Happiness Is Pleasant, or Is It? Implicit Representations of Affect Valence Are Associated with Contra-Hedonic Motivation and Mixed Affect in Daily Life

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Abstract

People typically want to feel good. At times, however, they seek to maintain or enhance negative affect or to dampen positive affect. The prevalence of such contra-hedonic motivation has been related to simultaneous experiences of positive and negative (i.e., mixed) affect. We investigated the role that implicit mental representations of affect valence may play in this regard in a study with $N = 400$ participants aged 11–88 years. Results demonstrated the age-fairness and reliability of the affect-valence IAT, a newly developed implicit measure of inter-individual differences in mental representations of affect valence. The older participants were, the more distinctively they implicitly associated happiness with pleasantness and/or unhappiness with unpleasantness. Participants furthermore carried mobile phones as assessment instruments with them for three weeks while pursuing their daily routines. The phones prompted participants on average 54 times to report their momentary affective experience and affect-regulation motivation. Contra-hedonic motivation and mixed affect were most prevalent among adolescents and least prevalent among older adults, and thus showed a similar pattern of age differences as the affect-valence IAT. Furthermore, the more distinctive participants' implicit associations of happiness with pleasantness, and/or unhappiness with unpleasantness, the less likely participants were to report contra-hedonic motivation and mixed affect in their daily lives. These findings contribute to a refined understanding of the mixed-affect perspective on contra-hedonic motivation by demonstrating the respective role of implicit affect-valence representations.

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People want to feel good most of the time—but there are occasional exceptions. Listening to plaintive music to indulge in sadness or seeking to put oneself into a somber mood before delivering bad news are examples. Previous investigations showed that contra-hedonic tendencies of wanting to maintain or enhance negative affect, or to dampen positive affect can be associated with episodes of mixed affect, that is, with simultaneously experiencing affective states of opposing valence, such as sadness and enjoyment, or pride and embarrassment (e.g., Andrade & Cohen, 2007). Proceeding from this finding, the present research focused on the role that people's implicit mental representations of the valence of affective states play in this regard. We investigated whether individuals from different age groups differ in how distinctively they implicitly associate specific affective states with pleasantness versus unpleasantness, respectively; and whether these affect-valence representations are related to self-reported experiences of contra-hedonic motivation and mixed affect in everyday life.

The Mixed-Affect Perspective on Contra-Hedonic Motivation

Contra-hedonic motivation involves momentary tendencies to dwell on or intensify negative affective experiences, such as anger or sadness; or to lessen positive ones, such as pride or amusement (e.g., Riediger, Wrzus, Schmiedek, Wagner, & Lindenberger, 2011; Tamir, 2009). It has often been associated with mental-health problems. Clinical conditions can indeed involve such symptoms as the deliberate inflicting of injury and pain upon oneself (e.g., Klonsky, 2007). Occasionally, contra-hedonic motivation, albeit at lower frequency and intensity, however, also occurs in non-clinical populations (e.g., Erber, Wegner, & Therriault, 1996; Tamir, Chiu, & Gross, 2007).

It has been argued that episodes of mixed affect, that is, experiencing positive and negative affect at the same time, could be one reason for why psychologically healthy individuals may at times be inclined to seek apparently negative affective experiences, or to dampen apparently positive ones (Andrade & Cohen, 2007; Riediger, Schmiedek, Wagner, & Lindenberger, 2009). This perspective is consistent with the idea that affective experiences at a given point in time and as a whole, may not always be unequivocal or simple, but can be complex and multifaceted (Schimmack, 2001). This potential complexity of affective states is reflected, for example, in the extent to which people differentiate distinct experiential facets of a given affective state (e.g., Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Feldman Barrett, Gross, Christensen, & Benvenuto, 2001). Particularly relevant for the present considerations is evidence that affective episodes may specifically entail a blend of various affective states of opposing valence (e.g., Larsen & McGraw, 2011; Schimmack, 2001). A common example is the simultaneous experience of sadness and enjoyment, but other combinations of affective states of opposing valence can also co-occur (e.g., disgust and amusement; Hemenover & Schimmack, 2007). Anticipated or actual mixed affective experiences might motivate individuals to seek or maintain a negative affective state because of the positive aspects they associate it with (e.g., when they enjoy being sad), or to dampen a positive affective experience because it is accompanied by negative feelings as well (e.g., when they are embarrassed to be proud).

Evidence in line with the idea that contra-hedonic motivation is associated with such mixed affective experiences stems from a series of studies reported by Andrade and Cohen (2007) who showed that students who liked to watch horror movies were more likely to experience both fear and happiness while watching, whereas persons who avoided horror movies typically only experienced fear. Also in accordance with the mixed-affect perspective, a study reported by Riediger and colleagues (2009) demonstrated that

occurrences of the contra-hedonic motivation of wanting to maintain their momentary negative affect in everyday life was related to participants' being more likely to report mixed affective experiences in these situations.

Age Differences in Contra-Hedonic Motivation and in Experiences of Mixed Affect

Riediger and colleagues (2009) also demonstrated age-related differences in the prevalence of contra-hedonic motivation in the everyday lives of individuals aged 14 to 86 years. Adolescents reported contra-hedonic motivation most frequently. A steep reduction in the prevalence of contra-hedonic motivation was observed between the adolescent and the young adult subsamples, and a further decrease in contra-hedonic motivation, throughout the adult subsamples into old age. The mixed-affect perspective suggests that age differences in contra-hedonic motivation might be associated with differences in the prevalence of mixed affect. Riediger and colleagues (2009) indeed found pronounced age-related differences in the frequency of mixed affective experiences that followed the same pattern as those for the prevalence of contra-hedonic motivation. Mixed affective experiences were most frequent among the adolescent participants, and least prevalent among the older adults. The processes underlying these individual differences, however, remained unclear. The purpose of the present research was to contribute to a refined understanding of the mixed-affect perspective on contra-hedonic motivation by investigating associations with the implicit mental representations of affective states that individuals have previously formed throughout their lives.

Mental Representations of Affective States

Individuals differ in their mental representations of affective states. Generally speaking, mental representations are cognitive structures that reflect the residue of an individual's prior lifetime of observation, thought, and experience. They provide the material upon which cognitive processes operate and shape the individual's perceptions, preferences,

experiences, and behaviors, which, in turn, subsequently become incorporated into the structure of mental representations (Carlston, 2010). Mental representations of affective states have typically been studied in terms of people's self-reported attitudes towards them, such as how desirable (Eid & Diener, 2001) or useful (Tamir & Ford, 2012) they perceive certain affective states to be; how much they like or dislike particular affective states (Harmon-Jones, Harmon-Jones, Amodio, & Gable, 2011), or how they would ideally like to feel (Tsai, 2007). These studies have demonstrated inter-individual (Harmon-Jones et al., 2011; Tamir & Ford, 2012) and cross-cultural (Eid & Diener, 2001; Tsai, 2007) differences in mental representations of affective states. They also suggest that representations of affective states could be related to people's affect-regulatory preferences. Harmon-Jones and colleagues (2011), for example, showed that the more students reported liking particular affective experiences, the more interested they were in viewing pictures that evoked these states.

The present research extends the empirical inquiry on mental representations of affective states in two respects. First, proceeding from the mixed-affect perspective, we proposed that individual differences in how individuals mentally represent *the valence* of affective states should be related to differences in how often they report contra-hedonic motivation and mixed-affective experiences in their everyday lives. Affect valence refers to the hedonic tone (i.e., pleasantness–unpleasantness) of an affective experience. As discussed in more detail below, we define affect-valence representations as the distinctiveness with which people implicitly associate specific affective states with pleasantness versus unpleasantness. Second, we developed an implicit (i.e., behavioral) measure to assess such mental representations of affect valence. Cognitive-psychological models of mental representations stipulated the theoretical framework for our predictions and provided the conceptual basis for the development of this measure.

Despite differences in details, contemporary models of mental representations converge on several basic principles (Wyer, 2007). It is widely accepted, for example, that it is helpful to construe an individual's system of mental representations as an associative network. Another popular assumption is that in order to guide people's behavior and experience, represented concepts have to be activated either through sensory input or through interconnections with other activated concepts (e.g., Anderson & Bower, 1973). Such interconnections represent the degrees of learned or inferred associations between concepts. Activation spreads more quickly the stronger the associations between connected concepts are, and co-activation of concepts further enhances the association strength between them (for an overview, see Carlston, 2010).

Proceeding from these theoretical assumptions about the organization of mental representations, we conclude that individual differences in mental representations of the valence of affective states can be characterized by how strongly an individual associates a given affective state with pleasantness and unpleasantness, respectively. Whereas some people might associate some affective states (e.g., happiness) distinctively with pleasantness (rather than unpleasantness) and/or other affective states (e.g., unhappiness) distinctively with unpleasantness (rather than pleasantness), other individuals might have less distinctive (i.e., more ambiguous) representations of affect valence, associating happiness also with unpleasantness and/or unhappiness also with pleasantness.

