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The Role of Personality in the Assessment of Subjective and Physiological Emotional Reactivity: A Comparison between Younger and Older Adults

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Abstract

This study brings more clarity on the inconsistent findings on emotional reactivity differences between older (OA) and younger (YA) adults, by examining the influence of (mal)adaptive personality traits on emotional reactivity and by applying several assessment methods. We recruited 60 YA (25-50 years) and 60 OA (65+ years) from a nonclinical population. We used Visual Analogue Scales to measure subjective reactivity, and facial electromyography (corrugator and zygomaticus reactivity), heart rate, heart rate variability, and skin conductance level to assess physiological reactivity during happy and sad film clips. Results showed that personality influences on emotional reactivity in OA were largely comparable to YA, although the influence of negative emotionality and neuroticism on subjective reactivity in response to the sad film was significantly stronger in OA. It is thus important to assess both subjective and physiological reactivity when comparing agerelated differences in OA and YA given the differential relation with personality features.

Keywords: personality, emotional reactivity, psychophysiology, older adults

The Role of Personality in the Assessment of Subjective and Physiological Emotional Reactivity: A Comparison between Younger and Older Adults

Age is an important factor in emotional experience. Some studies have suggested that older adults can more easily regulate their emotions cognitively than younger adults, because of attenuated physiological reactivity (e.g. Scheibe & Carstensen, 2010; Tsai, Levenson, & Carstensen, 2000). It may indeed be the case that individuals with lowered physiological reactivity have diminished need to regulate their emotional responses (Isaacowitz & Blanchard-Fields, 2012). This age-related change could account for findings that healthy older adults, despite typically experiencing late-life losses (e.g., passing of family and friends, depleted physical capacities) tend to show more positive affect and less negative affect than younger adults (English & Carstensen, 2014). As a further possibility to consider, the attenuated physiological reactivity of older adults might be a result rather than a cause of their heightened cognitive emotion regulation (Tsai, et al., 2000).

Along with age, personality characteristics also influence aspects of emotional experience. Certain personality traits in particular have been linked with a sense of well-being (e.g. Aglim & Grant, 2016) and also with how emotions are processed, which plays an important role in such regulation strategies as how and where people direct their attention. As an example of the relationship between personality characteristics and emotion regulation, neuroticism tends to be associated with more rapid processing of negative than of positive emotions, whereas the Big Five trait of extraversion tends to be associated with more rapid processing of positive than of negative emotions (Borkenau & Mauer, 2007). In addition to mediating emotion regulation, personality traits may contribute to cultural differences in emotion regulation. Matsumoto (2006) has suggested in this regard that Americans are more likely than Japanese to use emotion reappraisal strategies, as a consequence of their having a

more extraverted personality style. However, such possible cross-cultural differences in how personality characteristics influence emotional reactivity have not yet been well-established.

The apparent connection of both ageing and personality with both physiological reactivity to emotional stimuli and the subjective experience of emotion calls for further examination of (a) how personality can influence the assessment of emotional reactivity and (b) whether there are age-related differences between younger and older adults in this respect. In pursuing these questions, the present study sought also to validate questionnaire assessment of certain personality traits based on emotionality. Additionally investigated were whether expected relationships between personality and emotions can be identified with experimental measures of emotional reactivity and whether these relationships are similar in younger and older adults. The following introductory paragraphs summarize previous research on age-related differences in subjective and physiological reactivity to emotional stimuli.

Age-Related Differences in Subjective Reactivity

Extensive attention to age-related differences in subjective reactivity to emotional stimuli has thus far yielded mixed findings. In measurements using broadly defined positive and negative stimuli, older adults have been found sometimes to show higher subjective ratings of their feelings than younger adults (Grühn & Scheibe, 2008; Gavazzeni, Wiens, & Fischer, 2008); sometimes similar ratings (Wieser, Mühlberger, Kenntner-Mabiala, & Pauli, 2006; Ferrari, Bruno, Chattat, & Codispoti, 2016); and sometimes lower ratings (Keil & Freund, 2009; Streubel & Kunzmann, 2011).

It has been suggested that measurement with more discrete and age-relevant emotions than pleasant/unpleasant would bring more clarity to these comparisons. Sadness, for example, is a discrete emotion that, as mentioned previously, may be expected to be more prevalent in older than younger adults (Kunzmann & Grühn, 2005). Hence reactivity to this emotion would consequently not be expected to be lower in older than in younger adults. In

studies using the discrete emotion of sadness, older adults have in fact shown either higher subjective ratings of affect than younger adults (Fajula, Bonin-Guillaume, Jouve, & Blin, 2013; Streubel & Kunzmann, 2011) or the same level as younger adults (Levenson, Carstensen, Friesen, & Ekman, 1991; Tsai, et al., 2000), but not a lower level. For the positive discrete emotion happiness, older adults have shown either the same amount of happiness as younger adults (Labouvie-Vief, Lumley, Jain, & Heinze, 2003; Levenson, et al., 1991; Tsai, et al., 2000) or lower level (Fajula, et al., 2013; Tsai, et al., 2000). Although measurement with discrete emotions thus clarifies in part age-related differences in subjective reactivity, the research findings in this area remain inconsistent.

Another consideration that might account for the inconsistent findings in subjective reactivity is the level of stimulus arousal. Age-related differences seem more prominent when low-arousing stimuli are used (Streubel & Kunzmann, 2011), perhaps because cognitive processes then play a bigger role in reactivity (Holland & Kensinger, 2013). High-arousing stimuli, on the other hand, might be more likely to elicit automatic processes that are maintained in older adults (Mather & Knight, 2006). However, most studies of emotional reactivity either did not report the levels of arousal of their stimuli or used stimuli of mixed arousal level in aggregated sets of stimuli. In studies that did take level of arousal into account, older adults were found to rate low-arousal pleasant stimuli higher (i.e., as more pleasant) than did younger adults (Backs, da Silva, & Han, 2005; Ferrari, et al., 2016; Streubel & Kunzmann, 2011). For negative stimuli, only Streubel and Kunzmann (2011) have reported age-related differences, with older adults rating low-arousing negative stimuli as more unpleasant than did younger adults. However, the positive association between level of arousal and strength of ratings of (un)pleasantness appears to decrease with age. Older adults, especially women, have been found to rate high-arousing pleasant stimuli, such as erotic pictures, as less pleasant than they are rated by younger adults (Ferrari, et al., 2016).

Age-Related Differences in Physiological Reactivity

Older adults show the same patterns of physiological responses to emotional stimuli as younger adults, but the amplitude of this reactivity, especially as measured by cardiovascular assessments, is attenuated in old age (see Levenson, 2000). A recent meta-analysis by Uchino, Birmingham, and Berg (2010) has confirmed this attenuation. However, other studies have indicated that this attenuation depends on the age-relevance of the emotions used as stimuli and report lesser physiological differences between older and younger age-groups when sadness elicitors are used as the stimuli (Kunzmann & Grühn, 2005; Seider, Shiota, Whalen, & Levenson, 2010). Despite this lesser difference, Labouvie-Vief, and colleagues (2003) nevertheless still found lower heart rate reactivity in older than younger adults in response to a sad emotion induction. Once more, then, stimulation by discrete rather than general helps to clarify age-related differences in physiological reactivity but does not fully account for them. As for physiological responses to happy stimuli, older adults have been found similarly to show the same or less reactivity than younger adults, depending on the physiological measures used (Tsai, et al., 2000; Labouvie-Vief, et al., 2003).

Discrepancies between Physiological and Subjective Measures.

