Let me see your smile
The relation between autobiographical memories and smiling of healthy older adults

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Abstract

At the moment in the Netherlands 280.000 people are diagnosed with dementia (Alzheimer-Nederland, 2019). Because of the expected exponential growth in dementia cases in the next decades, it is important that the disease is investigated. Since not only cognition, but also emotion expression changes with age it is important to study the way healthy older adults express their emotions. This might lay the groundwork for emotion recognition for older adults that are diagnosed with a form of dementia. This study aims to contribute to the groundwork of emotion expression in healthy older adults by mapping what smiling looks like in healthy older adults. The research question is: *Is there a relation of valence and intensity with smiling in older adults when they talk about autobiographical memories?* This question was answered by comparing the different characteristics of smiling with the valence and intensity of the memory. This was done by using interviews about autobiographical memories that were conducted with eleven men and ten women. The participants all belonged to the category of healthy older adults. Based on the thematic coherence a valence code could be assigned by using the coding scheme that was developed by Tournier (2019). The intensity score that was used in this study, was a self-reported score based on the question of how the participants felt during the recall of the different memories. Smiling was measured by different smiling characteristics. The different smiling characteristics were derived by using the automatic facial recognition software Imotions (Imotions, 2020). The findings of this research partly show that there is a relation between both valence and intensity on smiling in the same way this relation exists for younger adults. However, part of the findings also indicates that the relation between valence and intensity on smiling might be different for healthy older adults compared to younger adults. Since the findings of this study are complex, no clear relation between valence, intensity and smiling can be discerned. For future research it is advised to study smiling at multiple modalities such as body posture or language in order to grasp the concept of smiling more fully. In addition, it is advised for future research to use manual coding of emotions, since this might add to the reliability and validity of the different smiling constructs. Future research is needed to be able to discern a clearer pattern in the way healthy older adults smile. This clearer pattern is needed to be better able to interpret the emotion expression in older adults who are diagnosed with a form of dementia in order to provide better and more personalized healthcare.

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1 Introduction

At the moment in the Netherlands 280.000 people are diagnosed with dementia (Alzheimer-Nederland, 2019). Because of an aging population in the Netherlands, the cases of dementia will exponentially rise to more than 500.000 people in 2040. In 2050 this number will be as high as 620.000 cases (Alzheimer-Nederland, 2019). Because of the expected exponential growth in dementia cases in the next decades, it is important that the disease is investigated. The current research will contribute to groundwork about how dementia relates to emotion-expression. Investigating emotion expression can help in better understanding people who are diagnosed with a form of dementia. This can lead to a more efficient way of taking care of people who are diagnosed with a form of dementia.

Age is the most important risk factor for dementia (Alzheimer-Nederland, 2019). 8% of the people above 65 is diagnosed with a form of dementia. For people above the age of 80 this is 25% and for people above 90 this percentage lies at 40% (Alzheimer-Nederland, 2019). Since high age is the most important factor for dementia, this study focusses on older adults. In order to examine how dementia relates to the expression of emotion in older adults, it is important to know how healthy older adults express their emotions. When it is objectified how healthy older adults express their emotions, then these results can be compared in later research with the emotion-expression of older adults who are diagnosed with a form of dementia.

The aim of this study is to expand the current knowledge on the link between autobiographical memories and emotion expression regarding the facial expression of smiling of older adults. In the current research emotion expression is investigated by using autobiographical memories told by healthy older adults. Specifically, this study focuses on different smiles of healthy older adults during the recall of autobiographical memories. This study focuses on smiling because the basic form of laughter/ smiling is preserved in dementia patients (Takeda, Hashimoto, Kudo, Okochi, Tagami, Morihara, Sadick, & Tanaka, 2010). Adults with a diagnosis of dementia smile when they are well fed, when they slept well, but also when they have a feeling that they attained their self-set goals or when they are regarded as superior (Takeda, et al., 2010). Studying smiling in healthy older adults can therefore lay the groundwork for smiling recognition in older adults who are diagnosed with a form of dementia in order to understand them better.

1.1 Autobiographical Memories

As written above, this study uses autobiographical memories of healthy older adults in order to

investigate emotion expression. Autobiographical memories can be defined as memories of one's life. These memories can be about past experiences, encounters with people or facts about oneself (Luchetti & Sutin, 2018; Xu et al., 2017). Research found that autobiographical memories have different functions in daily life (Bluck, Alea, Habermas, & Rubin, 2005). First of all, there is the directive function. The directive function of autobiographical memories is when the past is used for problem-solving. The second function of autobiographical memories is the self-function. In literature the most commonly referred function of the self-function is self-continuity (Alea & Bluck, 2008; Bluck & Liao, 2013; Addis & Tippett, 2008; Wilson & Ross, 2003). Self-continuity is the experience of knowing that we are the same person over time. However, Bluck, Alea, Habermas & Rubin (2005) have found that another part of the self-function is the tendency to think about your own past. This evaluative recall and consideration of your own past is known as 'life reflection' that may lead to self-insight and in some cases self-growth. The third function of autobiographical memories is the social function. The social function consists out of developing relationships and nurturing relationships (Bluck, et al., 2005).

Besides the different functions that autobiographical memories have in daily life, they also have an influence on mental well-being and emotions. Because of this influence autobiographical memories are researched in many different areas of psychology (Conway & Pleydell-Pearce, 2000). The use of autobiographical memories can contribute to self-regulation as well as the regulation of subjective well-being (Ferring & Tournier, 2017). Regulation of subjective well-being through autobiographical memories can be done through working with narrative identities. Using narrative identities can offer insights into dealing with negative experiences (Ferring & Tournier, 2017). This is a two-step process. During the first step the person explores the negative experience in depth. In the second step the person commits the self to a positive resolution of the event (Ferring & Tournier, 2017). Research suggests that the first step is related to personal growth, while the second step is related to happiness and well-being (Ferring & Tournier, 2017). In addition, recalling and sharing positive memories contribute to planning the future and regulating emotional well-being. For example, in dyadic conversations about past events the original positive emotional qualities are retained, but the negative emotion is less evident in retelling an event than in originally experiencing it (Alea & Bluck, 2009). In addition, research considering nostalgia found that recalling positive memories is effective against negative moods (Wildschut, et al. 2006).

Finally, autobiographical memories have often been described by their valence and their intensity. However, for autobiographical memories the description based on valence and

intensity works through emotion. Emotion can best be classified by using a dimensional model. This dimensional model suggests that emotion can best be understood in a dimensional space, namely according to its valence and intensity (Anderson, & Adolphs, 2014). Valence indicates to what degree a memory is recognized as negative or positive (Lang, 1994; Berntsen & Rubin, 2006; Sutin & Robins, 2007, according to Nazareth et al.,2019). The arousal/intensity dimension is about the intensity of emotions, varying from very low to very high (Viinikainen, 2010). One can be happy, cheerful, excited or ecstatic. The differences between these emotions might be reflected in differences in the level of intensity that is associated. Some autobiographical memories/ emotions may be high in intensity but differ in their valence (one is negative, one is positive), whereas other emotions may be of similar valence but differ in their intensity (happy versus ecstatic) (Anderson, & Adolphs, 2014).