From the well-replicated finding that activated concepts in mental representations guide behavioral preferences (for an overview, see Wyer, 2007), we concluded that more ambiguous affect-valence representations should be associated with a higher likelihood of contra-hedonic motivation and mixed affective experiences. For example, the more ambiguous individuals' affect-valence representations, the more likely they should be to occasionally seek to avoid or dampen seemingly positive affective states because of

unpleasantness they associate them with, or, vice versa, to occasionally seek ostensibly negative affective experiences because of the pleasantness they associate them with as well. As a consequence, people with more ambiguous affect-valence representations should also experience mixed affective states more frequently. This, in turn, should further enhance the ambiguity of affect-valence representations; that is, experiencing affective states that are pleasant and unpleasant at the same time should again strengthen the association of seemingly positive states with unpleasantness, and/or of seemingly negative states with pleasantness via the co-activation of these concepts.

From these considerations, we derived the following hypotheses: Implicit mental representations of affect valence should show a pattern of *age differences* that is similar to that of the prevalence of contra-hedonic motivation and mixed affective experiences. On the basis of our previous cross-sectional findings, we hence expected adolescents to have the least, and older adults to have the most distinctive representations of the valence of affective states within an age-heterogeneous sample (Hypothesis 1).

Furthermore, mental representations of affective states should also be *associated* with people's inclinations for contra-hedonic motivation and for experiencing mixed affect. The more distinctively people associate affective states with either pleasantness or unpleasantness (rather than with both), the less likely they should be to report contra-hedonic motivation in their daily lives (Hypothesis 2), and the less frequently they should experience episodes of mixed affect in their daily lives (Hypothesis 3).

Methodological Approach

The investigation of our hypotheses required a reliable and age-fair measure of mental representations of affect valence. To develop such an instrument, we used the implicit-association-test (IAT) paradigm (Greenwald, McGhee, & Schwartz, 1998). This choice was informed by a large body of research that has established the utility of this paradigm as a

measure of the relative association strength between concepts in mental representations (for overviews, see Greenwald, Poehlman, Uhlmann, & Banaji, 2009; Lane, Banaji, Nosek, & Greenwald, 2007; Nosek, Greenwald, & Banaji, 2005). There also is evidence that IAT indices can be reliably compared across different age groups, provided that the effects of age-related differences in cognitive functioning are appropriately controlled for (Back, Schmukle, & Egloff, 2005; Baron & Banaji, 2006; Hummert, Garstka, O'Brien, Greenwald, & Mellott, 2002; Mierke & Klauer, 2003).

The classic IAT paradigm derives the relative association strength between two pairs of concepts from reaction times in categorization tasks. These concept pairs include targets (e.g., flower–insect) and attributes (e.g., good–bad). Participants categorize the stimuli according to the corresponding concepts by pressing one of two response keys. In the critical parts of the experiment, after the categorization tasks have been practiced, each response key is assigned to one target and one attribute concept. The basic assumption is that the categorizations should be easier (and response times thus shorter) the more strongly the participants associate the two concepts that share the same response key. We applied this paradigm to investigate participants' associations between prototypical instances of positive and negative affect, namely, *happy–unhappy* (target concepts), and prototypical instances of valence descriptors, namely, *pleasant–unpleasant* (attribute concepts), respectively.

Method

This study was conducted between fall 2010 and spring 2011 as part of an ongoing and partially longitudinal research project: the Multi-Method Ambulatory Assessment (MMAA) project. About 55 percent of the sample had already participated in a previous data collection of the MMAA project (conducted in 2007 and 2008; e.g., Riediger et al., 2009). The present investigation conceptually and empirically extends this previously published research. None of the data reported here have been published before.

Sample

The sample was recruited by a fieldwork agency in three metropolitan areas in Germany (Berlin, Munich, and Duesseldorf). It initially comprised $N = 400$ participants ranging from 11.6 to 88.1 years of age ($M = 39.9$, $SD = 20.5$; 48.0% men). Of the adult participants (> 18 years; $n = 321$), 23.1% held a college or university degree. Of the adolescent participants (11–18 years; $n = 79$), 34.2% attended the lower track of the German secondary school system, and 63.3% the higher track (required for university entrance); 2.5% were in vocational training or employed as untrained workers. All participants were native German speakers.

Procedure

The study started with an individual instruction session for the experience-sampling phase. Participants received mobile phones (Nokia E50) and practiced navigating and responding to the experience-sampling instrument installed on the phones. Two people ended their participation after the instruction session, reducing the effective sample size for the experience-sampling phase to $N = 398$.

Following the instruction session, participants carried their phones with them while pursuing their daily routines. During three weeks, three experience-sampling periods of three consecutive days each were scheduled, covering six weekdays (Monday through Friday) and three weekend days (Saturday and Sunday) and being separated by breaks of six days. The purpose of this experience-sampling phase was to obtain, via a short assessment instrument, information on participants' experiences of contra-hedonic motivation and mixed affect in their everyday lives. On each experience-sampling day, six assessments were distributed across a time window of 12 hours, the beginning of which was chosen by the participants according to their personal waking habits. During each of the six 2-hour time periods within the respective participant's personal time window, one signal was scheduled randomly. If

participants did not respond, they were reminded twice by auditory signals, occurring after five and after ten minutes. If there was still no response, the instrument closed after 15 minutes, thus reducing participants' degrees of freedom in determining when to complete the instrument. On average, participants completed at least five of the six daily assessments on 87.5% of their assessment days, *SD* = 19.3. To obtain a sufficient number of assessments, experience-sampling periods were extended for a day if participants had completed fewer than five assessments on a given day. Overall, *M* = 2.6, *SD* = 2.0, of these extension days were scheduled per participant. Participants completed an average of 54.1 assessments, *SD* = 5.7.

After the experience-sampling phase, a second individual session was conducted during which participants completed, among other things, explicit measures of affect valence as well as a task-switching IAT and the affect-valence IAT (in that order). Both IATs were programmed in DMDX (Forster & Forster, 2003) and administered on laptop computers (Fujitsu ESPRIMO Mobile D9510) with 14-inch monitors (1024 × 768 pixels). One participant did not complete the explicit measure of affect valence, and IAT data were lost for four participants due to technical problems, reducing the effective sample size for these measures to *N* = 397 and *N* = 394, respectively. Participants were reimbursed with €100 (approximately $135). The study had the approval of the ethics committee of the Max Planck Institute for Human Development.

Measures

Experience-sampling measures. We describe the experience-sampling measures in the order participants responded to them at each measurement occasion.

Mixed affect. Participants first indicated the degree to which they were currently experiencing each of 13 feelings using a scale ranging from 0 *"not at all"* to 6 *"very much."* The items were selected to represent prototypical positive and negative affect facets of

various arousal levels that are relevant for, and evince sufficient intra-individual variation in, the daily lives of individuals from different age groups. We averaged responses across the positive (joyful, content, interested, enthusiastic, relaxed, energetic, and balanced) and negative affect items (angry, downcast, anxious, disappointed, tense, and tired) to obtain indicators of positive (average within-person $M = 2.78$, $SD = 0.81$) and negative affect (average within-person $M = 1.05$, $SD = 0.66$), respectively. Simultaneous reports of momentary positive and negative affect that were both more intense than the individual's respective averages were regarded as indicating episodes of mixed affect. Such episodes occurred on average in 12.7% of the measurements obtained per participant ($SD = 8.6$).[1]

Situational context. Information on participants' momentary activities and social partner(s) were obtained as situational covariates for control analyses. Participants reported their current activity by checking the appropriate response option(s) among *work/school/study*, *chores/errands, leisure activity*, *doing nothing/sleeping/watching TV, doctor visit/office run*, *conversation/visit,* and *other*. For our control analyses and in the interest of parsimony, we combined responses into four overarching categories: *occupation* (work/school/study), *errands* (chores/errands and doctor visit/office run), *leisure* (leisure activity, conversation/visit, and doing nothing/sleeping/watching TV), and *unspecified* (other or multiple categories chosen).

Participants further indicated which other persons were present at the time by choosing a response (or several) from *alone, partner, family, colleagues/fellow students, strangers*, and *other*. Again, we used more parsimonious categories in our control analyses: *alone*, *private acquaintance(s)* (partner, family, friends), *non-private acquaintance(s)* (colleagues/fellow pupils or students), *stranger(s)*, and *unspecified* (other or multiple categories chosen).

Affect-regulation motivation. At the end of the experience-sampling protocol participants also reported whether they currently wanted to (a) *dampen*, (b) *maintain*, (c) *enhance*, or (d) *not influence at all* their respective feelings, separately for joy, interest, contentment, anger, anxiousness, and feeling downcast (forced-choice format, 6 items). On the basis of these responses, we identified measurement occasions in which participants reported the wish to maintain and/or enhance at least one negative affect facet and/or to dampen at least one positive affect facet as a dichotomous (yes/no) indicator of contra-hedonic motivation. Such contra-hedonic motivation was reported on average in 16.6% of the measurements obtained per participant (SD = 24.37).