Studies investigating subjective and physiological reactivity to emotion-inducing stimuli have indicated that these two forms of reactivity are often dissociated in older adults. Older adults experiencing higher levels of subjective reactivity than younger adults have shown the same (Kunzmann & Grühn, 2005) or even lower (Gavazzeni, et al., 2008) physiological reactivity. When experiencing the same level of subjective reactivity as younger adults, older adults have shown lower physiological reactivity (Tsai et al., 2000). This dissociation between response systems may be due to the fact that affective reports intermix the current experience of physiological changes with subjective comparisons of this experience with past experiences (Gavazenni, et al., 2008). The fact that older adults have

lived longer than younger adults and probably had more varied life experiences against which they can compare their current feelings might account for their dissociation between these two reactivity systems.

Personality and Emotional Reactivity: The Conceptual Framework

There are thus several factors that could have influenced the inconsistent findings in studies of age-related differences in emotional reactivity. With this consideration in mind, the focus of the present study is restricted to discrete emotions (happy-sad) and a low arousal level. Also of note are the recent suggestions that research on the assessment of emotional reactivity in older adults should give increased attention to individual differences in personality (Ferrari, et al., 2016). As far as the present authors know, the impact of personality characteristics on emotional reactivity has not yet been investigated in older adults.

There is good reason to expect personality to play an important role in subjective and physiological emotional reactivity, given that emotional processing is a central feature of personality functioning (Keltner, 1996). Of the previously mentioned Big Five personality traits, extraversion (defined in part as "positive emotionality") and neuroticism (defined in part as "feeling anxious, nervous, and tense") would appear to have a particularly clear relationship with emotionality (see John & Srivastava, 1999, p. 30). Several explanations have been proposed for the association of certain emotional tendencies with prominent neuroticism or extraversion. Gray's reinforcement sensitivity theory (1970) states that people scoring higher on neuroticism than extraversion are relatively more sensitive to punishment, which makes them more vigilant to negative stimuli, whereas people scoring higher on extraversion than introversion are relatively more sensitive to reward, which increases their attention to positive stimuli. These differences in sensitivity may explain why people high higher in

extraversion experience more positive affect than people high in neuroticism, who experience more negative affect (e.g. Anglim & Grant, 2016).

From the perspective of variations in temperament, two models have been proposed for differential effect of personality characteristics on emotional processing: an affect-level model and a reactivity model. According to the affect-level model, personality-affect differences stem from differences in levels of tonic affect. Specifically, highly extraverted and neurotic individuals will consistently display higher levels of positive and negative affect than individuals low in extraversion and neuroticism (Gross, Sutton, & Ketelaar, 1998). According to the reactivity model, highly neurotic individuals will show larger changes in negative affective responses to negative stimuli than highly extraverted individuals, who will show larger changes in positive affect (Gross, et al., 1998; Larsen & Ketelaar, 1991). These models support he expectation that personality will be related to both subjective and physiological emotional reactivity.

Personality and Emotional Reactivity: The Empirical Support

Subjective Reactivity. Research with younger adults has demonstrated that personality plays a role in subjective emotional reactivity. In particular, neuroticism has been related to relatively high ratings of sadness in response to sad music and films (Thake & Zelenski, 2013; Vuokoski & Eerola, 2011). Extraversion, by contrast, has been found associated with relatively low ratings in response to sad music and film clips (Park, Lee, Sohn, Eom, & Sohn, 2014; Vuoskoski & Eerola, 2011), but also with relatively higher ratings of positive affective reactions to various mood inductions (Lucas & Baird, 2004). However, most of the effect sizes in these studies have been on the small side (e.g. Lucas & Baird, 2004). The other Big Five personality traits – agreeableness, conscientiousness, and openness – have not been found related to ratings of happiness and sadness in response to music clips (Vuoskoski & Eerola, 2011).

Physiological Reactivity. The relationship between personality and physiological reactivity has been investigated to a lesser extent than the relationship between personality and subjective reactivity, and with less conclusive results. Research using pleasant inductive stimuli has found no significant relationship between extraversion and skin conductance (Norris, Larsen, & Cacioppo, 2007). Relatively high neuroticism has been reported as related to increased skin conductance in response to both unpleasant and pleasant pictures. However, this relationship was not replicated with induction by sad film clips (Reynaud, El Khoury-Mahalme, Rossier, Blin, & Khalfa, 2012; Brumbaugh, Kothuri, Marci, Siefert, & Pfaff, 2013). These same studies also found no relationships between neuroticism and corrugator muscle, heart rate, or respiration rate or between extraversion and heart rate, skin conductance, or respiration rate while viewing sad film clips (Reynaud, et al., 2012; Brumbaugh, et al., 2013).

There is a study in which extraversion was found significantly associated with lower heart rate while viewing sad film clips and higher respiratory sinus arrhythmia, which is a measure of heart rate variability and indicates increased regulatory parasympathetic activity (Park, et al., 2014). Investigations of other discrete emotions, such as anger and fear, have also found few relationships, as exemplified by a lack of association between neuroticism and heart rate in an anger induction (Jonassaint, et al., 2009). The other Big Five personality traits have been investigated in the study by Brumbaugh, et al. (2013), in which a higher level of openness was associated with a higher respiration rate when viewing a sad scene. No other significant Big Five relationships were found for the sad film clip or a happy, but conscientiousness was positively related to heart rate when respondents viewed a scene of violence in which a man with a gun is threatening to shoot another apparently terrified man.

The Current Study

As far as the present authors know, the above mentioned relationships between personality and emotional reactivity have not been investigated in older adults, while the

assessment of personality might help clarify the inconsistent results found for age-related differences in emotional reactivity. Personality is known to change slightly over the lifespan (e.g. Debast et al., 2014), which means that, if personality is related to emotional reactivity, the latter may change as well. For example, neuroticism decreases slightly with age (e.g. Debast, et al., 2014). If neuroticism is associated with a higher level of such physiological reactions as skin conductance in response to sadness-inducing stimuli, and if older adults show less skin conductance when viewing a sad film clip, then there are two possibilities: it could be that their decrease in physiological reactivity reduces their subjective reaction to sad stimuli, or it could be that their decrease in neuroticism makes them physiologically or subjectively less responsive to negative stimuli. On the other hand, if higher neuroticism is related to higher skin conductance in response to a sad film clip in younger adults, but not in older adults, this would have important implications for personality assessment. It would, for example, suggest that emotional reactivity is unrelated to neuroticism in older adults, which would be contrary from the conceptualization of neuroticism, and that the definition of neuroticism should be adjusted or nuanced in the assessment of older adults.

The present study accordingly has two aims. Its first aim is to clarify why differences have been found between younger and older adults in their subjective and physiological emotional reactivity, which will be accomplished by assessing reactivity to discrete emotional stimuli with a low-arousal cognitive stimulus. The second aim of the study derives from the fact that, despite the conceptual links of extraversion and neuroticism with emotionality, there has been only limited investigation of the relationship between personality and emotional reactivity, especially as concerns physiological reactivity. Also relevant is the possibility that personality changes occurring with ageing can be accompanied by changing emotional experiences, such as improved emotion regulation strategies in older adults (e.g. Urry & Gross, 2010). Accordingly, this second aim of the study is to assess whether personality is

similarly related to emotional reactivity in older and younger adults and whether certain experimental methods are helpful in casting light on conceptual relationships between personality and emotional reactivity. A further consideration in this regard is whether personality should be taken into account as a moderator in assessing the differences in emotional reactivity between younger and older adults.

