect and subjective well-being.

People's difficulty recalling mixed emotions also raises questions about the value of measuring emotions in the moment as opposed to retrospectively. As Schwarz, Kahneman, and Xu (2009) note, it is not yet clear how long after an activity people can make accurate reports about how much they had enjoyed the activity. It is clear that general ratings can diverge from previous-day ratings (Krueger et al., 2009) and that retrospective reports made as little as two weeks after events that elicit mixed emotions can diverge from in-the-moment reports (Aaker et al., 2002). Perhaps retrospective reports made within a day of events that elicit mixed emotions will also show such divergence.

Whatever the timeframe, evidence for divergence raises questions about whether the experience or the recollection of the experience has greater effect on well-being. To give one example, suppose that people simply forget how unpleasant their day of childcare was during the

quiet hours at day's end but manage to remember the undercurrent of pleasant feelings they had experienced. To what extent will their overall subjective well-being influenced by the predominantly negative emotions they actually experienced as opposed to the predominantly positive emotions they recalled experiencing?

To this point we have raised concerns about the validity of retrospective reports, but there are also concerns about the validity of in-the-moment reports. Specifically, in-the-moment reports might be reactive to the extent that making such reports influences people's emotional reactions to events. If in-the-moment reports are reactive, such reactivity should be most apparent in the case of moment-to-moment measures, which require participant to make in-the-moment reports continuously as an evocative event (e.g., an amusing film clip) unfolds. The most common moment-to-moment measure of affect is the affect dial, which requires participants to turn a knob in one direction to report increasingly intense positive emotions and in the other direction to report increasingly intense negative emotions. To examine whether the affect dial is reactive, Mauss, Levenson, McCarter, Wilhelm, and Gross (2005) investigated the coherence between facial expressions of emotions and affect dial ratings. They asked some participants to report their emotions with the affect dial as they viewed a set of evocative film clips for the first time. Other participants merely watched the films during the first viewing. During a second viewing, these participants used the affect dial to report how they had been feeling during the first viewing. Results indicated that emotional facial expressions during the first viewing were just as highly correlated when participants merely watched the clips during the first viewing as they were when participants operated the affect dial during the first viewing. These data suggest that the affect dial was not reactive. Of course, the affect dial does not allow people to report mixed emotions. As described above, the continuous evaluative space grid

(Larsen et al., 2009) provides moment-to-moment measures of both positive and negative emotions, which makes it sensitive to mixed emotions. To the extent that the structure of the grid calls participants' attention to the possibility that they may be experiencing mixed emotions, the grid may be more reactive than the affect dial. No research to date has directly examined this possibility.

An interesting question is whether the amount of time spent experiencing predominantly unpleasant mixed emotions is also associated with lower well-being. According to the coactivation model of healthy coping, predominantly unpleasant mixed emotions may contribute to *increased* well-being, but only if experienced in the face of stressful or difficult life events.

To clarify, it is important to consider that experiencing mixed emotions may be healthier in some situations than others. According to the coactivation model of healthy coping, there is an optimal balance of positive and negative emotions and the optimal balance will be lower in the context of severe stressors. Healthy coping involves experiencing more negative emotions for someone who is dealing with bereavement than for someone who is waiting behind one other customer to purchase some chocolate truffles at a high-end grocery store. The latter individual is likely to derive more benefit by experiencing gratitude for having the means to purchase a luxury food item at a high-end grocery store than by experiencing the slightest bit of annoyance about their brief delay. By this account, experiencing even the mildest of mixed emotions is detrimental in some situations.

Adler and Hershfield's (2012) evidence that mixed emotions may be associated with well-being suggest that an extension of Krueger et al.'s (2009) basic approach may shed additional light on the role of emotions in well-being. Whereas Krueger et al. (2009) demonstrate the value of bipolar measures of affect in predicting well-being, Larsen et al.'s (2003)

coactivation model of health, and Adler and Hershfield's findings suggest that bivariate measures (i.e., those that are sensitive to mixed emotions) may be even more informative.

Using both experience sampling (e.g., Hershfield et al., in press) and the day reconstruction method pioneered by Krueger et al. (2009), future research could address several related questions that have not yet been examined. For example, when it comes to predicting subjective well-being from affective reactions to daily activities, are predominantly unpleasant activities less deleterious if they are also somewhat pleasant? Relatedly, are predominantly pleasant activities less beneficial if they are also somewhat unpleasant? Finally, can such mixed emotions be beneficial during certain life circumstances (e.g., in the midst of transitions or the aftermath of traumas) more so than others?