For control analyses, we also derived an indicator of pro-hedonic motivation. Pro-hedonic motivation was more frequently reported than contra-hedonic motivation. As an indicator of momentary pro-hedonic motivation, we therefore determined a count (rather than a dichotomous) variable for each measurement occasion, representing the number of responses indicating the wish to maintain or enhance positive affect or to dampen negative affect (average within-person M = 3.61, SD = 1.34).

Time in study. Intensive repeated assessments can result in reactivity-caused shifts in the mean levels of observed variables over time. To control for possible time-related effects in our analyses, we included the linear and quadratic effects of momentary observation number as covariates in our control analyses.

Individual session after the experience-sampling phase.

Explicit (self-reported) measures of affect valence. In the concluding session, participants completed, among other things, an explicit measure of affect valence (N = 397). They indicated, separately for each of three positive (joy, interest, contentment) and three negative affect facets (anger, anxiousness, and feeling downcast), how often they experience the respective feeling as pleasant, and how often they experience this feeling as unpleasant.

Response options ranged from 1 *"never"* to 7 *"(almost) always"*. Averaging these responses across the positive and negative affect facets yielded explicit indicators of the pleasantness of positive affect (M = 6.10, SD = 1.00)**,** the unpleasantness of positive affect (M = 1.60, SD = 0.79), the pleasantness of negative affect (M = 1.52, SD = 0.77)**,** and the unpleasantness of negative affect (M = 5.17, SD = 1.45).

Affect-valence IAT. The affect-valence IAT is an implicit (not self-reported) measure of the distinctiveness with which people associate happiness with pleasantness (versus unpleasantness), and unhappiness with unpleasantness (versus pleasantness). It consists of a series of categorization tasks in which 20 stimulus words have to be repeatedly assigned to the four categories *happy, unhappy* (target categories)*,* and *pleasant, unpleasant* (attribute categories). Category labels were shown on the top left and right of the computer screen. Stimulus words (e.g., joyful, sad, comforting, repulsive; see Appendix) were successively presented in the center of the computer screen. The participants' task was to assign the stimulus word to the corresponding category as quickly and accurately as possible by pressing one of two response keys. When the stimulus word represented a category shown on the left, the letter "Q" (which is on the far left of the German keyboard layout) had to be pressed; and when the stimulus word represented a category shown on the right, the letter "Ü" (which is on the far right of the German keyboard) had to be pressed. Correct categorizations initiated presentation of the next stimulus word (inter-trial interval = 33.5 ms). Incorrect categorizations caused a red "X" to appear in the place of the stimulus word. Participants had to correct their response to proceed to the next trial. To maximize speed of responding, participants kept their left and right index fingers on the "Q" and "Ü" keys, respectively, throughout the entire experiment. In line with the typical IAT procedure, the affect-valence IAT comprised a sequence of five blocks of trials (see Table 1 for an overview). Stimulus words and category labels were presented in the same color to facilitate

categorizations (blue font for happy–unhappy category labels and stimuli; black font for pleasant–unpleasant category labels and stimuli). Figure 1 illustrates the setup of the task for Blocks 3 and 5. Within each block, stimuli were presented in randomized order, with the provisions that stimuli were only repeated after all other stimuli of the respective category had been presented (through repeated sampling without replacement), and that target and attribute stimuli alternated in the combined Blocks 3 and 5.

Stimulus selection. Word stimuli of the affect-valence IAT are shown in the Appendix. They were selected based on data from a pre-study in which 35 native German speakers (14–78 years, 51.4% female) had, among other tasks, categorized and rated 39 potential German stimulus words for the affect-valence IAT. Rating dimensions included familiarity, meaning, and intensity. On the basis of these ratings and of information on word frequency in German language use (determined using the German online linguistic database "Wortschatz-Portal," University of Leipzig Natural Language Processing Group, 2013), we selected five stimulus words per category. We started by choosing the stimulus with the highest number of correct classifications for one category (e.g., for happy). We then identified the respective counterpart for the opposing category (e.g., for unhappy), that is, the stimulus with the most similar pattern of responses and word frequency. This procedure was continued until five stimuli were identified for each of the categories (see Appendix). The four stimulus lists do not differ significantly regarding their (a) average word frequency, (b) average number of letters, and (c) average number of syllables, as indicated by a non-significant main effect for category in a multivariate analysis of variance, $F(9, 34.22) = 0.63$, $p = .77$, according to Wilks' Lambda. Univariate follow-up analyses also yielded non-significant main effects of category for each of the three word characteristics, all $p \geq .46$.

Scoring algorithm. An indicator of the distinctiveness of implicit mental representations of affect valence was computed according to the D-scoring algorithm

proposed by Greenwald and colleagues (2003). This algorithm scales the difference in mean reaction times between Block 3 and Block 5 (i.e., between the compatible and the incompatible block) in units of the individuals' standard deviations. High D-scores indicate that the valence of the happy–unhappy concepts is distinctively represented, with happiness being more strongly associated with pleasantness, and/or unhappiness more strongly with unpleasantness, than vice versa. Lower D-scores, in contrast, indicate a less differentiated representation of the valence of affective states, where the difference in the strength of the association between happy and pleasant versus happy and unpleasant is small (and the same for unhappy). Greenwald and colleagues proposed several variants of this measure. We used the D_1-variant because it has been shown to account for method-specific variance that is due to individual differences in fluid cognitive functioning (Back et al., 2005; Mierke & Klauer, 2003), which are a potential confound in age-comparative research (Hummert et al., 2002). Computing this measure involved (a) determining response times until the correct categorization was made for each trial in Blocks 3 and 5 (built-in error penalty[2]), (b) eliminating trials with response times greater than 10,000 ms, (c) subtracting the mean response times in Block 3 from the mean response time in Block 5, separately for Trials 1–20, and 21–80, respectively, (d) dividing these differences by the pooled within-person standard deviations (across Blocks 3 and 5) in response times in Trials 1–20 and 21–80, respectively, and (e) computing the D_1-measure as the weighted average of the scores (following Back et al., 2005). For control analyses, we also computed a variant of this measure that eliminated all trials with initially incorrect categorizations from the scale score.

We adjusted 11 (2.79%) univariate outliers ($z < -3$, cf. Tabachnick & Fidell, 1996) to the closest non-outlying observed value in the data distribution. The Spearman-Brown corrected split-half correlation of $r = .84$ attested good internal stability to this newly developed instrument ($M = 1.10$, $SD = 0.34$; skewness = –1.28, SE skewness = 0.123;

kurtosis = 1.50, *SE* kurtosis = 0.25). (An independent pilot study additionally showed a satisfactory test-retest reliability of .68 across two weeks. See Supplementary Material.)

Task-switching IAT. We also assessed task-switching ability directly using a task-switching IAT (Back et al., 2005) that follows the same logic and procedure as the affect-valence IAT described above, but involves categories with minimal individual differences in the strengths of pre-existing associations. These categories include letters and numbers (target categories) and words and calculations (attribute categories, see Table 1). Detailed information on the development of the task and its psychometric properties can be found in Back et al. (2005). To derive a control variable of method-specific variance due to task-switching ability, we used the following variant of the conventional scoring procedure (Greenwald et al., 2003): (a) determination of response times until the correct response was given for each trial in Blocks 3 and 5 (built-in error penalty[3]), (b) elimination of trials with response times greater than 10,000 ms, (c) log-transformation of response times, (d) determination of the mean difference in log-transformed average response times between Block 3 and Block 5. Following recommendations by Tabachnick and Fidell (1996), we adjusted three (0.76%) univariate outliers ($z < -3$) to the closest non-outlying observed value in the data distribution ($M = 0.24$, $SD = 0.09$; skewness = –0.26, *SE* skewness = 0.12; kurtosis = 1.88, *SE* kurtosis = 0.25). For control purposes, we also computed a variant of this measure that eliminated all trials with initially incorrect categorizations from the scale score.

Results

Age-Fairness of the D_1-Scoring Method

To assess the age-fairness of the new IAT measure of implicit mental representations of affect valence, we first tested whether the D_1-scoring method indeed removes method-specific variance that is due to age-related differences in task-switching ability. If that were the case, age-related differences in the conventionally scored task-switching IAT should not

be evident when the D_1-scoring method is used. As expected, there was a significant age effect in the conventionally scored task-switching IAT, reflecting an age-related increase in task-switching costs ($r_{age} = 0.23$, $p < .001$). This age effect, however, was indeed no longer evident when the D_1-scoring method was used ($r_{age} = 0.09$, $p = .063$), and the relative reduction in the size of the age correlation was significant ($z = 3.39$, $p < .001$), which supports the suitability of the D_1-scoring method in age-comparative research.