To investigate these matters, the authors used film clips intended to elicit the discrete emotions of sadness and happiness. Discrete emotions were chosen because multiple emotions elicited by aggregated stimuli can confound the observed effect, depending in part on the age-relevance of these emotions, and thereby diminish the clarity of the results (Kunzmann & Grühn, 2005). Film clips were used because they provide more controlled and standardized way of eliciting emotions than such other mood-induction procedures as calling on imagination (Tsai, et al., 2000), and, by relying less on cognitive processes, they are likely to be less influenced by cognitive ageing (Fajula, et al., 2013). Moreover, film clips are more vivid than imagination of emotions, in that they provide both visual and auditory stimuli, and they are consequently likely to elicit more emotional reactions than imagination. The two film clips used were low in arousal (one a laughing baby, the other a mourning boy), because the age-related differences to be examined most often occur when stimuli are low in arousal and thus less automatically processed (Streubel & Kunzmann, 2011).

Earlier research has shown that the finding of age-related differences in emotional reactivity might depend on the measures used and by which physiological system reactivity is innervated (Tsai, et al., 2000). With this consideration in mind, five different measures were used in the present study to assess the underlying process of physiological reactivity as innervated by different systems: electrodermal activity, heart rate (HR), heart rate variability (HRV), and facial electromyography (*f*EMG) of corrugator and zygomatic muscle. In addition, electrodermal activity, as measured by skin conductance level (SCL), was used to

identify changes in sympathetic arousal, because it is the only autonomic psychophysiological measure that is not influenced by parasympathetic activity as well (Braithwaite, Watson, Jones, & Rowe, 2015). Both pleasant and unpleasant stimuli have been found elicit greater skin conductance reactivity than neutral stimuli (Bradley & Lang, 2007, p. 590).

To measure changes in regulatory parasympathetic activity, we used heart rate variability (HRV), which has been found to decrease when stressful situations are encountered (Delaney & Brodie, 2000). Because the film clips were short, the selected measure of HRV was the Root Mean Square of Successive Interbeat Differences (RMSSD), which is recommended by the Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology (1996) as an estimate of short-term HRV. Heart rate (HR) was used as a reactivity measure because it has been included most of the research on age-related differences in emotional reactivity (Tsai, et al., 2000). HR is innervated by both the sympathetic and parasympathetic system and has often been used as an indicator of higher arousal in previous studies (Tsai, et al., 2000). However, the psychological meaning of HR appears to depend on the method used to induce emotions (Bradley & Lang, 2007). For example, HR reactivity increases when people are imagining emotional events, compared to neutral ones (Vrana, Cuthbert, & Lang, 1986), but decreases when viewing emotional film clips (Brumbaugh, et al., 2013). Lang, Bolls, Potter, and Kawahara (1999) have found that HR deceleration was associated with increased attention when watching television. In the present study, accordingly, HR deceleration was used as an index of greater attention to the film clips.

*f*EMG measures of the corrugator and zygomaticus muscle were used to measure facial expressions in a relatively objective manner. Both measures have proven to vary with the emotional quality of valence of stimuli. Corrugator activity, which contributes to a frowning facial expression, has been found to increase with the induction of negative

emotions and to decrease with the induction of positive emotions. The zygomaticus muscle, which contributes to smiling behavior, does not show such a linear relationship with emotional quality. Instead, it shows a quadratic effect: more activity when positive emotions are induced than in a neutral state, but slightly increasing activity when strong negative mood, like disgust, is induced (Larsen, Norris, & Cacioppo, 2003).

As in the previous studies, the present study is focused on the two broad trait domains from the Big Five that are most related to emotional experience: neuroticism and extraversion. Also examined are two subscales from each of these domains: anxiety and depression from neuroticism and assertiveness and activity from extraversion. Because psychopathology and personality disorders are strongly associated with dysfunctional emotion regulation (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Jazaieri, Urry, & Gross, 2013), attention is also paid to also look at the more maladaptive variants of neuroticism and extraversion: negative emotionality and low positive emotionality, as assessed with the Minnesota Multiphasic Personality Inventory-2-Restructured Form Personality Psychopathology Five scales (MMPI-2-RF PSY-5-r, see materials). For the sake of completeness, results are also reported for the other three Big Five and PSY-5-r scales, but without any elaboration on them or hypotheses concerning them, due to the absence of previous empirical evidence or a conceptual framework relating them to emotionality.

Expectations with regard to differences in subjective emotional reactivity between younger and older adult age groups are difficult to formulate, given the lack of relevant theory and the mixed research results in the literature. On basis of studies using discrete emotions, older adults can be expected to have either higher (Fajula, et al., 2013) or the same (Tsai, et al., 2000) ratings of sadness, and either the same (Labouvie-Vief, et al., 2003) or lower ratings of happiness (Fajula, et al., 2013) than younger adults. With physiological measures, we can hypothesize that older adults will show the same physiological reactivity to sadness as

younger adults, which would be consistent with most previous studies of sadness reactivity (e.g. Kunzmann & Grühn, 2005). For the happiness emotion, differences in reactivity can be expected for some physiological measures but not others (Tsai, et al., 2000). Once more, in light of the mixed results in previous research, it is difficult to formulate definite hypotheses concerning which measures can be expected to show these age-related differences. Results of the subjective and physiological measures can also be expected to differ. If physiological responses are found to be the same in younger and older adults, subjective reactivity is likely to be higher in older adults. If physiological reactivity is found to be lower in older adults than in younger adults, then subjective reactivity would be likely to be the same in both age groups (Kunzmann & Grühn, 2005).

With respect to the main aim of the present study, personality should show a relationship with the assessment of emotional reactivity, given the close relatedness of certain personality traits and emotionality. Based on the previously presented conceptual framework, neuroticism, negative emotionality, and low positive emotionality should correlate positively with ratings of sadness, corrugator reactivity (frowning), HR deceleration (with increased attention), and SCL change (with increased arousal) to a sad film clip, and also correlate positively with corrugator reactivity to the happy film clip. Conversely, neuroticism, negative emotionality, and low positive emotionality should correlate negatively with HRV (regulatory parasympathetic activity) to the sad film clip and with ratings of happiness, zygomaticus (smiling), HR deceleration, HRV, and SCL change to the happy film clip. For extraversion, the anticipated findings will be in the opposite directions: a negative correlation with ratings of sadness, corrugator, HR deceleration, and SCL change to the sad film and with corrugator reactivity to the happy film, but a positive correlation with HRV to the sad clip and with happiness ratings, zygomaticus, HR deceleration, HRV, and SCL change to the happy film clip. The previously reviewed empirical findings lead further to the expectation that these

relationships will be larger for subjective reactivity than for physiological reactivity. As has been noted, these relationships have not previously been investigated in older adults, and the present study is the first investigation of whether personality influences the assessment of emotional reactivity similarly in older and younger adults.

Method

Participants

For the present study, 60 younger (25-50 years) and 60 older adults (65+) were recruited from a Dutch-speaking community by means of flyers, advertisement, social media, and appearances at recreational clubs and education centers for seniors. Potential participants were screened by telephone, and individuals who reported cognitive problems (i.e. dementia) or a diagnosis of psychological disorder in the last five years were excluded from the study. Seven participants with invalid MMPI-2-RF profiles (see materials) and one participant who scored too low on the Mini Mental State Examination (MMSE, see materials) were excluded, resulting in $N = 112$. Analyses with the Visual Analogue scales (VAS; see materials) were performed with 57 younger adults (*M*age = 32.12, *SD* = 8.12, *range* = 25-49) and 55 older adults (*M*age = 71.16, *SD* = 5.09, *range* = 64-91). Demographics can be found in Table 1. All participants were Caucasian. Psychophysiological data (see materials) of 16 participants were not recorded or stored due to technical problems. In addition, HRV data of nine participants were removed because of numerous artifacts, *f*EMG data of one participant were removed because of excessive noise, and SCL data of one participant were removed because the baseline value (29.52 microsiemens (µS)) fell far above the expected range of 2-16 µS (Braithwaite, et al., 2015) and was also much higher than those of the other participants (max. 13.27µS). Consequently, analyses on the *f*EMG, HRV and SCL data were performed respectively with 46, 42, and 45 younger adults and with 49, 45, and 50 older adults. Participation was voluntary, and participants were compensated 20 euros for expenses.