1.2 Autobiographical memories in older adults

As explained before, autobiographical memories have an important role and function in daily life (Bluck, et al., 2005). This is not different for older adults, although there are some differences in the way older adults retrieve autobiographical memories (Levenson, Carstensen, Friesen, & Ekman 1991).

Even though age often has an influence on cognitive control which is defined as a set of neural processes that allow us to interact with our complex environment in a goal-directed manner (Anguera, Boccanfuso, & Gazzaley, 2013), age does not seem to have that same influence on emotional control, which is about emotion regulation (Mather, & Cartensen, 2005). In comparison with younger adults, older adults report that they focus more on self-control of their emotions. In addition, Mather & Cartensen (2005) found that when participants experienced a negative mood, it was less likely to persist at the next sampling situation in older adults than in younger adults. This shift to a more positive mindset has been found in other studies as well (Ford, Digirolamo, & Kensinger, 2015). For example, it was found that older adults tend to report more positive personal memories than younger participants. This is in line with a bigger phenomenon that was first found by Carstensen in 2004, which is an age-related 'positivity effect' (Ford, et al., 2015). This phenomenon holds that ageing is associated with an increasing focus on positive affect relative to negative effect. It is hypothesized that the positivity effect shows a shift in motivation across the lifespan (Ford, et al., 2015). Younger adults perceive their time as expansive, therefore they focus more on goals related to their future. Older adults, on the other hand, realize that their time is not as expansive as it was before. This realization places a focus on emotional goals. This shift in goal orientation may cause older adults to focus more on positive events when recalling their past (Ford, et al., 2015). The effects

of this positivity effect are that older adults are more likely to forget the intensity of their negative affect (Levin & Bluck, 1997). This positivity effect in recalling is also present in memory for emotional pictures (Charles, Mather & Carstensen, 2003). In the study from Charles, Mather & Carstensen (2003) it was found that although older adults were less likely to remember the pictures overall, the age difference influenced the retaining of the negative images more than the retaining of the positive images. This positivity effect was consistent across men and women, African- and European-Americans and people of low and high socio-economic class. In addition, Sullivan and Ruffmann (2003) found that older adults seemed to be more impaired in recognizing anger and sadness, while no impairments were found in recognizing happiness and fear. Having no impairments in recognising happiness might further show an orientation towards the positive aspects of situations.

1.3 Emotions

Since this study focusses on the study of emotions in healthy older adults through using autobiographical memories, it is important to know the different aspects that make up emotions and the way emotions can be measured.

Wundt was one of the first psychologists that argued that emotions involves at least two properties: valence and arousal (Kuppens, Tuerlinckx, Russel, & Barrett, 2013). Valence refers to pleasantness which varies from negative (very unpleasant) to positive (very pleasant) values (Viinikainen, Jääskeläinen, Alexandrov, Balk, Autti & Sams, 2010). The arousal dimension is about the intensity of emotions, varying from very low to very high (Viinikainen, et al., 2010).

Emotions are shown by emotion expressions. Emotion expressions can be measured in different ways. According to Feidakis, Daradoumis, & Caballé (2011), emotion measurement can be grouped into three groups: psychological, physiological and motor-behavioural. In psychological emotion measurement self-reporting is used a lot. In physiological research a lot of research focusses on brain scans or electrodermal activity. This study uses motor-behavioural expression to study emotions. Motor-behavioural expression is the most common way to evaluate one's affective state in everyday life. (Feidakis, et al., 2011). This type of measurement often measures behavioural expressions and characteristics of facial expressions that relate to emotional experiences (Feidakis, et al.,2011).

It is known that age has an influence on emotional expression. Bondareff (1980) according to Levenson et al. (1991) found that stress produces a longer activation of the autonomic nervous system (ANS) reactivity in older adults relative to younger adults. If other strong emotions also have an effect on the duration of the activation of the ANS, and that

activation is experienced as unpleasant, then it might be that older adults avoid strong emotions in order to escape the physiological consequences (weight gain, high blood pressure, muscle weakness, mood swings, osteoporosis, etc) (Levenson, Carstensen, Friesen, & Ekman, 1991). If older adults indeed try to escape the physiological consequences of the activation of the ANS then that might be the explanation of the fact that the appearance in terms of emotional facial expression of older adults seems more flattened (Levenson, et al., 1991). In addition, a study from Magai, Consedine, Krivoshekova, Kudadjie-Gyamfi and McPherson (2006) found that older adults produced significantly reduced emotional expression.

According to research in social psychology, facial expressions are the main modality in human communication (Yeasin, Bullot, & Sharma, 2006). Tomkins (1963) once stated that facial activity is always part of an emotion, even when the appearance of the emotion might seem inhibited. This is supported by Ekman (1993) who found that even though the emotional expression might not be apparent, there is a discernible activity in the facial muscles that accompany an emotion. A lot of research with facial recognition has been done (Chiarugi et al, 2014). Of the different methods that are available, the Facial Action Coding System (FACS) developed by Ekman is the most comprehensive (Cohn, 2006). This method allows the identification of basic emotions over time, using the image of a face for analysis and expression change (Wolf, 2015). When using FACS and viewing video-recorded facial behaviour at frame rate and slow motion, coders can manually code almost all possible facial expressions (Cohn, 2006). The facial expressions can be broken down into action units (AU's) (Yeasin, et al.,2006). Action units are the smallest discernible facial movements that can be seen (Cohn, 2006). Breaking the facial activity down into action units is helpful in researching emotions. In addition, using facial recognition in order to study emotion provides the benefit that observers can obtain a high level of agreement if the facial expressions are carefully selected (Ekman & Oster, 1979). Furthermore, the advantage of using this method is that facial expression can be measured without bias from the researcher (Wolf, 2015). Another benefit of using facial recognition in studies is that there is a universality in facial expressions, which means that facial expressions of basic emotions are the same in different cultures (Ekman & Oster, 1979). The different emotions that can be discerned through facial muscular activity are anger, fear, disgust, sadness, surprise or enjoyment/happiness (Ekman, 1993). Discerning different facial muscular activities can be done manually by using the FACS as developed by Ekman, but different software programs have also been developed for the automatic extraction of facial expressions. Automatic facial extraction software mimics the human coding skills by capturing raw, unfiltered emotional expressions towards any type of emotionally engaging content. These

emotion expressions are recognized in real time by using automated computer algorithms (Imotions, 2020). A benefit of using automatic facial recognition is that it is very time-efficient, but it might go at the cost of the reliability of screening the different facial expressions (Skiendziel, Rösch, & Schultheiss 2019).