Associations of Affect-Valence IAT D_1-Scores with Explicit Reports of Affect Valence

The D_1-score of the affect-valence IAT was significantly associated with three out of four explicit measures of affect valence (see Table 2). The more distinctively participants implicitly associated happiness with pleasantness, and/or unhappiness with unpleasantness according to the affect-valence IAT, the more they reported experiencing positive affect as pleasant, and the less they reported experiencing positive affect as unpleasant, and negative affect as pleasant (see left column of Table 2). These correlations remained significant when controlling for participants' age (right column of Table 2).

Age Differences in Implicit Mental Representations of Affect Valence

We specified a multiple regression model with the affect-valence IAT D_1-score as the dependent variable, and age (grand-mean centered) as the independent variable. Data exploration had revealed a significant effect of gender, which was therefore also included as model predictor (effect coded, 1 female, -1 male), even though we had not hypothesized finding gender differences (see Table 3).

In line with Hypothesis 1, and as graphically illustrated in Figure 2, the significant main effect of participants' age indicates an age-related increase in the distinctiveness with which participants implicitly associated happiness with pleasantness (rather than unpleasantness) and/or unhappiness with unpleasantness (rather than pleasantness). Repeating the regression analysis with a quadratic age term as an additional predictor did not

yield indication of non-linearity in the age effect; quadratic age term: beta = –0.06, $p = .25$; R square change = .003, F change (1, 390) = 1.34, $p = .25$.

The significant gender effect in Table 3 indicates that women ($M = 1.15$, $SD = 0.32$) obtained higher affect-valence IAT scores than the sample average and, consequently, also than men ($M = 1.05$, $SD = 0.36$). In other words, compared to men, women (irrespective of their age) associated happiness more distinctively with pleasantness, and/or unhappiness more distinctively with unpleasantness (rather than vice versa).

The gender and linear age effects in the affect-valence IAT also emerged when we additionally controlled for age-related differences in task-switching ability, that is, when we included the conventionally scored task-switching IAT as an additional predictor. There was no indication of a significant age x gender interaction ($p > .05$), and the age and gender effects remained significant in single-predictor models as well. We also repeated the analysis after excluding trials with initially incorrect categorizations from the affect-valence IAT score and again obtained the same pattern of results.

Associations of Implicit Affect-Valence Representations with Contra-Hedonic Motivation in Daily Life

We specified a series of multilevel binary logistic regression models in SAS NLMIXED using the macro provided by Van Ness, O'Leary, Byers, Fried, and Dubin (2004). The dependent variable in these analyses was the presence (or absence) of contra-hedonic motivation at a given measurement occasion. Participants' affect-valence IAT score (D_1, grand-mean centered) and age (grand-mean centered) served as predictor variables. We also included squared age as model predictor because exploratory analyses had indicated non-linearity of the age effect (see Figure 3).

Parameter estimates are summarized in Table 4. The odds ratio for the intercept represents the estimated odds of reporting contra-hedonic motivation assuming all predictor

variables to be zero (i.e., for participants of average sample age and with average scores in the affect-valence IAT). The odds ratio for a given predictor variable represents the predicted change in the odds of reporting contra-hedonic motivation for a one-unit increase in the respective predictor, assuming the other predictor to be zero (i.e., to be at the sample mean). In agreement with Hypothesis 2, the model predicts a decrease of 70% in the odds of reporting contra-hedonic motivation for a one-unit increase in the affect-valence IAT (observed range: 1.56), assuming age to be at the sample average. The higher participants' affect-valence IAT scores were, that is, the more distinctively they associated happiness with pleasantness and/or unhappiness with unpleasantness (rather than vice versa), the less likely they were to report contra-hedonic motivation in their everyday lives.

The model also predicts a decrease in the odds of experiencing contra-hedonic motivation of 4% for every one-year increase in the participant's age, assuming an average affect-valence IAT score. The significant squared effect of age indicates that this decrease was smaller for older than for younger age ranges in the investigated sample (see Figure 3).

Results shown in Table 4 were robust to (a) excluding trials with errors from the affect-valence IAT score, and to (b) controlling for participants' performance in the task-switching IAT, for their momentary activities and social partners, as well as for possible time-related effects (operationalized by including the linear and quadratic effects of momentary observation number as predictor variables).

Exploratory analyses did not yield any indication of a significant gender effect on contra-hedonic motivation. There also was neither indication of a significant interaction between the model predictors, nor of a quadratic effect of the affect-valence IAT.

We also explored whether the effect of the affect-valence IAT score was specific to contra-hedonic motivation (as we had hypothesized), or whether it was due to participants with less differentiated affect-valence representations generally endorsing affect-regulation

more. To disentangle these possibilities, we specified a multilevel regression model that was analogous to the model shown in Table 4, but used a continuous indicator of pro-hedonic motivation as the dependent variable. The model was estimated in SAS PROC MIXED, using restricted maximum likelihood estimation and spatial power residual co-variance structure (an autoregressive structure that can take unequal spacing of measurement occasions into account, cf. Littell, Milliken, Stroup, Wolfinger, & Schabenberger, 2007). The intercept estimate (i.e., the estimated pro-hedonic motivation for participants with average affect-valence IAT scores and of average sample age) was 3.40, $p < .0001$. There was no significant effect of the affect-valence IAT score on pro-hedonic motivation (parameter estimate –0.21, $SE = 0.20$, $p = .287$), indicating the specificity of this effect to contra-hedonic motivation. Both the linear and quadratic age effects, however, reached statistical significance (linear age effect: 0.009, $SE = 0.0036$, $p = 0.014$; quadratic age effect: 0.0005, $SE = 0.00018$, $p = 0.004$). Consistent with findings from earlier research (Riediger et al., 2009), these estimates indicate an age-related increase in pro-hedonic motivation that accelerates with higher age.

Associations of Implicit Affect-Valence Representations with Mixed Affect in Daily Life

We used a corresponding statistical approach to investigate whether implicit representations of affective states are related to participants' likelihood of reporting episodes of everyday mixed affect. The dependent variable in these analyses was the presence (or absence) of mixed affect at a given measurement occasion (i.e., the simultaneous experience of positive and negative affect that were both more intense than the individual's respective averages). Independent variables were the affect-valence IAT (grand-mean centered) and age (grand-mean centered). Parameter estimates are shown in Table 5. Exploratory steps of the data analyses had revealed that neither gender, nor any of the possible interactions between the model predictors, nor quadratic terms of the affect-valence IAT or age contributed significantly to the prediction of mixed affect ($p > .05$).

In line with Hypothesis 3, the model predicts a decrease of 26% in the odds of experiencing mixed affect for a one-unit increase in the affect-valence IAT (observed range: 1.56), assuming age to be at the sample average. The higher participants' affect-valence IAT scores, that is, the more distinctive the implicit association of happiness with pleasantness and of unhappiness with unpleasantness (rather than vice versa), the less likely the participants were to simultaneously experience positive and negative affect that were both more intense than their individual averages. The model also predicts a decrease in the odds of experiencing mixed affect of 1% for every one-year increase in the participant's age, assuming an average affect-valence IAT score (see also Figure 4). Control analyses demonstrated the robustness of the results shown in Table 5 after (a) excluding trials with errors from the affect-valence IAT score, and (b) controlling for the participants' performance in the task-switching IAT, their momentary activities and social partners, as well as the momentary observation number (linear and quadratic).

Discussion

The mixed-affect perspective contends that contra-hedonic motivation can occur when actual or anticipated experiences of mixed affect (e.g., enjoying to be sad, or feeling ashamed to be happy) invoke individuals to maintain or enhance seemingly negative, or to dampen seemingly positive affective states. The present investigation demonstrates that implicit mental representations of the valence of affective states are associated with the frequency of such contra-hedonic motivation and experiences of mixed affect in daily live.

Such implicit affect-valence representations were operationalized with a newly developed affect-valence IAT, which demonstrated good reliability and suitability for use in age-comparative research. These satisfactory psychometric properties are particularly noteworthy given that both target and attribute stimuli in the affect-valence IAT are adjectives semantically related to emotional experiences, whereas in standard implicit

association tests, targets and attributes often stem from different word classes and are semantically more distinct. Even though we had established in a pre-study that individuals from various age groups were familiar with the stimuli of the affect-valence IAT and could unambiguously identify them as belonging to the intended attribute or target categories, we cannot rule out that the combined blocks, and particularly the incompatible Block 5, may be more difficult in the affect-valence IAT than is typically the case in this paradigm. This characteristic, however, obviously did not impair the construct validity of the measure as evidenced by the significant associations of the affect-valence IAT with explicit measures of affect valence. The size of these associations was relatively small, which is consistent with the assumption that implicit and explicit measures address partially distinct facets of mental representations, as implicit representations may not be fully accessible to introspection (e.g., Carlston, 2010). Taken together, this nomological network supports the validity of the affect-valence IAT score as an indicator of the distinctiveness with which individuals implicitly associate happiness with pleasantness, and/or unhappiness with unpleasantness (rather than vice versa).