< insert Table 1 here>

Materials

Questionnaires

Mini-Mental State Examination (MMSE). The MMSE (Folstein, Folstein, & McHugh, 1975; Dutch version: Kok & Verhey, 2002) screens for cognitive impairment and mild dementia and was administered to the older adult group. Scores on this measure range from 0 to 30, with lower scores indicating more cognitive impairment. Because of the intent to examine a cognitive healthy sample, older adults scoring lower than the conventional cut-off of 24 were excluded.

Minnesota Multiphasic Personality Inventory-2-Restructured Form (MMPI-2-RF). The MMPI-2-RF (Ben-Porath & Tellegen, 2008; Dutch version: Van der Heijden et al., 2013) assesses personality and psychopathology and consists of 338 statements to which participants respond with 'agree'/'do not agree'. Criteria for the validity scale scores described in Van der Heijden et al. (2013, pp. 36-50) and consisting of TRIN < 80, VRIN < 80, F < 110, Fp < 100, L < 80, and K < 75 were used to evaluate whether an MMPI-2-RF profile was valid. The personality assessment scales of interest for the current study – negative emotionality and introversion/low positive emotionality (both revised) – are part of the revised Personality Psychopathology Five scales (PSY-5-r; Harkness & McNulty, 2007). The present samples demonstrated the following internal consistencies for these scales: among younger adults, Cronbach's α of .75 and .74, respectively; among older adults, .80 and .68. The Cronbach's alpha for the other PSY-5-r scales were good for aggression (.80 among younger adults, .77 among older adults), but low for psychoticism and disconstraint (among younger adults, .65 and .55, respectively; among older adults, .47 and .43). For this reason, results for these last two scales are not reported.

Big Five Inventory (BFI). The BFI (John & Srivasta, 1999; Dutch version: Denissen, Geenen, Van Aken, Gosling, & Potter, 2008) comprises 44 statements that can be answered on a 5-point likert scale ranging from 'totally disagree' to 'totally agree' and was used to measure neuroticism and extraversion. BFI scales were corrected for acquiescence, following Rammstedt and Farmer (2013). The current samples showed good internal consistencies for neuroticism and extraversion (among younger adults, Cronbach's $\alpha = .83$ and .87, respectively; among older adults, .78 and .76). For the subscales, Average Interitem Correlations (AICs) were used in view of the low number of items in each scale (i.e., between 2 and 5). Clark and Watson (1995) recommended an AIC between .40 and .50 for narrow constructs (like our subscales), and a range from .15 to .20 for broader constructs. Accordingly, there appears to be acceptable to good internal consistency for anxiety, assertiveness, and activity (among younger adults, AIC of .51, .54, .38, respectively; among older adults, .43, .34, .46), but limited internal consistency for the depression subscale (among both groups, an AIC of .21). In light of this low reliability of the depression subscale, it is not included in the data analyses reported here.

For the other Big Five scales – agreeableness, conscientiousness, and openness – there were acceptable to good Cronbach alphas (among younger adults, .66, .78, and .80, respectively; among older adults, .75, .79, and .66). For the subscales of agreeableness there were low AIC's for altruism and compliance (among younger adults, .21 and .19, respectively; among older adults, .25 and .30). The AIC's for conscientiousness' subscales were acceptable to good for order, but low for self-discipline (among younger adults, .45 and .28, respectively; among older adults, 38 and .33). The openness subscale of aesthetics showed acceptable to good AIC's, but the ideas subscale was low in internal consistency (among younger adults, .67 and .32, respectively; among older adults, 37 and .28). Because of

the low reliability in our samples of the altruism, compliance, self-discipline and ideas subscales, results concerning them are also not reported.

Visual Analogue Scales (VAS). Two VAS scales per film clip were created to measure subjective emotional reactivity. These scales required participants to indicate on a 100mm line how happy or sad they felt at the moment. The low end of the scale was denoted as "Neutral" and the high end as "As happy/sad as I can imagine." To validate the emotionality conveyed by the film clips, participants were also asked how positive and how negative they thought each film clip was, again on a scale "Neutral" to "As positive/negative as I can imagine."

Stimuli. Five film fragments were used. Two were considered likely to induce either happy or sad emotions, and the other three intended to be emotionally neutral. Selected for the sad film clip was a 73 second excerpt from the film "The Champ," in which a young little boy has just lost his father. This clip has previously been found a reliable provoker of sadness in both older and younger populations (Beaudreau, MacKay, & Storand, 2009; Gross & Levenson, 1995), and it has frequently been used in studies of emotional reactivity (e.g. Tsai et al., 2000). Because no suitable film clip reliably demonstrated to provoke happiness was available, a pilot study was conducted with 31 persons (*M*age = 26, *SD* = 9.46, *range* 20-54) who were not involved in the actual experiment. These 31 individuals were asked to indicate on a VAS scale how happy they felt when viewing each of four fragments from YouTube that seemed likely to elicit positive emotions. This procedure helped choose, as the happy clip in the present study, a 72 second depiction of a baby laughing heartily while watching his father ripping up pieces of paper. For the three neutral clips, which had a duration of 239 seconds, we used three camera images of the trajectory of a moving train.

Psychophysiological Measures. Psychophysiological signals were sampled continuously from first until last film clip at 1000 Hz with a Biopac MP150 data acquisition

hardware and the software AcqKnowledge 3.9 (Biopac systems Inc., CA). Triggers were inserted during the experiment to indicate exactly when each film clip started and ended.

*Facial Electromyography (fEMG). f*EMG corrugator and zygomaticus signals were measured using bipolar electrode recording (two shielded 4mm Ag-AgCl surface electrodes per site and one ground electrode) according to the placement recommended by Fridlund and Cacioppo (1986). All electrodes were placed on the right side of the participant's face. The amplified signals were high-pass filtered at 20Hz and low-pass filtered at 200Hz. An additional filter was used at 50, 100, and/or 150Hz if noise artifacts were present. This evaluation and adjustment was made offline for each participant. Finally, all signals per used fragment (see Data Reduction for the Psychophysiological Measures) were root-mean-squared to remove negative values.

Heart Rate and Heart Rate Variability (HR and HRV). To measure HR and HRV, pre-gelled electrodes were placed in a Lead II configuration: one at the right collar bone and one at the tenth left rib. The ground electrode was placed at the tenth right rib. Signals were band-pass filtered between 0.5 and 35Hz. ARTiiFACT (Kaufmann, Sütterlin, Schulz, & Vögele, 2011) was used for R-peak detection, artifact detection and correction, which were also both visually inspected, and for calculation of the mean HR and RMSSD per used fragment (see Data Reduction for the Psychophysiological Measures).

Skin Conductance Level (SCL). SCL was recorded with two 6mm Ag-AgCl Velcro-strapped electrodes placed at the palmar surfaces of the index and middle finger of the non-dominant hand of the participant. Signals were low-pass filtered at 1Hz. Mean SCL per fragment (see Data Reduction for the Psychophysiological Measures) was calculated.

Data Reduction for the Psychophysiological Measures. Psychophysiological measures were taken continuously from the instructions given to the participants to the end of the third neutral film clip. The second and third neutral film clips were used to restore participants to a

neutral emotional state following their viewing of the emotional clips, so these recordings were not used in the analyses. The three clips used in the analyses were made equally long, by using the whole happy film clip (72sec), cutting off the first second of the sad film clip (73sec – 1sec), and using the middle 72 seconds of the first neutral film clip (sec79-sec151), which served as a baseline measure.