1.4 Smiling

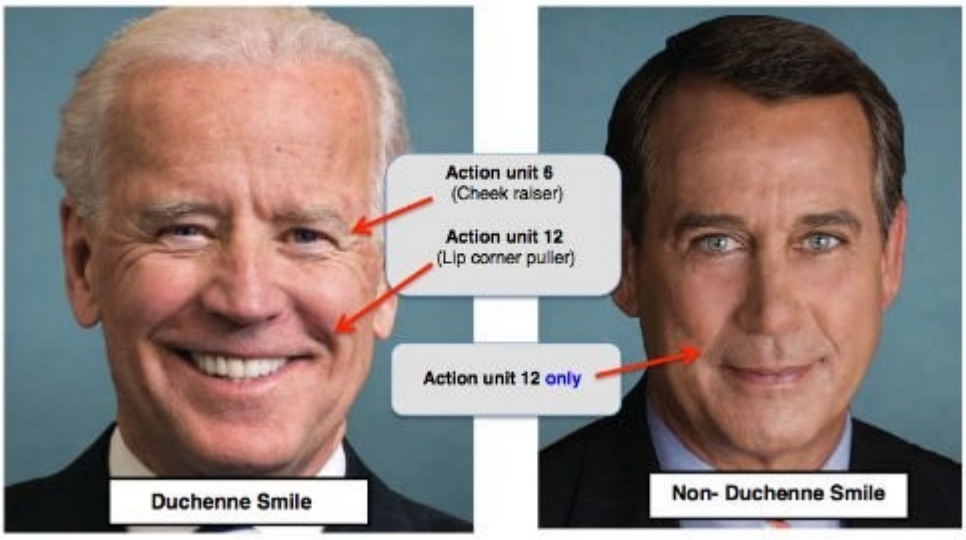
As written above, the different emotions that can be discerned through facial muscular activity are anger, fear, disgust, sadness, surprise or enjoyment/happiness (Ekman, 1993). Of all the different emotions, happiness seems to be the emotion that people strive for most (Cherry, 2020). Happiness is often described as a pleasant emotion that is accompanied with feelings of joy, satisfaction, well-being and gratification (Cherry, 2020). This type of emotion can be expressed through body language, tone of voice or facial expressions. This study will focus on facial expressions. In case of facial expressions, happiness can be expressed in smiling (Cherry, 2020).

Smiles can be simple, yet they can be complicated. (Niedenthal, Mermillod, Maringer, & Hess, 2010). Historically, smiles have been divided between genuine, so-called Duchenne smiles, and non-Duchenne smiles, which are not associated with positive emotion and are considered to be disingenuous (Ekman, Davidson, & Friesen, 1990). The Duchenne-smile shows activation of two specific action units, namely a joint contraction of the zygomatic major and orbicularis oculi muscles. This means pulling the lip corners backwards and upwards and raising the cheeks which results in causing eye wrinkles (Ruch & Ekman, 2001) (see picture 1). It has been argued that only smiles that involve both facial actions should be regarded as Duchenne/genuine smiles (Krumhuber & Manstead, 2009). In contrast the cheek raiser should be absent in non-Duchenne or voluntary smiles, which only show movement in the mouth region (Krumhuber & Manstead, 2009). In addition, genuine smiles can be discerned from disingenuous smiles based on their duration. Duchenne/ genuine smiles tend to be shorter in total duration than disingenuous/ non-Duchenne smiles (Schmidt, Ambadar, & Reed, 2009).

Ultimately, a number of psychological studies found that both intensity and valence of affective stimuli potentiated facial electromyographic (EMG) activity (Soussignan, 2002). For example, it was found that EMG activity over the cheek and the lips tended to be higher when pleasant scenes were presented (Soussignan, 2002). This seems to show that a positive valence (pleasant stimuli) results in more genuine/Duchenne smiling. In addition, in the study from Soussignan (2002) it was found that a higher experienced positive intensity leads to more genuine/Duchenne smiling. Ultimately, Duchenne-smiling is more present in situations where people share and show a form of altruism, situations where people experience a higher social

power and situations wherein people want to convince other people that they have a high intrinsic motivation in order to attain an accessible goal (Mehu, Grammer, Dunbar, 2007; Hecht, Lafrance, 1998; Cheng, Mukhopadhyay, & Williams, 2020).

Picture 1. Duchenne smile vs. Non-Duchenne smile



1.5 This study

As written above, it is known that there are different types of smiling, namely Duchenne/genuine and non-Duchenne/ disingenuous smiles (Ekman, et al., 1990). In addition, it is known that the Duchenne smile is characterized by showing both a cheek raise and a lip corner pull, whereas the non-Duchenne smile only shows a lip corner pull (Krumhuber & Manstead, 2009). Ultimately, a number of psychological studies found that both intensity and valence of affective stimuli potentiated facial electromyographic (EMG) activity (Soussignan, 2002). For example, it was found that EMG activity over the cheek and the lips tended to be higher when pleasant scenes were presented (Soussignan, 2002). This seems to show that a positive valence (pleasant stimuli) results in more genuine/Duchenne smiling. In addition, in the study from Soussignan (2002) it was found that a higher experienced intensity leads to more genuine/Duchenne smiling.

However, what is not known is whether the same relation of valence and intensity with smiling is present for healthy older adults. Since healthy older adults produce significantly reduced emotional expression (Magai, Consedine, Krivoshekova, Kudadjie-Gyamfi and McPherson, 2006) and show a positivity effect that results in older adults to be more likely to forget the intensity of their negative affect (Levin & Bluck, 1997), it might be that the relation between valence, intensity and smiling is different for healthy older adults.

This study investigates the relation between valence, intensity and smiling in healthy older adults through analysing different autobiographical memories of older adults. This study tries to differentiate smiles between memories with a positive and negative valence and a high and low level of intensity. The smiles will be analysed by using the action units of Ekman (Cohn, Ambadar, Ekman, 2007). In addition, the smiles will be analysed by looking at the frequency and duration of the smiles.

This leads to the following research question: *Is there a relation of valence and intensity with smiling in older adults when they talk about autobiographical memories?* In order to answer this question, the following sub questions arise:

1. Is there a relation between smiling and valence during the recall of autobiographical memories?
2. Is there a relation between smiling and intensity during the recall of autobiographical memories?
3. Is there an interaction effect of valence and intensity on smiling?

2 Method

2.1 Design

The current study is a quantitative research that tries to discern different types of smiling that correspond to different types of memories (negative valence/ neutral valence/ positive valence, intense/non-intense). This study is part of an overarching study of Nazareth (2020). Parts of this research might be used in the overarching research of Nazareth (2020). During this experimental research it will be researched whether there is a difference in the dependent variable smiling (duration, amount, Duchenne/Non-Duchenne) based on the independent variable intensity and valence. The participants were interviewed in a place they felt most comfortable; however, an artificial environment (set up with cameras and microphones) was created in which the participants were interviewed. Therefore, this study is considered to be an experimental study.

2.2 Participants

The current study is based on 21 participants (11 males; 10 females), aged between 65 and 85 years old (M= 74, Sd= 5.86). These participants are the participants from the research of Nazareth (2020). The inclusion criteria are that participants were at least 65 years old, have a functional vision and hearing and are fluent in the Dutch language. Exclusion criteria were cognitive impairments, tested by the MoCA which is a screening for dementia (Thissen, van Bergen, de Jonghe, Kessels,& Dautzenberg, 2010), the experience of traumatic life experiences

which was tested with the MINI, a screening for PTSS (Lecrubier, Sheenan, Hergueta & Weiller, 1998) and having a pacemaker.