Gender Differences in Mental Representations of Affect Valence

Female participants obtained higher affect-valence IAT scores than same-aged male participants; that is, compared to male participants, females implicitly associated happiness somewhat more distinctively with pleasantness, and/or unhappiness somewhat more distinctively with unpleasantness (rather than vice versa). One could speculate that socialization-related experiences may contribute to the formation of implicit affect-valence representations. Male gender roles in contemporary Western societies, for example, prescribe strict control of emotional experiences and expressions (e.g., Jansz, 2000). Overall, boys and men are thus socialized to be less emotional than their female counterparts. There are only few affective states, such as anger, for which this pattern is reversed (e.g., Fischer, Rodriguez

Mosquera, van Vianen, & Manstead, 2004). Experiencing and expressing positive affect may hence also entail an implicit negative connotation for males, as it is inconsistent with cultural stereotypes of masculinity (see also Shields, 2000). This could contribute to more ambiguous implicit representations of affect valence in male than in female individuals. It is also possible that unrestricted experience and display of affective states, which is more consistent with female gender roles, facilitates the development of distinctive implicit representations of affect valence through exposure and experience. At this point, these considerations are speculative. In addition, given that we had not hypothesized finding gender differences in the affect-valence IAT, this finding needs to be regarded with caution until replicated in future studies.

Age Differences in, and Associations between, Affect-Valence Representations, Contra-Hedonic Motivation, and Mixed Affect in Daily Life

Consistent with our hypotheses, we found that the older participants were, the more distinctively they implicitly associated happiness with pleasantness (rather than unpleasantness) and/or unhappiness with unpleasantness (rather than pleasantness). These age differences remained robust to controlling for task-switching ability, thus confirming that they do not merely reflect age differences in fluid-cognitive functioning. There also was no significant age-related difference in the number of categorization errors participants committed in Block 5 (i.e., the incompatible combined block), and all results reported in this paper were robust to excluding trials with erroneous classifications of stimuli from the analyses. This renders the speculation improbable that our findings might be merely due to participants' of various ages differing in how well they can semantically distinguish between the four stimulus categories. In addition, there was no significant age effect in the D_1-Score of the task-switching IAT, which speaks against a possibility of a generalized age-related increase in the distinctiveness of implicit mental representations of concepts.

Also in line with our predictions, we found similar patterns of age-related differences for the experience-sampling measures of contra-hedonic motivation and mixed affective experiences. Replicating findings from an earlier investigation (Riediger et al., 2009), the average prevalence both of contra-hedonic motivation and of episodes of mixed affect in everyday life decreased from adolescence to old age. Furthermore, we observed significant associations between implicit affect-valence representations and experience-sampling reports of contra-hedonic motivation and mixed affect. The less distinctive participants' implicit representations of affect valence were, the more likely they were to report contra-hedonic motivation and mixed affect in their daily lives. This finding is in line with the possibility that individuals with more ambiguous affect-valence representations might be more inclined to dampen seemingly positive affective experiences because they also associate them with unpleasantness, and/or to occasionally seek seemingly negative affective states as they also associate them with pleasantness. Such contra-hedonic motivation might then lead to more frequent simultaneous experiences of affective states of opposing valence (i.e., mixed affect), which, in turn, might strengthen the mental association of positive states with unpleasantness, and of negative states with pleasantness, thus recursively fostering more ambiguous (i.e., less distinct) representations of affect valence.

Our cross-sectional investigation does not allow investigating such a potential causal sequence in the observed relationships. Future research will need to employ well-controlled experiments to disentangle the causal mechanisms involved. This will also contribute to a better understanding of the reasons for the observed age-related differences in the phenomena studied. For example, are the observed age differences in the propensity of experiencing mixed affect (partly) due to differences in implicit mental representations of affect valence and resulting differences in the likelihood of contra-hedonic motivation? Yet another open question for future research pertains to the factors that might trigger age-related shifts in

implicit representations of affect valence. We believe that they are formed and shaped throughout life, and thus reflect the individual's accumulated history of affect-related experiences, observations, thoughts, and motivations. Differences in the instrumentality of affective experiences in different life phases could be particularly relevant. For example, when negative affect helps dealing with the developmental tasks of adolescence (e.g., with establishing emotional autonomy from parents and other adults or developing a sense of identity), it might be sought by the adolescent and experienced as rewarding to some extent, thus enhancing the likelihood of contra-hedonic motivation and mixed affect. When the adolescent has resolved these developmental tasks, however, the instrumental value of negative affect might decline and hence the frequency with which negative affective experiences are perceived as rewarding. This, in turn, should weaken the association of negative affect with pleasantness and thus enhance the distinctiveness of implicit representations of affect valence. Similarly, one could speculate that the instrumental value of positive affect might increase throughout adulthood and into older age because positive affect might facilitate the pursuit of generative and affiliation-related concerns, which gain in subjective importance as people grow older. Consequently, experiencing positive affect might become more rewarding throughout adulthood, and thus contribute to the observed increase in the distinctiveness of implicit affect valence.

Another important avenue for future research will be to explore whether age differences in mixed affective experiences are specific to particular cultures and nationalities, or to particular combinations of positive and negative affect facets. Empirical evidence suggests that Westerners tend to regard positive affect as being more desirable, and negative affect as being more undesirable than Easterners do (Eid & Diener, 2001), and that Easterners regard a dialectical balance between positive and negative affective experiences as more valuable than Westerners do (Miyamoto & Ma, 2011). It might thus be possible that the

pattern of findings in the present study do not generalize to Eastern cultures. In addition, long-term longitudinal investigations will be necessary in the future to determine the extent to which the age-related differences observed in the present study correspond to intra-individual change as people age, or to differences between birth cohorts.

In summary, the present research demonstrates an age-related increase in the distinctiveness of implicit affect-valence representations from adolescence to old adulthood, which corresponds to the pattern of age differences observed in the prevalence of contra-hedonic motivation and mixed affect. We also found that the more distinctively people implicitly associate happiness with pleasantness and/or unhappiness with unpleasantness (rather than vice versa), the less frequently they endorse contra-hedonic tendencies in their daily lives, and the less frequently they experience episodes of mixed affect. Taken together, this research contributes to a refined understanding of the mixed-affect perspective on contra-hedonic motivation by emphasizing the respective role of mental representations of affect valence.

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Footnotes

[1] Another indicator of mixed affect that has been used in previous experience-sampling studies involves the within-person correlation of positive and negative affect (e.g., Carstensen et al., 2011). This indicator is not reported here because various authors have pointed out that a negative correlation of positive and negative affect does not necessarily reflect the absence of mixed affect, and that the absence of such a negative correlation does not necessarily reflect the presence of mixed affect (for details, see Diener & Iran-Nejad, 1986; Hershfield & Larsen, 2012; Russell & Carroll, 1999).

[2] The average number of errors made were $M = 4.50$, $SD = 5.13$ in Block 3, and $M = 12.78$, $SD = 10.82$ in Block 5, respectively. In Block 3, participants tended to make fewer errors the older they were ($r_{age} = -.38$, $p < .001$), but there was no significant age effect of the number of errors made in Block 5 ($r_{age} = -.06$, $p = .24$).

[3] The average number of errors made were $M = 3.11$, $SD = 3.59$ in Block 3, and $M = 8.41$, $SD = 7.24$ in Block 5, respectively. Participants tended to make fewer errors the older they were (Block 3: $r_{age} = -.35$, $p < .001$; Block 5: $r_{age} = -.18$, $p < .001$).

Table 1

Sequence of Blocks in the Affect-Valence IAT and the Task-Switching IAT

				Response key assignment			
				Affect-valence IAT		Task-switching IAT (Back et al., 2005)	
Block	N trials	Function	Task	Left key	Right key	Left key	Right key
1	20	Practice	Target categorization	Happy	Unhappy	Letter	Number
2	20	Practice	Attribute categorization	Pleasant	Unpleasant	Word	Calculation
3	80	Test	Combined categorization (compatible key assignment)	Happy and Pleasant	Unhappy and Unpleasant	Letter and Word	Number and Calculation
4	20	Practice	Reversed target categorization	Unhappy	Happy	Number	Letter
5	80	Test	Reversed combined categorization (incompatible key assignment)	Unhappy and Pleasant	Happy and Unpleasant	Number and Word	Letter and Calculation

Table 2

Zero-Order and Partial Correlation (Controlling for Age) Between the Affect-Valence IAT D_1-Score and Explicit Reports of Affect Valence

	Correlation with affect-valence IAT D_1-score	
Explicit reports of affect valence	Zero-order	Partial (Controlling for age)
Positive affect - Pleasantness	.188 **	.192 **
Positive affect - Unpleasantness	–.202 **	–.196 **
Negative affect - Pleasantness	–.132 **	–.101 *
Negative affect - Unpleasantness	.073 n.s.	.049 n.s.

Note. $N = 392$. * $p < .05$. ** $p < .01$.