Procedure

The present study was part of a larger older adult project[1] approved by the ethical committee of the Faculty of Psychology and Educational Sciences of Ghent University. Participants were first screened over telephone (see Participants) and asked to restrain from coffee for at least two hours before coming to the laboratory. Prior to their laboratory session, they completed the BFI, MMPI-2-RF, and biographical questionnaire at home. On arriving at the University laboratory, they signed an informed consent document and next completed a task that was part of for another study[1]. Following completion of this task, the participants were prepared for the physiological measures in the present study by cleaning their skin with an abrasive gel at the sites where the electrodes would be placed. The electrodes were then placed and the recording begun, following which the instructions for the present task were given.

Participants were told that they would see five short film clips, that their perspiration, muscle tension, and heart rate would be measured, and that after each film clip, they would be asked to respond to a questionnaire about how they felt during it. They were given some practice in marking a VAS scale, and, to minimize artifacts in the psychophysiological recordings, they were asked to sit as still as possible and to refrain from talking while viewing the film clips. The order of the happy and sad emotional clips was randomized, and a neutral clip was shown before and after each of emotional film clips. Upon completion of the

experiment, the older adults had a MMSE interview. All participants were given a debriefing session.

Statistical Analyses

Because some of the *f*EMG (corrugator, zygomaticus) and HRV data were severely skewed (with skewness > 3 and/or kurtosis > 7), log-transformations on the HRV (log10) and *f*EMG (log10[*f*EMG + .01]) data were used for further analyses. For the *f*EMG, .01 was added prior to the normalization, because of the presence of some zero values that cannot be log-transformed.

To assess the validity of the film clips in both age groups, repeated measures ANOVA's were conducted using the happy, sad, and neutral film clip as within subject variables for each VAS scale (VAS happy, VAS sad, VAS positive, and VAS negative). Effect sizes (partial eta squared) were considered small from .01, medium from .06, and large from .14 (Lakens, 2013). If a significant difference was found between the three film clips, pairwise *t*-tests were performed to further examine this difference.

To assess whether older and younger adults differed in subjective and physiological reactivity measures on the emotional film clips, and to control for variability in baseline activity, standardized residuals were used. Residual change scores were calculated by performing a simple linear regression in which the activity measure at baseline predicts the reactivity measures at the emotional clips. Independent *t*-tests were then used to determine whether subjective happiness, corrugator, zygomaticus, HR, HRV, and SCL change to the happy film clip, and subjective sadness, corrugator, HR, HRV, and SCL change to the sad film clip, differed between both age groups. Because subjective sadness in response to the happy film clip and subjective happiness and zygomaticus reactivity in response to the sad clip would not be very meaningful, such responses were not used in the data analyses. Cohen's *d* effect sizes were calculated for all *t*-tests. Effect sizes were considered large when

they exceeded .80, medium when above .50, and small when higher than .20 (Cohen, 2009, pp. 24-27).

To examine whether personality traits play a role in the assessment of emotional reactivity in older and younger adults, several steps were taken. First, correlations were computed between the personality measures in both age groups. Next, independent *t*-tests and Cohen's *d* effect sizes were used to determine whether older and younger adults differed on the personality measures. Then, we used univariate ANCOVAs (age group as factor), for each reactivity measure, with negative and low positive emotionality, extraversion and neuroticism separately as continuous factors (covariates), to identify interactions between the personality traits and age group. Standardized residuals were used for the reactivity measures. When a significant interaction effect was found, follow-up zero-order correlations were used to assess the relationship between personality and subjective, *f*EMG, HR, HRV, and SCL change in the age groups. In cases where a main effect was found in absence of an interaction effect, correlations were performed for the entire participant group. When a significant effect with the univariate ANCOVA was found for neuroticism or extraversion, correlations were also calculated for their subscales for anxiety, assertiveness, and activity. Correlations were considered to show a large effect size when they exceeded 50, medium when above .30, and small above .10 (Cohen, 2009, pp. 78-81).

Results

Validity of the Film Clips

The repeated measure ANOVA's indicated that participants gave different sadness, happiness, negative, and positive ratings for the film clips (in younger adults, respectively: $F(1.15, 64.53) = 49.03$, $p < .001$, $\eta^2_p = .47$; $F(1.76, 98.74) = 66.52$, $p < .001$, $\eta^2_p = .54$; $F(1.62, 82.44) = 105.93$, $p < .001$, $\eta^2_p = .68$; $F(1.50, 76.34) = 358.05$, $p < .001$, $\eta^2_p = .88$; in older adults, respectively: $F(1.70, 91.98) = 60.39$, $p < .001$, $\eta^2_p = .53$; $F(2, 108) = 102.42$, $p <$

.001, η^2_p = .66; $F(2, 90) = 16.11$, $p < .001$, η^2_p = .26; $F(1.96, 87.99) = 41.87$, $p < .001$, η^2_p = .48). There were large effect sizes in each instance. Follow-up on these effects with pairwise *t*-tests indicated that the film clips were valid in both the older and younger adult group and thus appropriate for use in the study. Both age groups rated the sad film clip as more negative than the neutral clip (among younger adults, $t(51) = 9.13$, $p < .001$, $d = 1.65$; among older adults, $t(45) = 4.16$, $p < .001$, $d = .75$), and both rated the happy film clip as more positive than the neutral clip (among younger adults, $t(51) = 18.70$, $p < .001$, Cohen's $d = 3.79$; among older adults, $t(45) = 8.74$, $p < .001$, $d = 1.56$). Moreover, in both age groups the sad film clip elicited more sadness than the neutral clip (among younger adults, $t(56) = 6.78$, $p < .001$, $d = 1.22$; among older adults, $t(54) = 7.94$, $p < .001$, $d = 1.13$), and the happy film clip elicited more happiness than the neutral clip (among younger adults, $t(56) = 6.97$, $p < .001$, $d = 1.00$; among older adults, $t(54) = 3.54$, $p = .001$, $d = 1.50$).

Differences between Younger and Older Adults in Emotional Reactivity

Sad Film Clip. With respect to age differences in emotional reactivity (controlled for baseline individual differences) when viewing the sad film clip, independent samples *t*-tests showed that older adults had significantly stronger subjective feelings of sadness when seeing the sad film clip than younger adults (medium effect size). No differences occurred for corrugator, HR, HRV, or SCL change (see table 2).

<insert Table 2 here>

Happy Film Clip. With respect to age differences in emotional reactivity (controlled for baseline individual differences) when viewing the happy film clip, independent samples *t*-tests indicated that older adults had significantly stronger subjective feelings of happiness when seeing the happy film clip than younger adults (medium effect size). Younger adults showed higher SCL change (small effect size). No significant differences were found for corrugator, zygomaticus, HR, and HRV reactivity (see table 3).

<insert Table 3 here>

The Role of Personality

Personality Measures. In both younger and older adults, there were significant positive correlations with large effect sizes for neuroticism and negative emotionality (see Table 4). In the younger adult group, neuroticism was also positively correlated with low positive emotionality (small effect size) and negatively with aggression (small effect size). In both groups, low positive emotionality was negatively correlated with extraversion (large/medium effect size in younger/older adults) and aggression (large/medium effect size), respectively. Extraversion was also positively correlated with aggression (large effect size) and conscientiousness (small/medium effect size) in both groups. Finally, conscientiousness was positively correlated with openness (medium effect size) in the older adult group.