2.3 Procedure and Materials

The participants in this study were recruited through advertisements that were published in local newspapers. During the first interview, participants were audio recorded at their homes or other places in which the participants would feel comfortable. For a description of the experimental environment, see Nazareth et al. (2019). During the first interview a revised version of the Autobiographical Memory Test (AMT) from Williams and Broadbent (1986) was conducted in order to create an overview of the different autobiographical memories a participant had (Nazareth, et al., 2019). In addition, during the first interview, participants were audio recorded at their homes or other places in which the participants would feel comfortable. During the interview participants were exposed to two cue-words; one with a positive valence and one with a negative valence. The words were respectively 'happy' and 'sad'. Participants were instructed to choose memories that were specific and emotionally charged. Two neutral cue-words were used in order to practice the retrieval of the memories. The order in which the cue-words were provided were: grass, bread, sad (3x) and happy (3x). The memories were later written down in a 'life story book' that was discussed in a follow-up interview. The second interview, that was audio and video-recorded, was again conducted by Nazareth (2019). The participants were asked to talk about their memories that were presented in the life story book in detail. The second interviews are the input for the current study.

2.4 Analyses

2.4.1 Transcription

The audio/video-files were transcribed using the automatic speech recognition tool NLSpraak* and were manually complemented in the program Praat**.

2.4.2 Fragmentation

The video and audio recordings were categorized in separate memories that the participants recalled during the follow-up interview. However, each memory often consisted of multiple events that were related to one subject. Therefore, the memories were divided into fragments that shared thematic coherence. For example: during the subject of emigration somebody spoke about the moment they emigrated, the travel by boat to another country and the living in the

*The automatic speech recognizer can be found on https://github.com/opensource-spraakherkenning-nl/Kaldi NL

** The phonetic program Praat can be found on https://www.fon.hum.uva.nl/praat/download_win.html

other country. Those different topics were treated as different fragments. In total 687 fragments were used in this study.

2.4.3. Coding

The coding of the valence was done according to the coding scheme of valence of emotional memories scale (VEM-scale) of the research of Tournier (2019) that can be found in appendix A. To every fragment a code was assigned in order to be able to analyse the data.

The first analysis that was done for every memory was to decide what the valence code was of the memory. This was done by categorizing the specific event to the coding scheme developed by Tournier (2019), see appendix A. The coding scheme from Tournier (2019) was developed in order to be able to code life events in a memory based on valence. The codes ranging from 1.14 to 6.75 of the coding schemes were derived from literature about valence. An example of such a life event is 'Death child with a valence score of 1.14.' In addition, to the VEM-score of the life-events, a subjectivity score could be added by the researcher. The subjectivity score is a -1/+1 score that is only applied on top of the life-event valence score when the participant explicitly states that his/her memory is different in terms of valence than the VEM describes (Tournier, 2019). The coding was done by two researchers in order to calculate an interrater reliability. The interrater reliability was calculated using Cohen's κ. There was strong agreement (McHugh, 2012) between the two raters ($\kappa = .870$, $p < 0.001$).

In addition, the intensity of the memory was coded by using an intensity rating called the Self-Assessment Manikin (SAM) scale. This intensity rating is a self-rating of the participant of the intensity of the memory. The intensity rating was derived by asking participants '*How did you feel, when you were just talking about this event*' The intensity rating is a continuous score and has a range between -1 and 1. The closer the score gets to -1 the more negatively intense the memory is according to the participant. The closer the score gets to 1 the more positively intense the memory is according to the participant. The intensity rating is about intensity because the -1 to 1 provides a kind of intensity for either the negativity (close to -1) or positivity (close to 1) of an emotion during the recall of a memory.

The variables intensity (SAM) and valence were transferred to ordinal variables. The variable valence was split up in three groups based on the coding scheme of Tournier (2019, see appendix A), namely valence negative (valence score ≤ 4.20), valence neutral (valence score 4.20 ≥ 4.99) and valence positive (valence score ≥ 5.00).

The variable intensity (SAM) was split up in four groups, namely high negative intensity

(SAM score -1 ≤ -0,5), mild negative intensity (-0,5 ≤ 0), mild positive intensity (0 ≤ 0,5) and high positive intensity (0.5 ≤ 1).

2.4.4 Analysis of facial expressions/smiles

To prepare the analysis of the facial expressions/smiles a software program was used, called Imotions (version 8.1) that automatically extract facial features and emotions (Imotions, 2020). The videos of the different memories were imported into this program. The program gives the possibility to extract the frequency and duration of different emotions and facial expressions. First the different fragments were uploaded into the Imotions program. After this, different analyses for the facial expressions and emotions were added to the study. First it started out with a face recording in order to analyse all the different facial expressions and emotions that were shown inside a video. Since every memory consists out of different fragments/topics that have the same thematic coherence as explained in section 2.4.2 and their own valence and intensity score, the timestamps of those fragments were annotated in the video's in Imotions. Because of this it was possible to have the facial expressions and emotions for each timestamp/topic. After annotating the timestamps for the different fragments, a threshold was put in place. The threshold was used by Imotions in order to be sure that a distinguished facial expression is indeed the facial expression that it seems to be. In this study a threshold and certainty level of 50% was used, which means that only facial expressions were extracted that were found with a 50% or higher certainty level. After adding the threshold, the results of the analyses were exported. During the exportation it was possible to decide which emotions and facial expressions are taken into account. In this study the data considering smiling (smile time percentage, frequency, duration, cheek raise and lip stretch) was exported. These features are constructed by the AFFDEX database in Imotions through Support Vector Machine (SVM) classifiers that were trained on 10.000s of manually coded facial images collected from around the world (McDuff et al., 2016). Smile percentage shows the percentage of time inside a fragment that smiling was present. Frequency shows the number of frames inside a fragment where smiling was present. Duration, shows the length (<1 sec) or (>1sec) of the smiles inside a fragment. Cheek raising and lip stretch are the AU's that were extracted and show the frequency of lip stretching and cheek raising during smiling. A Duchenne-smile can be distinguished from a Non-Duchenne smile when in a fragment both the AU's (cheek raising and lip stretching) occur together. A Non-Duchenne smile was discernible when only lip stretching was present during a frame. A variable was computed for Duchenne smiles. This variable consisted out of the cases that had at least one count of cheek raise and one count of lip stretch. Another variable was computed for

non-Duchenne smiles, this variable consisted out of the cases that had at least one count of lip stretching and no counts of cheek raising.

2.4.5 Analyses in SPSS

Ultimately the exported data consisting of all fragments and their corresponding valence, intensity and smiling variables was imported into SPSS. First analyses were executed in order to describe the dataset. This was done by computing the frequencies of valence, intensity and the different characteristics of smiling (smile time percentage, smile short expressions count, smile long expressions count, lip stretching and cheek raising).

Afterwards a multivariate-analysis was done to check whether valence and intensity had a relation with the time percentage of smiling, and the duration (long vs. short expressions) of smiling. In addition, two separate univariate analyses were executed to look at the relation of valence and intensity on either non-Duchenne-smiles and Duchenne-smiles. Post-hoc Bonferroni tests were executed to look at the direction of the relation between valence, intensity and the different smiling characteristics (smiling percentage, smiling long expressions count, smiling short expressions count, Non-Duchenne-smiles and Duchenne-smiles).

Ultimately, to check the direction of the interaction of valence and intensity on the different smiling characteristics (smiling percentage, smiling long expressions count, smiling short expressions count, Non-Duchenne smiles and Duchenne-smiles) the statistically significant interaction effects were plotted.