Conclusion

In sum, a host of researchers have begun to examine mixed emotions in a variety of settings and recent work has provided preliminary evidence for the idea that mixed emotional experiences can benefit well-being. Yet, there has been little agreement (even among the authors of this paper!) regarding the best ways to measure mixed emotions. Different research questions require different methods and our analysis corroborates earlier suggestions (e.g., Diener & Iran-Nejad, 1986; Russell & Carroll, 1999; Schimmack, 2001) that, when it comes to measuring mixed emotions, cooccurrence-based measures are superior to measures of emotional complexity. Our review also indicates that both measures are associated with beneficial outcomes, which indicates that they both tap into meaningful emotional phenomena. As such, we look forward to future research on the relationships among mixed emotions and emotional complexity, how they influence well-being, and potentially how they interact to influence well-

being. Moreover, we look forward to further refinements in the measurement of mixed emotions, which will also allow researchers to paint a more complete picture of the nature of well-being.

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Table 1

Average Correlations Among Cooccurrence Based Measures from Monte Carlo Simulation

Measure	MIN	SIM	GTM
Dichotomous Cooccurrence	0.724**	0.674**	0.831**
MIN		0.943**	0.932**
SIM			0.952**

Note. **p<.001

Table 2

Relationship Among Cooccurrence Based Measures from Ersner-Hershfield et al. (2008)

Measure	MIN	SIM	GTM
Dichotomous Cooccurrence	0.737**	0.738**	0.892**
MIN		0.977**	0.934**
SIM			0.954**

Note. **p<.001

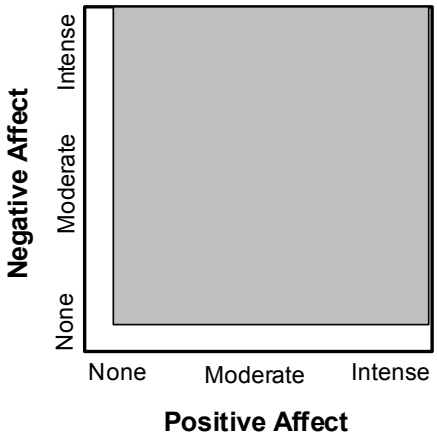

Figure 1. People experience mixed emotions when their affective state can be characterized as falling into the shaded area, which represents at least some amount of positive affect and negative affect. The absence of mixed emotions is illustrated by the non-shaded, L-shaped area (Russell & Carroll, 1999). The L-shaped area includes regions denoting neutrality (bottom left corner), exclusive positive affect (bottom edge), and exclusive negative affect (left edge).

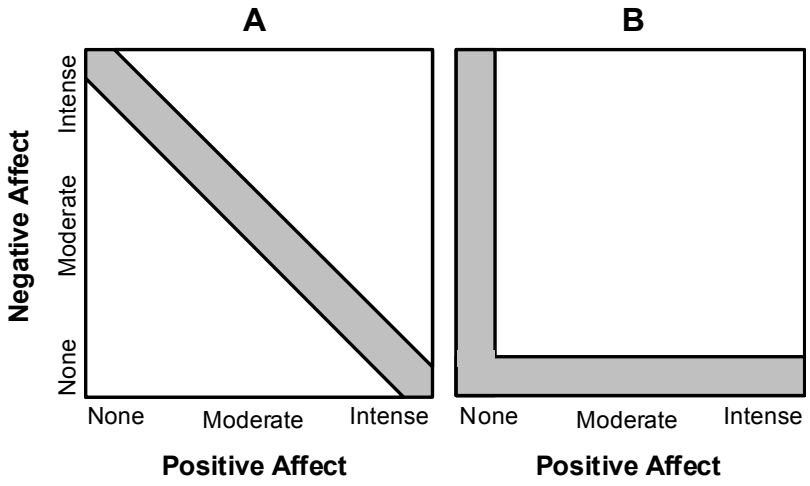

Figure 2. Two possible relationships between positive and negative affect. If all observations fall within Panel A's shaded area, the correlation between positive and negative affect will approach -1 but the incidence of mixed emotions can vary. If all observations fall within Panel B's shaded area, the incidence of mixed emotions will be low but the correlation between positive and negative will vary.