With respect to differences between the younger and older adult groups in their personality scores, independent *t*-tests showed younger adults scoring significantly higher than older adults on negative emotionality (medium effect size) and significantly lower on low positive emotionality/introversion (small effect size; see Table 5). No differences were found for neuroticism and extraversion or for the other Big Five and PSY-5-r personality traits.

<insert Table 5 here>

Sad Film Clip. With subjective feelings of sadness as the dependent variable, univariate ANCOVAs identified significant interaction effects between age group and personality for negative emotionality, $F(1, 112) = 5.28$, $p = .023$, $\eta^2_p = .05$ (small effect size), and for neuroticism, $F(1.112) = 4.25$, $p = .042$, $\eta^2_p = .04$ (small effect size). For both of these personality traits the main effects were significant (respectively, $F(1, 112) = 10.18$, $p = .002$, $\eta^2_p = .09$; medium effect size; $F(1, 112) = 9.56$, $p = .003$, $\eta^2_p = .08$; medium effect size). In

older adults, negative emotionality, neuroticism, and its anxiety subscale correlated positively and significantly (medium effect sizes) with ratings of sadness during a sad film clip (respectively, r = .43, p = .001; r = .40, p = .003; r = .36, p = .007). In younger adults these correlations had negligible and insignificant effect sizes (respectively, r = .10, p = .467; r = .12, p = .384; r = .06, p = .663).

With SCL as the dependent variable a significant interaction was also found between age group and neuroticism, $F(1, 95) = 5.76$, p = .018, η^2_p = .06 (medium effect size). In the younger adults, higher neuroticism and anxiety were associated (medium effect sizes) with lower SCL to sad film clips (respectively. r = -.35, p = .019; r = -.31, p = .040). In the older adults these correlations were in the opposite direction (small effect sizes), although not significantly so (respectively, r = .12, p = .419; r = .16, p = .260). No significant interaction effects were found for the other measures, with all $F < 2.53$, $p > .116$. There was, however, a main effect for low positive emotionality with HR, $F(1, 87) = 6.93$, p = .010, η^2_p = .08 (medium effect size), with a negative relationship (small effect size) between low positive emotionality and HR (r = -.29, p = .007). No other interaction or main effects for these personality traits were found, with all $F < 2.34$, $p > .130$.

With respect to the other personality traits, a significant interaction effect was found between openness and corrugator reactivity ($F(1, 95) = 5.17$, p = .025, η^2_p = .05; small effect size). In the younger group the correlations of corrugator reactivity with openness and with its aesthetics subscale were positive and significant (respectively, r = .32, p = .032; r = .48, p = .001). In the older adult group these correlations were negative but not significantly (all r < -.14, $p > .347$). No other interaction or main effects were found (all $F < 1.85$, $p > .177$).

Happy Film Clip. With the reactivity measures to the happy film clip as dependent variables, univariate ANCOVAs did not identify any significant interaction effects between age group and the four personality scales in the study, all with $F < 2.20$, $p > .142$. However,

there was a significant main effect between extraversion and corrugator activity, $F(1, 95) = 7.69$, $p = .007$, $\eta^2_p = .08$ (medium effect size). Follow-up correlations showed that extraversion and its assertiveness and activity subscales were negatively (small to medium effect sizes) correlated with corrugator activity (respectively, $r = -.28$, $p = .007$; $r = -.26$, $p = .011$; $r = -.30$, $p = .003$). A significant main effect of negative emotionality was also found for HRV, $F(1, 87) = 4.16$, $p = .045$, $\eta^2_p = .05$ (small effect size), and there was a positive correlation (small effect size) between them ($r = .23$, $p = .031$). No other main effects of personality were found, all with $F < 3.79$, $p > .055$.

As for the other personality traits, there was a significant interaction effect between openness and corrugator reactivity ($F(1, 95) = 4.08$, $p = .046$, $\eta^2_p = .04$; small effect size). In older adults, corrugator activity correlated negatively with openness, but not with its aesthetics subscale (respectively, $r = -.37$, $p = .008$; $r = -.14$, $p = .350$). In younger adults, none of these correlations was significant (all with $r < .11$, $p > .484$). Also found was an interaction effect between openness and heart rate ($F(1, 87) = 4.12$, $p = .046$, $\eta^2_p = .05$; small effect size). The correlations between heart rate, openness, and the openness aesthetics subscale were all positive in the younger adult group and all negative in the older adult group, although these correlations were not statistically significant (among younger adults, all $r < .22$, $p > .156$; among older adults, all $r < -.21$, $p > .163$).

Of further note, an interaction and main effect were found between heart rate variability (HRV) and agreeableness (respectively, $F(1, 87) = 5.06$, $p = .027$, $\eta^2_p = .06$; medium effect size; $F(1, 87) = 4.05$, $p = .047$, $\eta^2_p = .05$; small effect size). There were significant negative correlations between HRV and agreeableness in the younger adult group ($r = -.49$, $p = .001$), but not in the older adult group ($r < .02$, $p > .877$). A main effect was found for corrugator reactivity and conscientiousness ($F(1, 95) = 5.27$, $p = .024$, $\eta^2_p = .06$; medium effect size), which were negatively correlated ($r = -.23$, $p = .024$; subscale order: $r = -$

.09, p = .380). Finally, there was a main effect for skin conductance level (SCL) and agreeableness (F(1, 95) = 4.46, p = .038, η^2_p = .05; small effect size), which were negatively correlated (r = -.23, p = .025). No other main or interaction effects were found (all F < 3.60, p > .061).

Discussion

The main goal of the present study was to examine whether conceptual relationships between personality and emotional reactivity can be identified with experimental methods in younger and older adults and whether personality traits can influence differences between these two age groups in their emotional reactivity. To this end, changes in subjective and physiological reactivity were measured while participants viewed happy, sad, and neutral film clips.

Age-Related Differences in Emotional Reactivity

The film clips used in the study were demonstrated to be valid as happy and sad emotion inducing stimuli. With respect to their subjective reactivity, older adults reported a higher sad mood than younger adults while viewing a sad film clip and a higher happy mood while viewing a happy clip. Given that sadness may well be a more prevalent emotion among older adults, who are ordinarily more often confronted with losses than younger adults (e.g. Kunzmann & Grühn, 2005), it seems expectable that older adults would show stronger subjective reactivity to the sad stimulus. However, the findings with subjective reactivity to the happy film clip were less in accord with expectations. As mentioned previously, research results in the literature made it difficult to formulate clear hypotheses about subjective reactivity, and higher subjective reactivity in older compared to younger adults has already been found with broader measures of pleasantness as well (e.g. Grühn & Scheibe, 2008).

Older and younger adults did not differ in their physiological reactivity to the sad film clip, as measured by the corrugator, HR, HRV and SCL reactivity measures. This finding is

consistent with most of the earlier research into sadness (e.g. Kunzmann & Grühn, 2005). Because sadness is seen a relatively common emotion among older adults, attenuated reactivity for this emotion was indeed not expected. The results for the happy film clip were in line with expectations, being somewhat more diverse: older and younger adults did not differ in four of the five reactivity measures, but younger adults showed higher SCL change than older adults. In other words, then, older adults showed less sympathetic (arousal) reactivity to the happy film clip than the younger adults. Thus experienced happiness, which could be seen as a less prevalent emotion among older than young adults, elicited attenuated physiological reactions in the older adults. By contrast, the more age-relevant emotion of sadness did not do so. There is evidence that older adults are better in emotion regulation than younger adults (Urry & Gross, 2010). However, if older adults are better in regulating emotions because of their attenuated reactivity (e.g. Scheibe & Carstensen, 2010), it might be expected that such attenuation would also occur in the greater presence of age-relevant emotions. Since this is not the case, it seems unlikely that their attenuated physiological reactivity to emotional stimuli would be a cause of older adult's improved emotion regulation.