3. Results

3.1 descriptive analysis

In total 126 memories were analysed. The different memories consisted of different fragments or topics, so in total 687 fragments/topics were analysed in total. Each of these memories were coded on valence and intensity. A descriptive analysis of the variable's valence and intensity and their interaction can be found in table 1.

There were more memories with a negative valence (valence score ≤ 4.20) than memories with a neutral valence (valence score 4.20 – 4.99) or memories with a positive valence (valence score ≥ 5.00). In addition, most of the memories were considered to have a mildly positive intensity ($0 \leq$ intensity rating < 0.5), after that the most memories were considered to have a mildly negative intensity ($-0{,}5 \leq$ intensity rating < 0), after that the most memories were considered to have a strong positive intensity ($0.5 <$ intensity rating ≤ 1), fewest memories were considered to have a strong negative intensity ($-1 \geq$ intensity rating ≤ -0.5)

In addition, A chi-square analysis showed that there is a significant relation between

valence and intensity $X^2(6, 687) = 27.180$, $p < .001$. Furthermore, it can be seen that there are more positive fragments that were considered as strongly intense, than negative or neutral fragments that were considered as strongly intense. Also, there are fewer positive fragments that are non-intense than there are negative events that are non-intense. However, it can also be seen that a lot of memories that are considered to have a negative valence are positive in their intensity.

Table 1. Frequencies of valence (negative, neutral, positive), intensity (strong negative, mild negative, mild positive, strong positive) and their interaction.

	Valence			
Intensity	Negative	Neutral	Positive	Totals
Strong negative intensity	28	0	24	52
Mild negative intensity	111	8	48	167
Mild positive intensity	177	13	128	318
Strong positive intensity	60	6	84	150
(*N*)	376	27	284	687

In addition, a descriptive analysis of the smiling variables (smile long expression count, smile short expression count, smile time percentage) can be found in table 2. The frequencies of the Duchenne smiles and non-Duchenne smiles can be found in table 3. As can be seen the mean for smile time percentage is 6.01 which means that on average there is smiling present in 6.01% of a fragment. In addition, it can be seen that the mean for smile long expressions count is lower than the mean for smile short expressions count, which means that in general people tend to smile

shorter during the autobiographic memories. In addition, it can be seen that there are 336 instances of non-Duchenne smiles, which only show a movement in the lip stretching. There are only 129 instances of Duchenne-smiling which entail both a lip stretch and a cheek raise. This means that during the telling of the autobiographical memories people tend to have more disingenuous than genuine smiles.

Table 2. Descriptives for the smiling variables

	Frequency	Mean	Std. Deviation
Smile time percentage	687	6.01	11.43
Smile long expressions count (>1 sec)	687	1.69	3.95
Smile short expressions count (<1 sec)	687	2.50	5.49

Table 3. Frequencies for Duchenne-smiles and Non-Duchenne.

	Frequency	Percent
Duchenne-smiles	129	18.78
Non-Duchenne smiles	336	48.91
No Smiles	222	32.31
Total	687	100

3.2 Statistical analyses

In addition, one multivariate analysis and two univariate analyses were executed to study the relation of valence and intensity on the different smiling characteristics. These analyses can be found in table 4 to 6.

Table 4. Multivariate analysis for intensity and valence on the smiling variables (Smile time percentage, smile long expressions count (>1sec), smile short expressions count (<1sec).

	Dependent Variable	df	F	Sig.
Valence	Smile Time Percentage	2	10.62	**.00**
	Smile Long expressions Count (> 1 sec)	2	5.99	**.00**
	Smile Short expressions Count (< 1 sec)	2	4.17	**.02**
Intensity	Smile Time Percentage	3	4.59	**.00**
	Smile Long expressions Count (> 1 sec)	3	.69	.56
	Smile Short expressions Count (< 1 sec)	3	1.55	.20
Intensity * Valence	Smile Time Percentage	5	3.18	**.00**
	Smile Long expressions Count (> 1 sec)	5	3.87	**.00**
	Smile Short expressions Count (<1 sec)	5	4.91	**.00**

Table 5. Univariate analysis with independent variables; intensity and valence. Dependent variable; Duchenne-smiles

	Dependent variable	df	F	Sig.
Valence	Duchenne-smiles	2	.17	.85
Intensity	Duchenne-smiles	3	1.35	.26
Valence*intensity	Duchenne-smiles	5	.84	.51

Table 6. Univariate analysis with independent variables; intensity and valence. Dependent variable; non-Duchenne-smiles

	Dependent variable	df	F	Sig.
Valence	non-Duchenne-smiles	2	.87	.42
Intensity	non-Duchenne-smiles	3	1.01	.39
Valence*intensity	non-Duchenne-smiles	5	2.85	**.02**

3.2.1 Valence and Smiling

A statistically significant difference was found between valence and smile percentage, between valence and smile long expressions count, and between valence and smile short expressions count (see table 4). These results indicate that valence has a relation with the amount and duration of smiling in healthy older adults.

In order to specify the significant differences between the groups, a post-hoc analysis was executed for valence. The results of the post-hoc analysis can be found in table 7. The analysis shows that there is statistically significant less smiling in memories with a negative valence than in memories with a neutral valence. In addition, there is statistically significant less smiling in memories with a negative valence than in memories with a positive valence. Furthermore, in memories with a positive valence there is less smiling than in memories with a neutral valence.

For smile long expressions count, the analysis shows that there are statistically less smile long expressions in memories with a negative valence than in memories with a neutral valence. In addition, there are statistically less smile long expressions in memories with a negative valence than in memories with a positive valence. There is no statistically significant difference in smile long expressions between memories with a neutral valence and memories with a positive valence.

For smile short expressions count, the analysis shows that there are statistically less smile short expressions in memories with a negative valence than in memories with a neutral valence. In addition, there are statistically less smile short expressions in memories with a negative valence than in memories with a positive valence. There is no statistically significant difference in smile short expressions between memories with a neutral valence and memories with a positive valence.

Ultimately, no statistically significant differences were found between valence and Duchenne-smiles and valence and non-Duchenne smiles.

Table 7. Post-hoc analyses (Bonferroni) for significant differences of valence and the different smiling variables.

Dependent variable	Valence	Mean	std. Error
Smile time percentage	Negative	$3.42^{a,b}$	.59
	Neutral	$14.87^{a,c}$	2.13
	Positive	$8.99^{b,c}$	.69
Smile long expressions count (>1sec)	Negative	$.68^{a,b}$	.15
	Neutral	2.04^{a}	.53
	Positive	2.07^{b}	.17
Smile short expressions count (<1sec)	Negative	$1.31^{a,b}$	.21
	Neutral	3.41^{a}	.77
	Positive	2.81^{b}	.25

a = significant difference in means between negative and neutral valence.
b = significant difference in means between negative and positive valence.
c = significant difference in means between neutral and positive valence.

3.2.2 Intensity and smiling

A statistically significant difference was found between intensity (as measured by the SAM) and smile percentage, but not between intensity and smile long expressions count and smile short expressions count (see table 4). These results indicate that the intensity of an emotion has a relation with the amount of smiling in healthy older adults, but not on the duration of the smiling.