Table 3

Age and Gender as Predictors of the Affect-Valence IAT D_1-Score

	Affect-valence IAT D_1-Score			
Predictor	*B*	Standard error	Beta	
Constant	1.099	.016	--	**
Gender (effect code, 1 = female)	0.044	.016	.130	**
Age (grand-mean centered)	0.004	.001	.258	**
R^2	0.085			
F	18.259	**		

Note. $N = 394$. ** $p < .001$.

Table 4

Age and Affect-Valence IAT Scores as Predictors of Occurrences of Contra-Hedonic Motivation: Results from Multilevel Logistic Regression

	Presence (vs. absence) of contra-hedonic motivation		
Predictors	Estimate	Odds Ratio	95% CI[a]
Intercept	–3.058 **	0.05	0.03–0.06
Affect-valence IAT (D_1-score, grand-mean centered)	–1.198 **	0.30	0.16–0.56
Age (grand-mean centered)	–0.041 **	0.96	0.95–0.97
Squared age	–0.001 **	1.00	1.00–1.00

Notes. Results of multilevel binary logistic regression estimated using SAS NLMIXED and the macro by Van Ness et al. (2004).

[a] 95% confidence interval of odds ratio. ** $p \leq .001$.

Table 5

Age and Affect-Valence IAT Scores as Predictors of the Direct Indicator of Mixed Affect in Study 2: Results from Multilevel Logistic Regression

	Presence (vs. absence) of mixed affect		
Predictors	Estimate	Odds Ratio	95% CI[a]
Intercept	–2.068 **	0.13	0.12–0.14
Affect-valence IAT (D_1-score, grand-mean centered)	–0.303 **	0.74	0.59–0.92
Age (grand-mean centered)	–0.005 **	0.99	0.99–1.00

Notes. Results of multilevel binary logistic regression estimated using SAS NLMIXED and the macro by Van Ness et al. (2004).

[a] 95% confidence interval of odds ratio. ** $p < .001$.

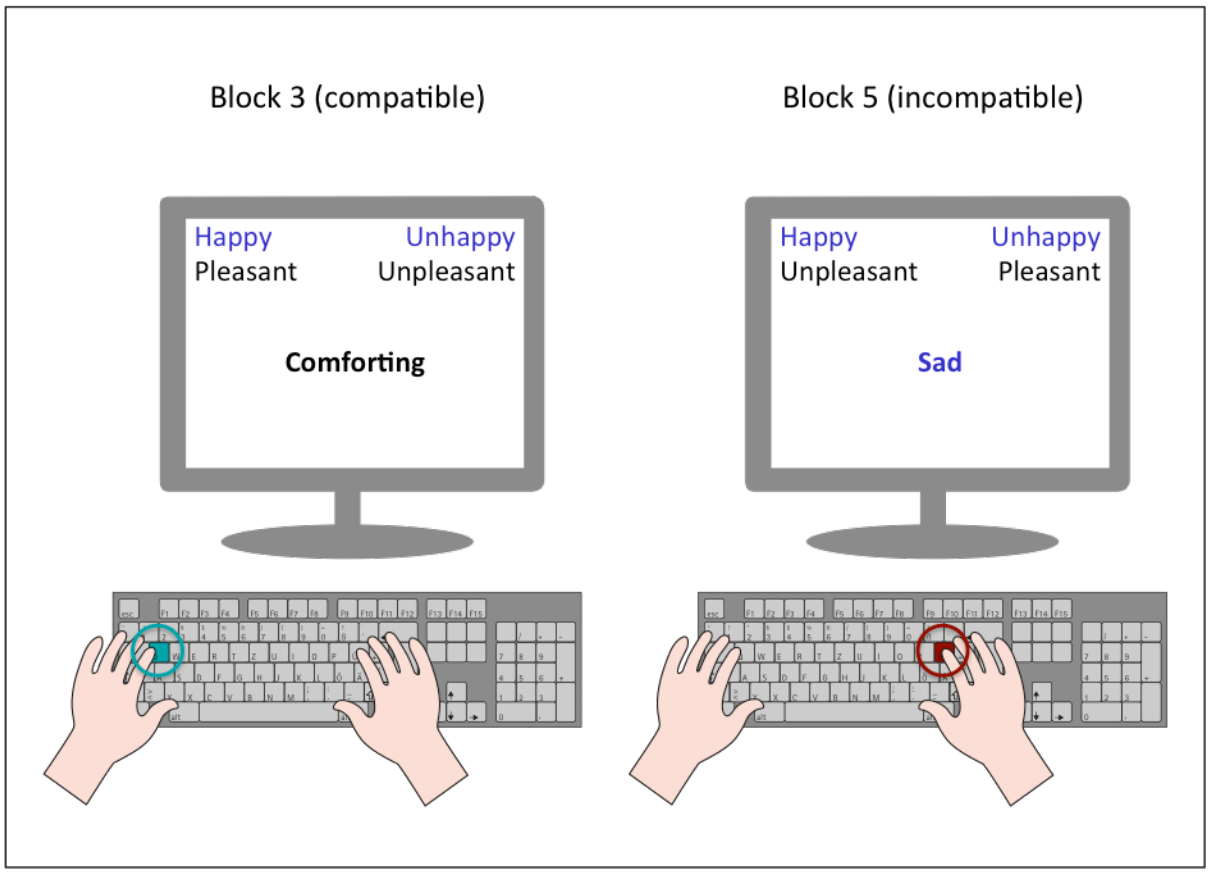

Figure 1. Task-switching IAT: Illustration of critical Blocks 3 and 5.

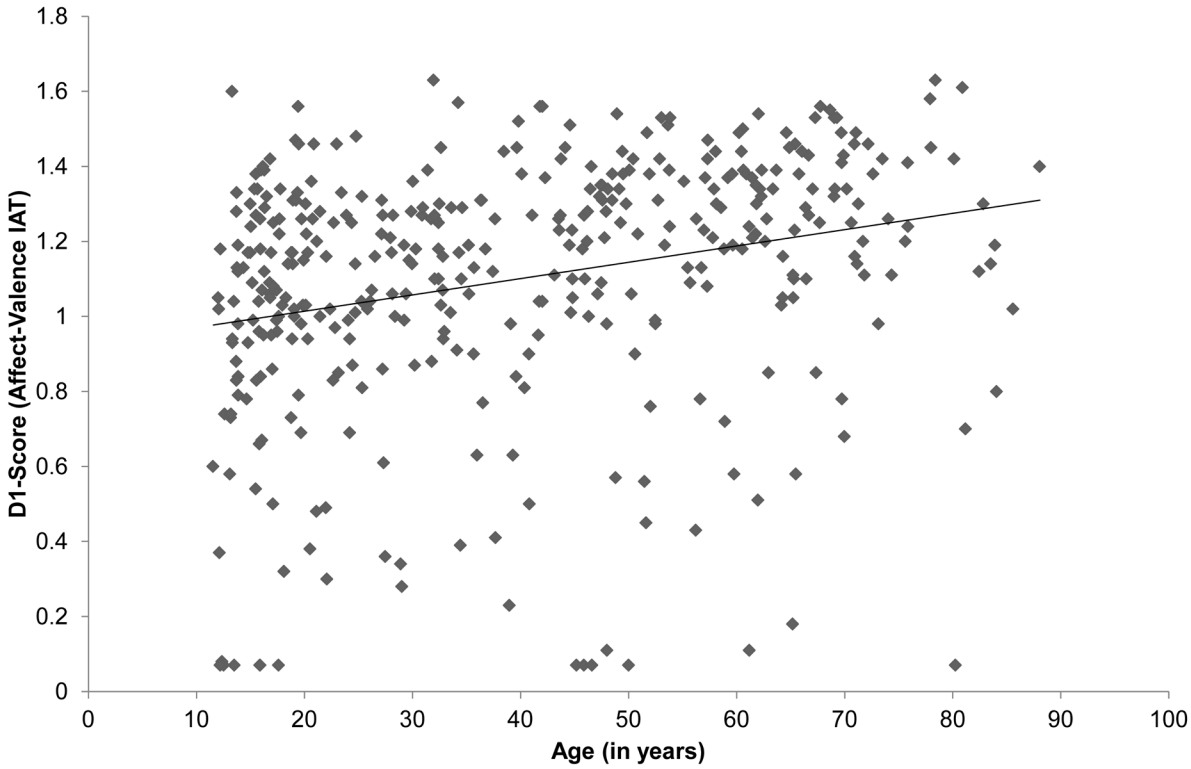

Figure 2. Participants' scores on the Affect-Valence IAT as a function of age.