As expected, the results for subjective reactivity differed from the results for physiological reactivity. Whereas the two groups were similar in physiological reactivity, the older adults reported a higher sad mood and a higher happy mood than younger adults while viewing the sad and happy film clips, respectively. Researchers (e.g. Gavazenni et al., 2008) have previously sought to explain such results by noting that subjective reports are actually a mix of reactivity (feelings of physiological change) and cognitive interpretations (comparisons with past experiences). Hence the disparity in this regard might result from the fact that older adults have had more numerous previous experiences with which to compare their current experiences than younger adults. Taken together, these findings of age-related

differences underscore the importance of assessing both subjective and physiological reactivity to emotions.

Personality

As expected, normal trait neuroticism correlated strongly and positively in both age groups with maladaptive negative emotionality. Also as expected, the maladaptive trait of low positive emotionality was significantly and negatively correlated with normal trait extraversion.

With respect to age differences in scores on these personality traits, older adults scored lower on negative emotionality and higher on low positive emotionality/introversion than younger adults. These findings are consistent with previous reports of changes in personality that normally occur with ageing. Literature reviews confirm that neuroticism decreases slightly in older people (Debast et al., 2014). Because negative emotionality is the maladaptive variant of neuroticism, this age-related decrease in negative emotionality can be expected. The results in the present study did not show a significant difference in neuroticism between the two age groups, but the neuroticism scores were in the expected direction, slightly lower in the older adults (.28 vs. -.07). Additionally, extraversion has been found to diminish with age, with older adults becoming more introverted (Debast et al., 2014).

Personality and emotional reactivity in older and younger adults

With regard to the main questions addressed in the present research, some personality traits were found to exert a different influence on emotional reactivity to sad information in younger and older adults. Negative emotionality, neuroticism, and anxiety were found to be related to higher ratings of sadness in response to the sad film clip, but these relationships were significant only in the older adult group. In previous studies with younger adults, neuroticism has been associated with stronger ratings of sadness in response to sad stimuli (Thake & Zelenski, 2013). Given that this correlation was in the same direction in both age

groups in the present study, it would appear that these negative personality traits are to some extent related to stronger ratings of sadness at all ages, but that this relationship becomes stronger as people age. These changes in personality with ageing do not seem to explain why older adults have higher ratings of sadness than younger adults when viewing a sad film clip, given that negative emotionality is lower in the older adult group than in the younger group and that no age-related differences appear in neuroticism scores. Longitudinal studies will be necessary to substantiate the inference that the relationship between negative emotionality and neuroticism grows stronger with age and to determine that what the underlying causes of this relationship might be.

Also found was an interaction effect found between neuroticism and SCL. Among younger adults higher neuroticism was associated with lower arousal to the sad film clip, whereas no significant relationships were found among older adults. This result in the younger adult group differs from what could be expected on the bases of the conceptual framework of personality and emotional experience. Similarly, previous research found either no relationship between neuroticism and skin conductance in response to sad stimuli (Reynaud, et al., 2012) or the opposite relationship, with higher neuroticism associated with higher skin conductance (Norris, et al., 2007). There were no personality differences between the younger adults in the present study and the Norris et al. (2007) younger adults that could account for this unexpected result, which signifies a need for further investigation of this matter.

Finally of note was the finding in both age groups of a negative relationship between low positive emotionality and heart rate reactivity (deceleration: see Table 2) in response to the sad clip. Contrary to expectation, then, was that participants with lower positive emotionality apparently attended less to the sad film clip than participants with more positive emotionality. The absence of a likely explanation for this unexpected finding warrants further

research on the relationship between maladaptive trait low positive emotionality and emotional reactivity.

Although differential influences of personality traits on emotional reactivity were not found for the reactions of the two age groups to the happy film clip, there was a main effect of extraversion on corrugator reactivity. As hypothesized, higher extraversion, assertiveness, and activity were related to lower corrugator (frowning) activity in response to the happy film clip, which is indicative of experiencing positive emotions. Also, we observed that the higher participants scored on negative emotionality, the higher their heart rate variability (HRV) and thus the more regulatory parasympathetic activity they showed during the happy film clip. This surprising finding seems to suggest that individuals characterized by negative emotionality tend to endorse more regulatory activity to deal with the positive, an emotion that is incongruent with their trait emotionality.

Can Personality Account for Age-Related Differences in Emotional Reactivity

Almost no differences in physiological activity between older and younger adults were found in response to either the happy or the sad stimulus. The only exception was for SCL (arousal) change, which was higher in younger adults than in older adults when viewing the happy film clip. However, there was no relationship between personality traits and the skin conductance level. Subjective reactivity, on the other hand, was higher in the older adult group than in the younger group, but personality characteristics did not appear to account for this particular difference.

Nevertheless, the results did suggest that personality can be differentially related to emotional reactivity in older and younger adults, but only in emotions that are considered to be more frequent in old age, such as sadness. Personality characteristics did influence emotional reactivity to the happiness stimulus, and this influence was similar for the two age

groups. Whether such personality influence characterizes emotionality beyond the two discrete emotions in the present study is a subject for further research.

Some of the results in the present study were directly opposite of expectations based on the posited conceptual frameworks of personality and emotionality. Further research is necessary to determine whether these particular results are robust and if so, what may account for them. Given that the definition of these personality traits is based on emotionality (including reactivity), and that assessment methods such as questionnaires contain items measuring reactivity to emotional situations, there is reason to investigate whether experimental methods accord with relationships between personality and emotional reactivity. Consistent with previous research, the effect sizes of the relationships found in the present study were rather small (e.g. Lucas & Baird, 2004). This being only the first study to examine these relationship in an older population, no firm conclusions are yet warranted.

Limitations and Future Directions

Five limitations of the present study merit mention. First, convenience sampling was used to recruit the participants, which may affect the representativeness of our sample. This is especially the case for the older adults, who were mostly active and socially engaged people recruited by going to hobby clubs or education centers, while more passive older adults who were unwilling or unable to leave their house were not included. Additionally, after the exclusion criteria were applied, the sample sizes were rather modest, with 42 to 57 younger adults and 45 to 55 older adults, depending on the measure used. Although results with medium and even small effect sizes were obtained, it would be advisable for future research on relationships between personality and emotional reactivity in different age groups to use larger samples.

Secondly, the current study is limited to the elicitation of two discrete emotions, sadness and happiness, and other emotions would be worth investigating as well. Anxiety

would be of particular interest in this regard, given that is also an age-relevant emotion among older adults (Bryant, Jackson, & Ames, 2008). Nevertheless, the present study is an important contribution to the existing literature because of the use of happiness stimuli, which have mostly not been included in previous research examining physiological reactivity and personality.

Third, there may be some shortcomings of using film clips as emotion-inducing stimuli. Film clips were employed because they are vivid, standardized measures that, unlike mood-induction by imagination, do not require much cognitive processing. However, taking as an example the fragment showing a mourning boy, one may feel sad for the boy, but this feeling may not relate to situations that are relevant for the older participants, like loneliness. Although film clips have some advantages over other methods, these other methods may have the advantage of more ecological validity. For example, imagining that nobody likes you or inducing anxiety to fail a test are less standardized methods, but they may be valuable to use in future studies, to test whether the present results with film clips or pictures generalize to more self-related situations.

Fourth, only one film clip was used for each of the two emotions, and for purposes of reliability and generalizability, it would be preferable to use multiple stimuli to measure reactivity to an emotion. It would be preferable in future studies to use several film clips to measure each emotion and perhaps a variety of persons (e.g. older vs. younger actors) and depicted contexts (e.g. loss vs. loneliness).