In order to specify the significant differences between the groups, another post-hoc analysis was executed for intensity (as measured by the SAM). The results of the post-hoc

analysis can be found in table 8. It was found that there is statistically significant less smiling in memories with a high negative intensity than in memories that have a high positive intensity. In addition, there is statistically significant less smiling in memories with a mild negative intensity than in memories with a mild positive intensity. Furthermore, there is statistically significant less smiling in memories with a mild negative intensity than in memories with a high positive intensity. No statistical differences were found in smiling between memories that have a mild positive intensity and memories that have a high positive intensity. Ultimately, no statistically significant differences were found between intensity and Duchenne-smiles and intensity and non-Duchenne smiles.

Table 8. Post-hoc analyses (Bonferroni) for significant differences of intensity and the different smiling variables.

Dependent variable	Intensity	Mean	std. Error
Smile time percentage	High negative intensity	4.18^{a}	1.57
	Mild negative intensity	2.72^{bc}	.89
	Mild positive intensity	7.09^{b}	.66
	High positive intensity	9.05^{ac}	.99

a = significant difference in means between high negative intensity and high positive intensity
b = significant difference in means between mild negative intensity and mild positive intensity
c = significant difference in means between mild negative intensity and high positive intensity

3.2.3 Interaction of valence and intensity on smiling

Statistically significant interaction effects were found for intensity and valence on smile short time percentage, smile long expression count, smile time short expressions count and non-Duchenne smiles (see table 4 and 6). No statistically significant interaction was found between valence and intensity on Duchenne-smiles (see table 5).

In order to specify the direction of the interaction-effects, the significant interaction effects of smile time percentage, smile short expressions count, smile long expression count and non-Duchenne smiles were plotted. The plots can be found in figure 1 to 4.

It was found that a negative valence in combination with a high negative intensity results in a higher smiling percentage than a high negative intensity with a positive valence. In addition, when the intensity is experienced as mildly negative then there is a lower smiling percentage during a negative or positive valence, than when the valence is neutral. When the intensity of a

memory is experienced as mildly positive, there is also a higher smiling percentage in memories with a neutral valence than in both the memories that are considered as positive or negative. Furthermore, when the intensity of a memory is experienced as highly positive then the smiling percentage is the lowest in autobiographical memories with a negative valence and highest in autobiographical memories with a positive valence.

For the interaction between valence and intensity on smile short expressions count it was found that when there is a mild negative intensity, there are more counts of smile short expressions in memories with a neutral valence than in both memories that have a negative or positive valence. In addition, in memories that are mildly positive in intensity it was found that the least smile short expressions are found in memories with a negative valence and the most smile short expressions are found in memories with a positive valence. Furthermore, it was found that when the intensity is considered highly positive, that the least smile short expressions are found in memories with a negative valence and the most smile short expressions are found in memories with a positive valence.

In addition, it was researched what the relation of valence and intensity is with smile long expressions count. It was found that when the intensity is considered mildly negative, that the most smile long expressions are found in stories with a neutral valence. In addition, when the intensity is considered as mildly positive it was found that the least smile long expressions are found in memories with a negative valence and the most in memories that have a positive valence. Furthermore, it was found that when the intensity is considered as highly positive, that there are more long smile expressions count in memories that have a positive valence than in both memories that have a negative or neutral valence.

Ultimately, it was found that when the intensity of a memory is mildly negative, there is more non-Duchenne smiling in memories with a negative or neutral valence than in memories with a positive valence. In addition, it was found that when the intensity of a memory is mildly positive there is more non-Duchenne smiling in memories with a positive valence than in both memories with a negative or neutral valence. Ultimately, in memories with a high positive intensity there is more non-Duchenne smiling in memories with a negative valence than in both memories with a positive or neutral valence.

Figure 1. Plot of the interaction between valence and intensity on smile time percentage.

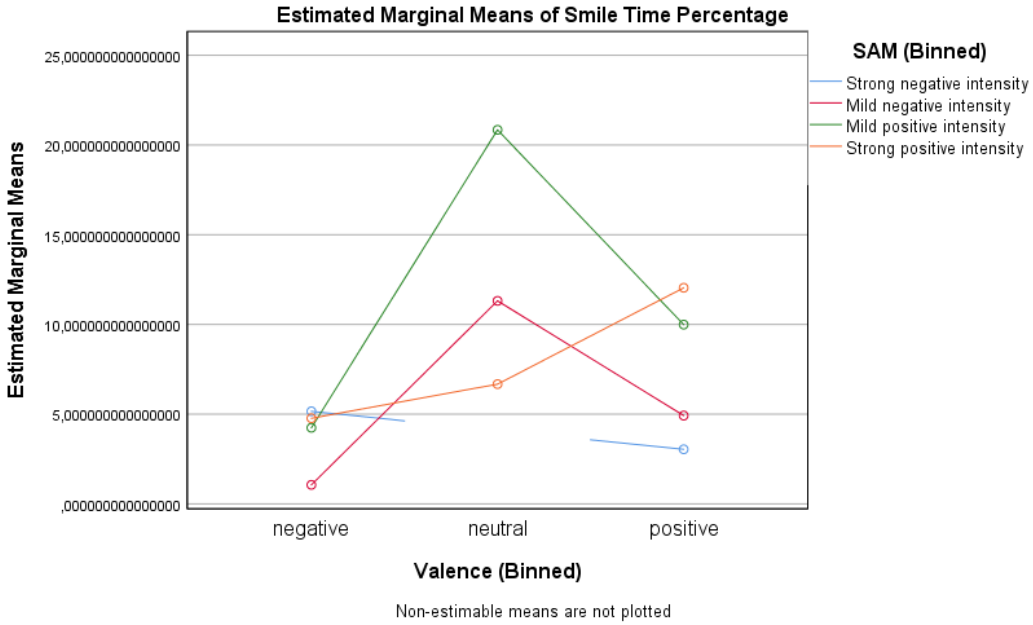


Figure 2. Plot of the interaction between valence and intensity on smile short expressions count.

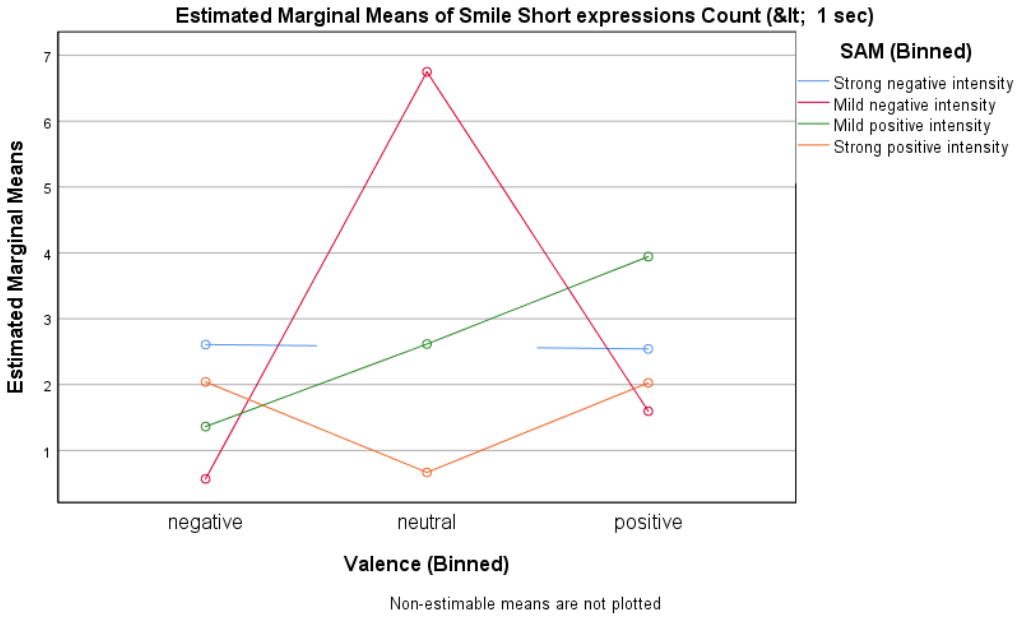


Figure 3. Plot of the interaction between valence and intensity on smile long expression count.