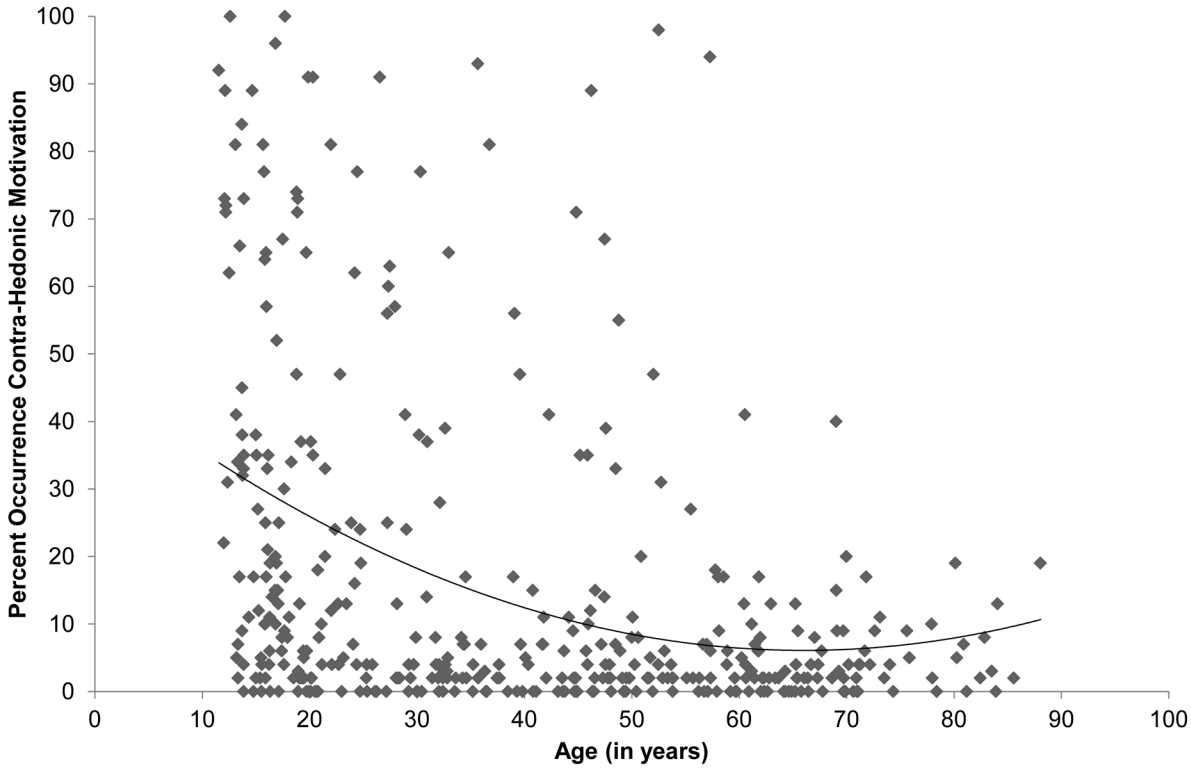

Figure 3. Prevalence of contra-hedonic motivation as a function of age.

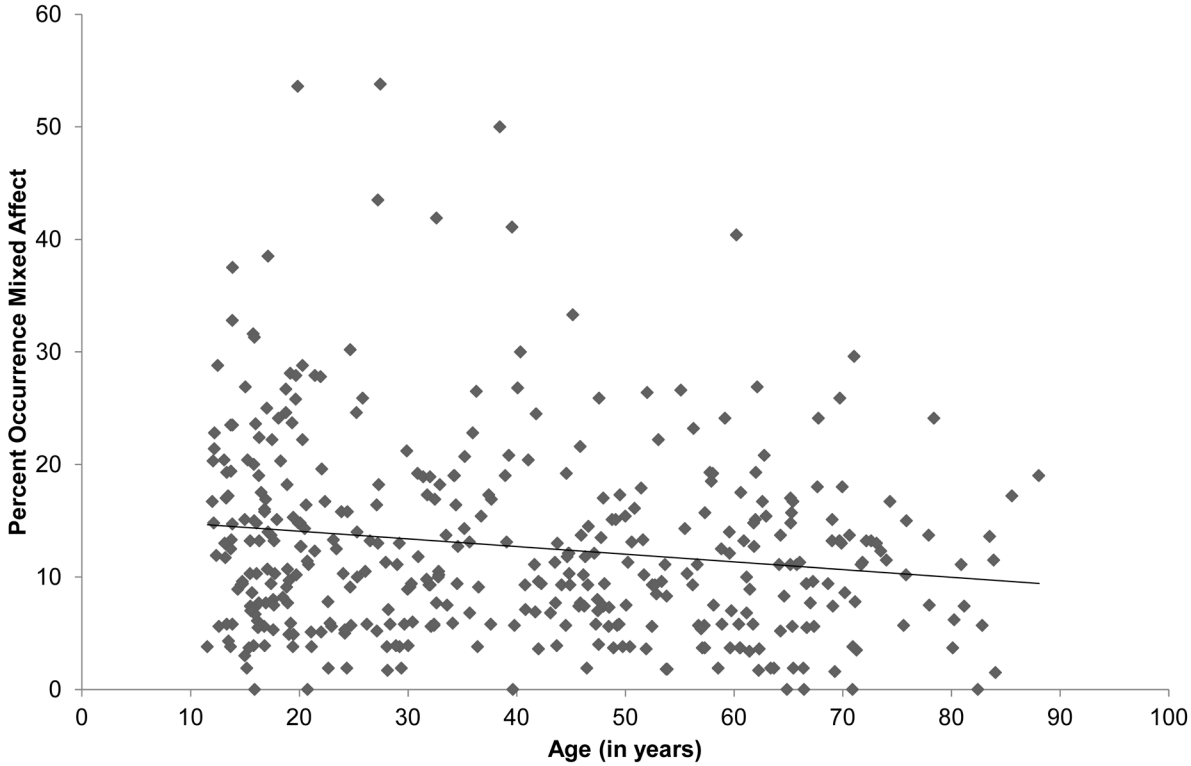

Figure 4. Prevalence of mixed affect as a function of age.

Appendix

Affect-Valence IAT: Stimulus Words for the Target Categories

German original		English translation	
Glücklich	Unglücklich	Happy	Unhappy
fröhlich	traurig	lighthearted	sad
glückselig	trübsinnig	rapturous	melancholy
selig	bekümmert	blissful	distressed
beglückt	bedrückt	delighted	despondent
freudig	betrübt	joyful	afflicted

Affect-Valence IAT: Stimulus Words for the Attribute Categories

German original		English translation	
Angenehm	Unangenehm	Pleasant	Unpleasant
wohltuend	belastend	soothing	burdensome
wohlig	abstoßend	comforting	repulsive
ansprechend	unerwünscht	appealing	undesirable
beliebt	schlimm	favored	upsetting
gut	böse	good	bad

Supplementary Material

Happiness Is Pleasant, or Is It? Representations of Affect Valence Are Associated with Contra-Hedonic Motivation and Mixed Affect in Daily Life

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Below, we describe a pilot study that we conducted in the context of the research reported in *"Happiness Is Pleasant, or Is It? Representations of Affect Valence Are Associated with Contra-Hedonic Motivation and Mixed Affect in Daily Life."* The purpose of this pilot study was to demonstrate the reliability and age-fairness of the newly developed affect-valence IAT and to test the prediction of age-related differences in mental representations of affect valence across adolescents, middle-aged, and older adults.

Method

Sample

We recruited 34 participants ranging in age from 14.1 to 77.5 years from the subject pool of the Max Planck Institute for Human Development in Berlin, Germany. The sample was stratified by gender (50% female) and age group (n = 11 adolescents, 14.1–16.9 years, M = 15.5, SD = 1.2; n = 11 middle-aged adults, 30.1–45.0 years, M = 33.9, SD = 4.2; n = 12 older adults, 61.3–77.5 years, M = 71.5, SD = 5.3). All adolescent participants attended secondary or higher secondary schools, and 47.8% of the adult participants held a college or university degree. All participants were native German speakers.

Procedure

The pilot study comprised two test sessions (T1 and T2) with an average interval of M = 14.56 days (SD = 1.42 days). In the interest of brevity, we describe only those instruments that are relevant for the present purposes. At T1, participants completed the affect-valence IAT as well as an IAT that assessed method-specific variance due to inter-individual differences in task-switching ability (task-switching IAT, Back et al., 2005). The task-switching IAT was administered first. Both IATs are described in more detail in the Method section of the main article. They were programmed in DMDX (Forster & Forster, 2003) and administered on personal computers with 19-inch monitors (1,280 by 1,024 pixels). At T2,

participants again completed the affect-valence IAT. Participants were reimbursed with €20 (approximately $27).

Measures

Affect-valence IAT (assessed at T1 and T2). Participants completed the same affect-valence IAT as in the main study, and we used the D_1-scoring method that was described in the Method section of the main manuscript.[1]

Task-switching IAT (T1). Participants also completed the same task-switching IAT (Back et al., 2005), and we used the same conventional scoring method described in the Method section of the main manuscript.[2]

Results

Reliability of the affect-valence IAT. Spearman-Brown adjusted split-half correlations of the affect-valence IAT were .80 and .67 at T1 and T2, respectively (D_1-measure). The test-retest correlation of the affect-valence D_1-scores obtained at T1 and T2 was $r = .68$, $p < .001$. As in the main study, the reliability of the newly developed affect-valence IAT was thus satisfactory.