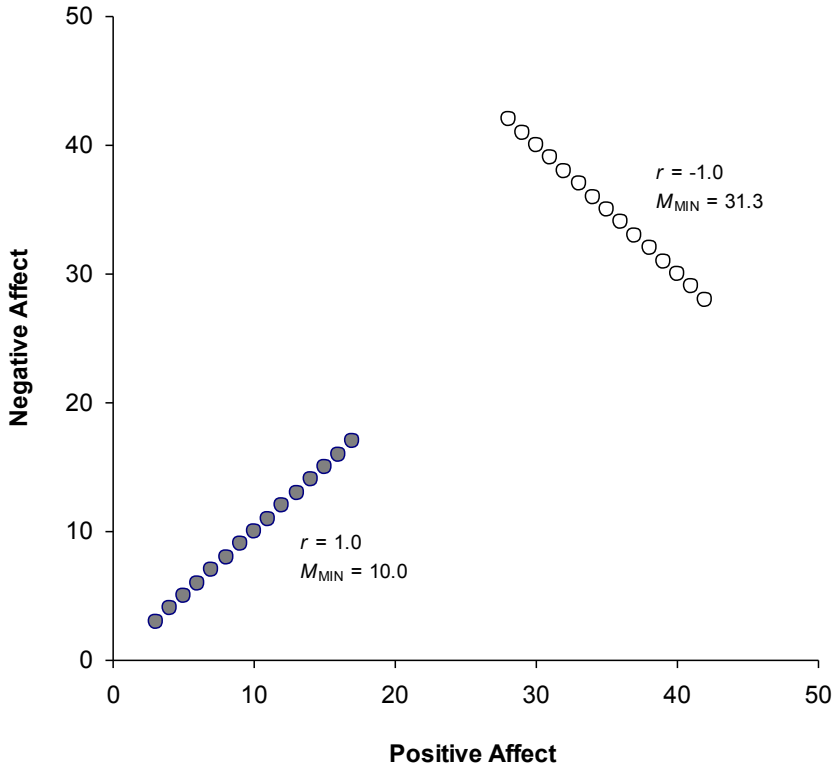

Figure 3. Correlation between positive and negative affect and mean MIN (positive affect, negative affect) scores for two hypothetical distributions. For the filled data points, positive and negative affect are perfectly positively correlated ($r = 1.0$), but the mean MIN score is fairly low ($M = 10.0$). For the hollow data points, positive and negative affect are perfectly negatively correlated ($r = -1.0$), but the mean MIN score is much higher.

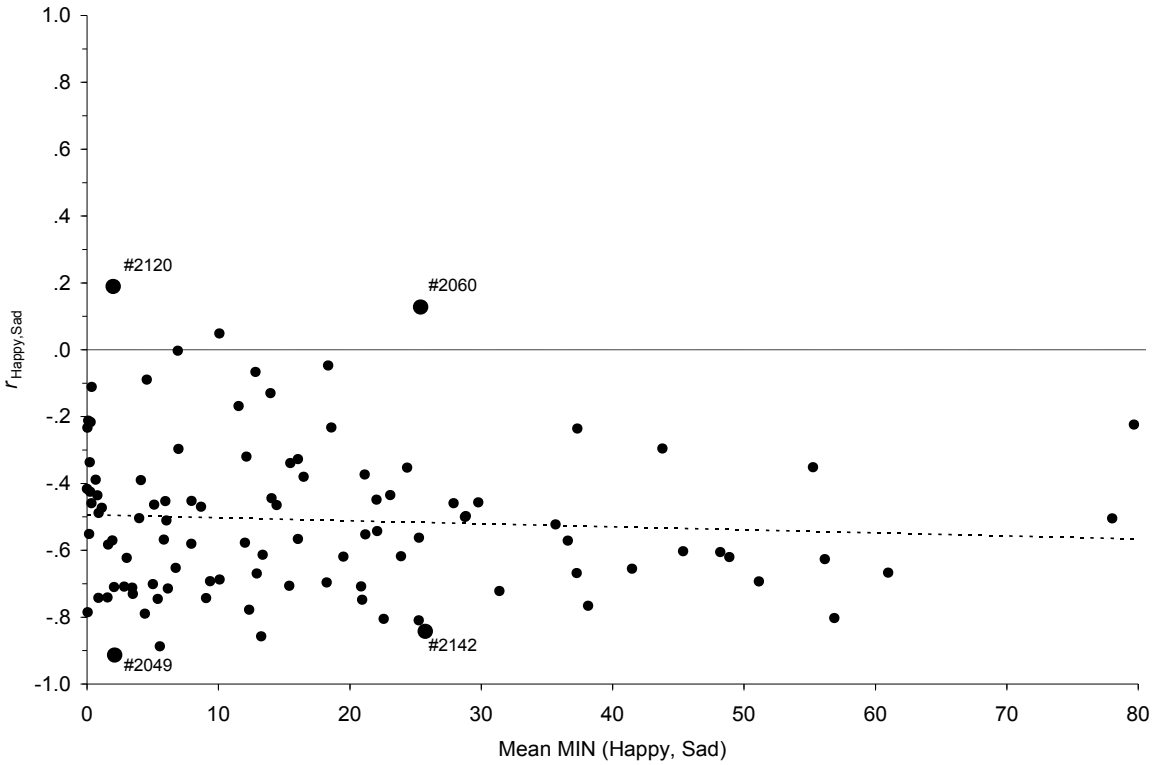

Figure 4. Intraindividual correlations between happiness and sadness plotted as a function of each participants' mean MIN scores collected from participants as they watched 23-min clip from *Life Is Beautiful*. Data taken from Larsen, Hershfield, Hester, and Stastny (2012).