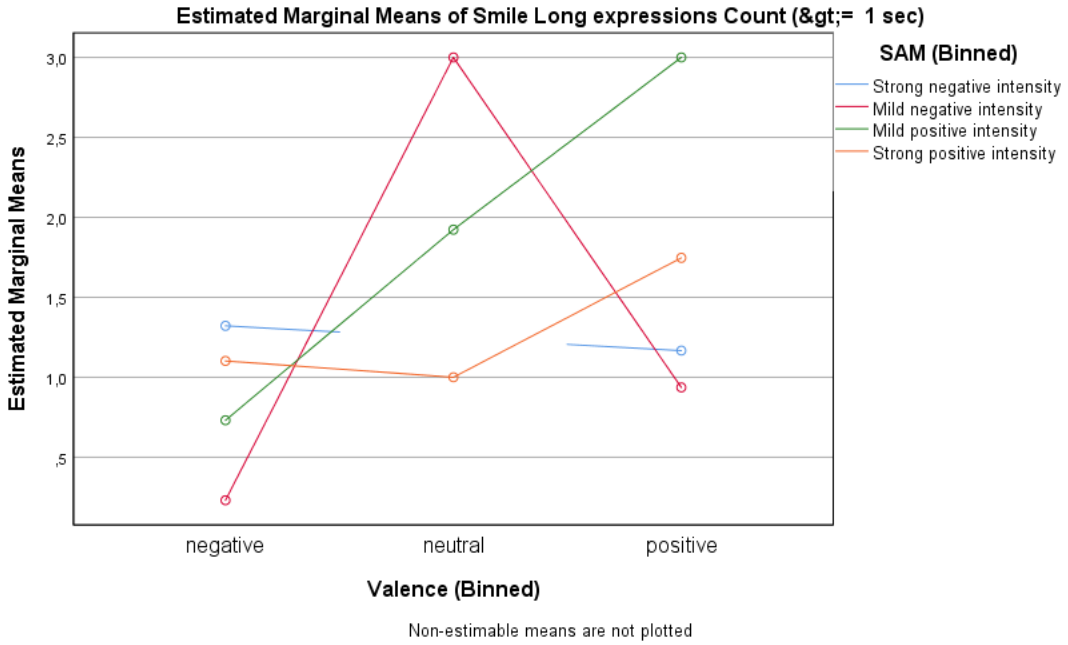
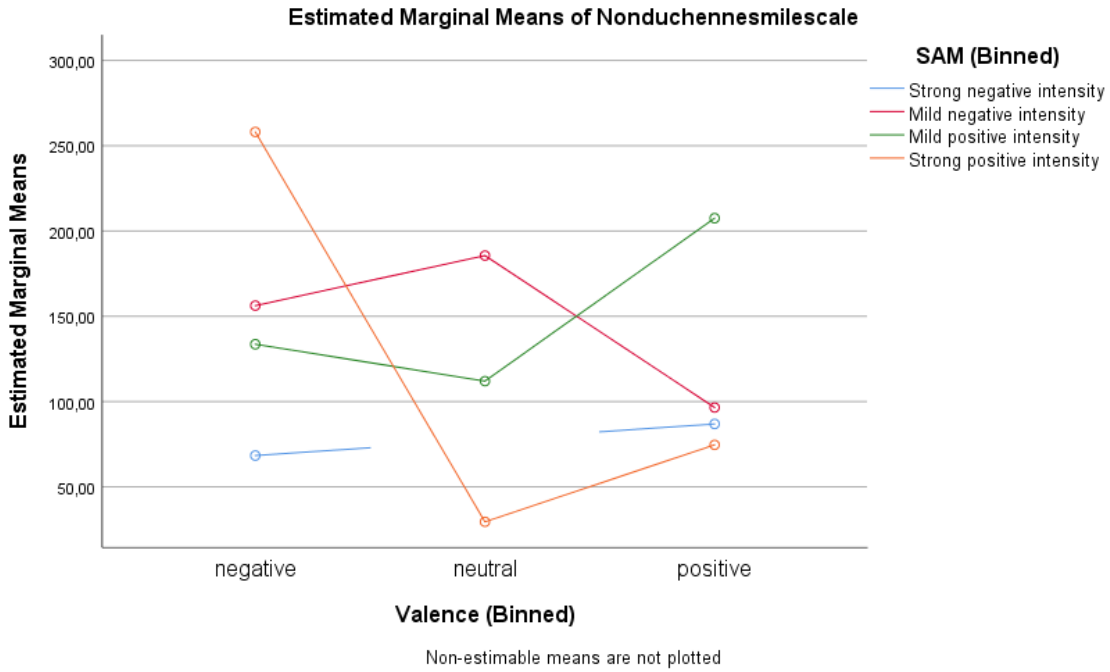


Figure 4. Plot of the interaction between valence and intensity on non-Duchenne smiles.



4. Discussion

The aim of this study was to expand the current knowledge on the link between autobiographical memories and emotion expression regarding the facial expression of smiling of older adults by answering the following question: *Is there a relation between valence, intensity and smiling in older adults when they talk about autobiographical memories?* This was investigated because healthy older adults might be influenced by the positivity-effect which can cause the relation between valence, intensity and smiling to be different for older adults than for younger adults. Investigating the relationship between valence, intensity and smiling for healthy older adults can contribute to the groundwork for smiling recognition in older adults that are diagnosed with a form of dementia in order to understand them better and provide better care.

4.1 Main findings

Multiple studies have found a relation of both valence and intensity with facial activation. For instance, Neumann, Hess, Schulz and Alpers (2005) found evidence that evaluative processing, which is about processing positive or negative information (valence) is directly linked to the motor schemata of facial muscles. In their research they found that processing positive evaluative information immediately triggers the motor schema of smiling (Neumann, et al., 2005). In addition, Dimberg, Thunberg and Grunedal (2002) found that even though participants got instructed to show no facial expression at all, they could not avoid producing a facial expression that corresponded to the negative stimuli (frowning) and positive stimuli (smiling). They state that their results fit the notion that facial reactions are automatically controlled in relation to the valence of the stimuli. Furthermore, Witvliet and Vrana (2007) found that participants smiled the most during positive arousing stimuli (music) and least during negative arousing stimuli (music). Ultimately, Soussignan (2002) found that a higher experienced positive intensity leads to more genuine/Duchenne smiling.