Age-fairness of the D_1-scoring method. To assess the age-fairness of the new IAT measure of mental representations of affect valence, we first tested whether the D_1-scoring method indeed eliminated method-specific variance in the IAT score that was due to age-related differences in task-switching ability. If that were to be the case, age-related differences that were evident in the conventionally scored task-switching IAT (and that indicate method-specific variance due to interindividual differences in task-switching abilities, Back et al., 2005) should not be evident when the D_1-scoring method was used. A univariate analysis of variance with age group (adolescent, middle-aged, older participants) as the between-person factor on the conventional score of the task-switching IAT indeed revealed a significant main effect of age group, $F(2, 31) = 4.26$, $p = .023$, partial $\eta^2 = .22$,

which was due to higher scores (indicating more pronounced task-switching costs) for older participants than for adolescent [$t(21) = 2.36$, $p = .028$] and middle-aged participants [$t(21) = 2.31$, $p = .031$], who did not differ significantly from each other [$t(20) = –0.57$, $p = .576$]. As predicted, however, no age-related differences in the task-switching IAT score were evident when the D_1-scoring method was used, $F(2, 31) = 0.31$, $p = .734$, partial $\eta^2 = .020$; all pairwise comparisons between age groups $p > .05$; this supports the suitability of the D_1-scoring method in age-comparative research and is consistent with the findings of the main study.

Age differences in mental representations of affect valence. To investigate age-related differences in mental representation of the valence of affective states, we conducted a repeated-measures analysis of variance with age group (adolescent, middle-aged, older participants) and gender (male, female) as between-person factors, and measurement occasion (T1, T2) as the within-person factor. The dependent variable was the D_1-score of the affect-valence IAT. In line with our prediction, the main effect of age group yielded statistical significance, $F(2, 31) = 12.34$, $p < .001$, partial $\eta^2 = .47$, whereas none of the other main or interaction effects were significant, all $p > .05$. Follow-up analyses revealed that the univariate age effect resulted from smaller D_1-scores (indicating less distinctive representations of affect valence) in adolescent as compared to middle-aged [T1: $t(20) = –2.81$, $p = .011$; T2: $t(20) = –3.63$, $p = .002$] and older [T1: $t(21) = –3.45$, $p = .002$; T2: $t(21) = –3.28$, $p = .004$] participants, who did not significantly differ from each other [T1: $t(21) = –0.743$, $p = .466$; T2: $t(21) = 0.299$, $p = .768$]. In other words, middle-aged and older participants on average associated happiness more distinctively with pleasantness (rather than unpleasantness), and unhappiness, more distinctively with unpleasantness (rather than pleasantness) than did adolescent participants. Figure 1 (Supplementary Material) illustrates these age differences in the affect-valence IAT. The same pattern of age differences in the

affect-valence IAT emerged when we additionally controlled for age-related differences in task-switching ability, that is, when we included the effects of the conventionally scored task-switching IAT in the analysis as a covariate. This further underscores that the age-related differences in the affect-valence IAT do not merely reflect age differences in task-switching ability. We also repeated the analyses after excluding trials with initially incorrect categorizations and obtained the same pattern of age-related differences.

References Supplementary Material

Back, M. D., Schmukle, S. C., & Egloff, B. (2005). Measuring task-switching ability in the Implicit Association Test. *Experimental Psychology, 52*, 167–179. doi: 10.1027/1618-3169.52.3.167

Forster, K. I., & Forster, J. C. (2003). DMDX: A Windows display program with millisecond accuracy. *Behavior Research Methods, Instruments & Computers, 35*, 116–124. doi: 10.3758/BF03195503

Footnotes Supplementary Material

[1] At T1, the average number of errors made in block 3 were $M = 4.44$, $SD = 1.07$ in the younger; $M = 3.09$, $SD = 0.51$ in the middle-aged; and $M = 2.08$, $SD = 0.50$ in the older group of participants, $F(2, 31) = 2.88$, $p > .05$, partial $\eta^2 = .16$. The average number of errors made in Block 5 were $M = 8.18$, $SD = 1.44$ in the younger; $M = 4.64$, $SD = 1.10$ in the middle-aged; and $M = 6.00$, $SD = 0.80$ in the older group, $F(2, 31) = 2.45$, $p > .05$, partial $\eta^2 = .14$. At T2, the average number of errors made in Block 3 were $M = 4.55$, $SD = 1.38$ in the younger; $M = 2.82$, $SD = 0.48$ in the middle-aged; and $M = 1.58$, $SD = 0.48$ in the older group of participants, $F(2, 31) = 2.93$, $p > .05$, partial $\eta^2 = .16$; and the average number of errors made in Block 5 were $M = 7.91$, $SD = 1.98$ in the younger; $M = 4.36$, $SD = 0.56$ in the middle-aged; and $M = 4.50$, $SD = 0.61$ in the older group, $F(2, 31) = 2.75$, $p > .05$, partial $\eta^2 = .15$.

[2] The average number of errors made in Block 3 were $M = 2.73$, $SD = 0.41$ in the younger; $M = 2.00$, $SD = 0.45$ in the middle-aged; and $M = 2.25$, $SD = 0.60$ in the older group of participants, $F(2, 31) = 0.53$, $p > .05$, partial $\eta^2 = .03$; and the average number of errors made in Block 5 were $M = 6.36$, $SD = 0.47$ in the younger; $M = 5.00$, $SD = 0.86$ in the middle-aged; and $M = 5.75$, $SD = 1.09$ in the older group, $F(2, 31) = 0,60$, $p > .05$, partial $\eta^2 = .04$.

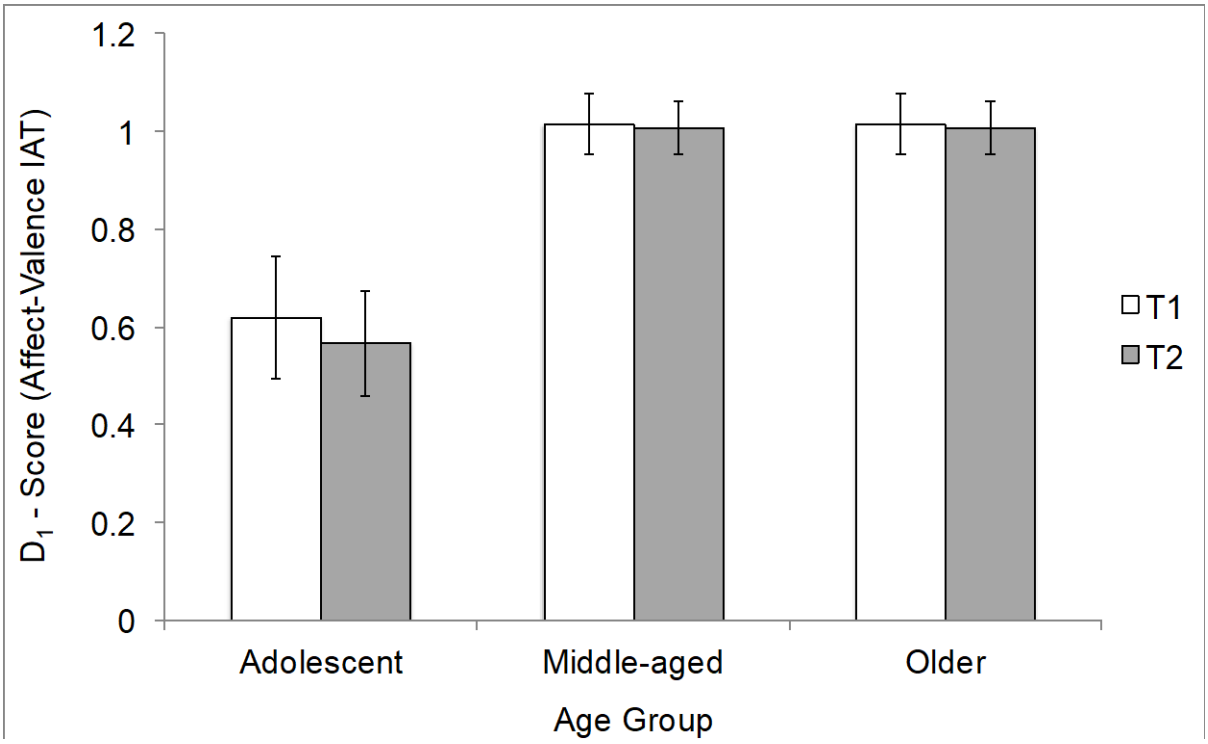

Figure 1 (Supplementary Material). Age differences in mental representations of affect valence.

Notes. D_1-scores of affect-valence IAT at T1 and T2 are shown. Higher scores indicate more distinctive associations of happiness with pleasantness (rather than unpleasantness) and unhappiness with unpleasantness (rather than pleasantness). Error bars = +/– 1 standard error.