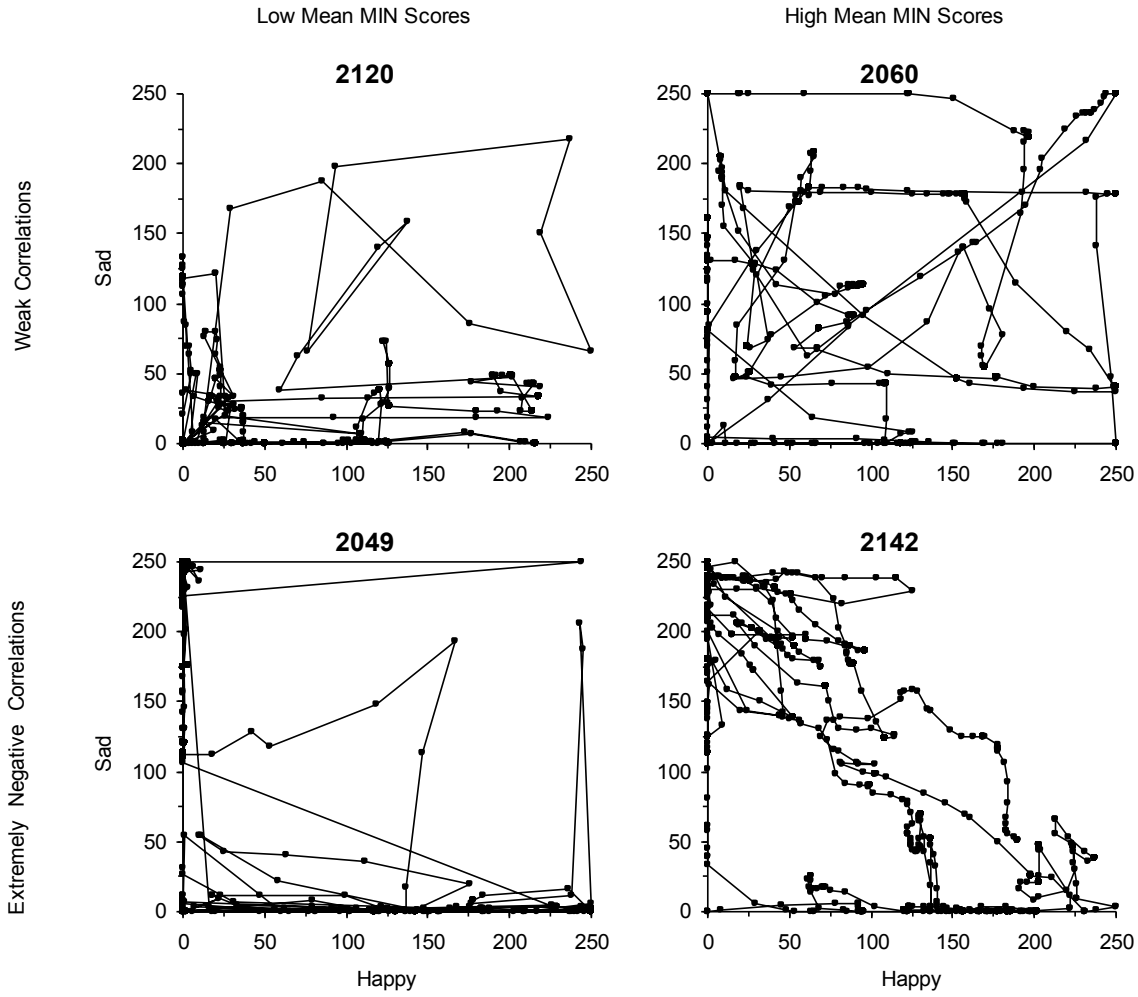

Figure 5. Data from 4 illustrative participants who reported moment-to-moment changes in their happiness and sadness as they watched a 23-min clip from *Life Is Beautiful* (Larsen, Hershfield, Hester, & Stastny, 2012).