Fifth, it was not possible to monitor recovery with the applied physiological measures, because participants were asked to complete the VAS scales between film clips, which can interfere with physiological measurements during this period for two reasons: (a) movements during writing could cause artifacts in physiological measures and (b) the time needed to fill in these scales varied across participants, and some measures (e.g. HRV) are duration

dependent. Given that the Strength and Vulnerability Integration theory (SAVI; Charles, 2010) indicates that older adults will be less flexible then younger adults in downregulating physiological reactivity and thus have slower recovery rates, it might also be of interest in future research to take account not only reactivity but of recovery as well.

Conclusion

Despite these limitations, the present research is innovative, given that relationships between personality and emotional reactivity, especially physiological reactivity, have not previously been fully clarified in a younger adult population, despite their conceptual relatedness. Furthermore, the present study is, to the authors' knowledge, the first study to investigate these relationships in an older adult population. The main aim of the study was to investigate whether personality is similarly related to emotional reactivity in older compared to younger adults and to evaluate whether personality should be taken into account as a moderator when assessing age-related differences in emotional reactivity. Although the obtained results are limited in scope, personality remains an interesting factor to take into account when assessing differences in emotional reactivity between older and younger adults, especially when inducing a sad emotion.

As an example, negative emotionality and neuroticism had stronger influences on subjective ratings of sadness in older adults than in younger adults. Other personality traits in the sad condition, and all personality traits in the happy condition, had either the same influence on emotional reactivity in both age groups or had no influence at all. However, some of the relationships found, differed from the expected direction, and further investigation is needed to determine if the present results are robust and if so, to account for them. Along with these findings, the results of the first part of the study indicate that there is a disparity in subjective and physiological reactivity when comparing older and younger adults, which is consistent with previous research. This finding points to the importance of assessing

both subjective and physiological forms of reactivity when investigating age-related differences in emotional reactivity.

Declaration of Conflicting Interests

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Table 1

Demographics per age group

	Younger adults *N = 57*	Older adults *N* = 55	X^2
Marital status			
Married/living together	42.1%	63.6%	
Single/divorced/widow(er)	57.9%	36.4%	5.21*
Education level			
Primary school	0%	7.3%	
Secondary school	15.8%	38.2%	
Higher education	84.2%	54.5%	12.92**
Gender			
Male	49.1%	47.3%	
Female	50.9%	52.7%	.04

Note. Significance: ** = < .01, * = < .05.

Table 2

Emotional reactivity differences to sad film between younger and older adults

	Younger adults		Older adults		Younger vs. Older	
	Baseline	Sad film	Baseline	Sad film	Sad films: reactivity	
	raw mean (SD)	raw mean (SD)	raw mean (SD)	raw mean (SD)	*t*-value	Cohen's *d*
VASsad	30.86 (28.25)	24.54 (21.53)	28.73 (29.98)	46.89 (34.65)	3.31**	.62
Corrugator	.032 (.022)	.050 (.047)	.041 (.049)	.048 (.043)	.53	.11
HR	70.18 (8.95)	68.83 (8.25)	67.18 (10.20)	66.09 (9.49)	.18	.31
HRV	42.16 (28.39)	43.79 (26.77)	19.90 (10.20)	23.57 (21.01)	1.51	.32
SCL	6.84 (2.65)	8.05 (2.87)	5.22 (2.53)	6.20 (2.84)	.79	.16

Note. Significance: ** = < .01.

Table 3

Emotional reactivity differences to happy film between younger and older adults

	Younger adults		Older adults		Younger vs. Older	
	Baseline	Happy film	Baseline	Happy film	Happy films: reactivity	
	raw mean (SD)	raw mean (SD)	raw mean (SD)	raw mean (SD)	*t*-value	Cohen's *d*
VAShappy	30.86 (28.25)	58.21 (26.17)	28.73 (29.98)	71.09 (26.53)	3.00**	.57
Corrugator	.032 (.022)	.018 (.014)	.041 (.049)	.022 (.017)	1.19	.24
Zygomaticus	.012 (.008)	.082 (.092)	.017 (.012)	.068 (.074)	.91	.19
HR	70.18 (8.95)	70.45 (8.97)	67.18 (10.20)	66.40 (9.75)	1.88	.43
HRV	42.16 (28.39)	39.26 (24.53)	19.90 (10.20)	20.41 (16.22)	.73	.15
SCL	6.84 (2.65)	8.56 (3.25)	5.22 (2.53)	6.33 (2.68)	2.06*	.43

Note. Significance: ** = < .01, * = < .05.

Table 4

Correlations between personality traits (Big Five and PSY-5-r)

	NEGE	N	lowPOSE	E	AGGR	A	C	O
NEGE	1							
N	.67***	1						
lowPOSE	.24	27*	1					
E	-.11	-.14	-.53***	1				
AGGR	-.05	-.27*	-.56***	.65***	1			
A	-.15	-.07	-.18	.07	-.26	1		
C	-.09	-.01	.03	.27*	.26	-.08	1	
O	.16	-.03	-.13	.14	.13	-.07	.17	1
	NEGE	N	lowPOSE	E	AGGR	A	C	O
NEGE	1							
N	.59***	1						
lowPOSE	.07	.01	1					
E	-.004	-.03	-.38**	1				
AGGR	-.10	-.24	-.46***	.59***	1			
A	-.02	-.10	-.13	.04	-.11	1		
C	.18	-.10	-.11	.30*	.19	.40**	1	
O	.05	-.17	-.13	.26	.25	.25	.32*	1

Notes. NEGE = negative emotionality, N = neuroticism, low POSE = low positive emotionality, E = extraversion, AGGR = aggression, A = agreeableness, C = conscientiousness, O = openness. Significance: *** = < .001; ** = < .01; * = < .05.

Table 5

Differences in personality traits in younger and older adults.

Scale	Younger adults Mean score/(SD)	Older adults Mean score/(SD)	*t*-value df(95)	Cohen's *d*
NEGE	7.25 (3.72)	5.24 (3.74)	2.85**	.54
N[a]	-.07 (.68)	-.28 (.65)	1.61	.32
Anxiety[a]	.01 (.81)	-.23 (.77)	1.62	.40
lowPOSE	7.49 (3.69)	9.04 (3.19)	2.37*	.45
E[a]	.26 (.71)	.35 (.60)	.74	.14
Assertiveness[a]	.30 (.84)	.34 (.73)	.27	.05
Activity[a]	.20 (.66)	.42 (.69)	1.73	.33
AGGR	8.16 (3.90)	8.31 (3.52)	.22	.04
A[a]	.50 (.49)	.63 (.55)	1.34	.25
C[a]	.44 (.55)	.60 (.60)	1.51	.28
Order[a]	.09 (.94)	.29 (.91)	1.19	.22
O[a]	.52 (.57)	.38 (.51)	1.38	.26
Aesthetics[a]	.22 (1.00)	.30 (.90)	.44	.08

Notes. NEGE = negative emotionality, N = neuroticism, low POSE = low positive emotionality, E = extraversion, AGGR = aggression, A = agreeableness, C = conscientiousness, O = openness.
Significance: ** = < .01; * = < .05.
[a]Mean scores and standard deviations are corrected for aquiescence.

Footnotes

[1] Therefore additional measures were administered for other studies. The informed consent was followed by an engagement-disengagement task. After this task, the physiological recording measures were attached to the participants, who next performed the emotional reactivity task described above. After a short break, they made an internal shift task and completed well-being and emotion regulation questionnaires and the MMSE. The additional tasks and questionnaires were related to research question addressed by other studies in the project and did not influence the current research.

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