The results of the current study are partly in line with the results of the different studies mentioned above. For instance, it was found that that healthy older adults tend to smile more, have more smile short expressions counts and more smile long expressions counts during memories that have a neutral and positive valence than during memories that have a negative valence. These results show that valence does have a relation with different smiling characteristics. In addition, it was found that healthy older adults tend to smile less during memories with a mild or highly negative intensity than in memories with a mild or highly positive intensity. These results show that the more positive the intensity of the memory is, the

more smiling there is present during recalling the memory (except between mild positive intensity and high positive intensity). Furthermore, the interactions of valence and intensity show that there are more short and long smile expressions count during memories with a positive valence regardless of the intensity level of the memory than during memories with a neutral or negative valence. Ultimately, healthy older adults have a tendency that regardless of the intensity level the most non-Duchenne smiles take place in either the neutral or negative conditions. Since the non-Duchenne smile is considered a disingenuous smile it might be that more non-Duchenne smiles are used in stories that are neutral or negative in valence. This is in line with research of Bonanno et al. (2003), who found that people who disclose information about a sexual abuse experience showed more non-Duchenne smiling as a sort of coping-mechanism.

However, some of the findings in the current study are in contrast with what was found in previous studies (Neuman, et al, 2005.: Dimberg et al., 2002.; Witvliet & Vrana., 2007.; Soussignan, 2002 and Bonanno et al., 2003). For example, in this study it was found that healthy older adults tend to smile less during memories with a positive valence than during memories with a neutral valence regardless of the intensity level. An explanation for this could be the limited amount of cases that are present in the neutral valence condition. Since the amount of cases in the neutral condition are few, the results have to be interpreted carefully. In addition, no significant differences were found between valence, Duchenne smiles and Non-Duchenne smiles. The fact that no significant differences in both non-Duchenne and Duchenne-smiles were found could be due to the fact that people are able to deliberately show a Duchenne-smile. Different studies have found that Duchenne-smiles can be feigned. In 1993 Frank and Ekman (according to Gunnery, & Hall, 2015) reported that up to 20% of the population can consciously contract the orbicularis oculi muscles (cheek raise), however in later research from Levenson et al. (1990) and Ekman and Davidson (1993) it was found that this percentage could go up to 71% of the population (Gunnery, & Hall, 2015). If a high percentage of people are indeed capable of consciously showing a Duchenne-smile, then it could be that valence has no relation with Duchenne and non-Duchenne smiling.

Furthermore, no relation was found between intensity and smile short expressions count, smile long expressions count, Duchenne smiles and non-Duchenne smiles. The fact that intensity does not have a relation with most smiling characteristics fits the findings of Sato, Fujimura, Kochiyama and Suzuki (2013) who did find significant effects between the zygomaticus major (lip stretch) and valence but not between the zygomaticus major and intensity.

Additionally, in the current study just as in the different studies mentioned above (Neuman et al., 2005.; Dimberg et al., 2002., Witvliet & Vrana., 2007, and Soussignan., 2002)

there is a high or sole emphasis on the zygomaticus major (lip stretch) as an indicator of smiling. However, Kappas (2003) found that in a lot of his studies the zygomaticus major is usually greater involved after instances of unpleasant events than pleasant events. In the same study, Kappan (2003) therefore warns about drawing inferences from the activation of the zygomaticus major. If the zygomaticus major might also be involved in other emotions than laughter or smiling then it might be that that is reflected in the results of both the current study as well as the previous studies mentioned above. Ultimately, this study made use of automatic facial expression software to derive the different smiling characteristics. It is not known entirely what made up the different smiling characteristics smile short expressions count, smile long expressions count and smile time percentage. Since these variables are unknown it might me be that other facial muscles are involved that were not involved in previous studies. Another difficulty was that although both the AU's (lip stretch and cheek raise) that make up Duchenne and non-Duchenne smiling could be extracted from Imotions, there was no possibility to ensure that both these AU's were present at the exact same time (as has to be the case for the Duchenne smile). Therefore, the results in light of Duchenne-smiling have to be interpreted cautiously.

Since the findings of this study are complex where some characteristics of smiling do have a relation with valence and intensity and some have not, it is hard to answer the three research questions, namely: Is there a relation between smiling and valence during the recall of autobiographical memories; Is there a relation between smiling and intensity during the recall of autobiographical memories? And; Is there an interaction effect of valence and intensity on smiling? To provide a better answer to these questions, future research regarding the relation of valence and intensity on smiling is needed.

4.2 Strong and weak points

This research focusses on the relation of valence and intensity with the different smiling characteristics. Since the valence for a topic was assigned through an elaborate coding scheme that was based on literature (Tournier, 2019) it was possible to code the valence from an outsider perspective and therefore compute an inter-rater reliability score. In addition, the valence score was based on the topic of the memory. The intensity score however was done through self-assessment. This score was an answer to the question *How did you feel, when you were just talking about this event*', and is therefore in the present. Because of the fact that the intensity score was a self-assessment (after talking about the memory) it could be prone to the positivity effect. The participants in the study could have forgotten about the intensity of their negative affect and therefore rate the intensity of the memories as lower than they might have experienced when they were telling it. This could have resulted in the fact that only few statistically

significant results were found for intensity. On the other hand, a self-assessment score is a handy tool since the intensity is a subjective experience. It is argued that self-assessment produces reliable scores (Mistar, 2011). In this study it was chosen to use the self-assessment as a measure for intensity. This was done, because the self-assessment tells something about subjective experience and comes closest to the construct of intensity. Another option would have been to look at intensity through bodily responses (skin conduction/ heart rate) although this would reflect arousal more than intensity.

In order to be able to execute a multivariate analysis some variables had to be changed from scale to categorical variables. In this process the valence and intensity levels were divided into respectively 3 and 4 categories. The categorizing took place based on the coding scheme of Tournier (2019). However only a limited range of categories and therefore assigned valence values belonged to the neutral valence category. This resulted in only a limited amount of memories that fell into the neutral valence category. This could have caused problems with the statistical power of the neutral valence category. In addition, there is also a skewed distribution of the Duchenne and non-Duchenne smiles. This might have caused problems with the statistical power as well. Furthermore, no statistically significant results have been found for Duchenne-smiling and non-Duchenne smiling, however statistically significant results have been found for smile time percentage and smile expressions count. This seems to show that there are different variables in smiling apart from the Duchenne and non-Duchenne smile. In this research no other types of smiles have been researched. An example of different kind of smiles, is the categorization of smiles in felt smiles (spontaneous expressions of positive emotion), false smiles (deliberate attempts to appear if positive emotions is felt when it is not) and miserable smiles (acknowledgements of feeling miserable but not intending to do much about it) (Ekman, & Friesen, 1982).

Ultimately, in this study it was chosen to use a software program in order to automatically extract the smile characteristics from the different video's Because of the use of the software program there is no researcher bias present in the categorizing or analysing of the facial expressions. However, there are some indications in current literature that software programs are not always better in coding facial expressions than manual coders (Skiendziel, Rösch, and Schultheiss, 2019). In addition, in this study it could not be ensured that both the lip stretch and the cheek raise that make up a Duchenne-smile occurred at exactly the same time in a fragment due to the limitations of the software program. In order to be sure that both cheek raise and lip stretch happen at the same time, manual coding (with for example the FACS coding system) should be used. Furthermore, by using a software program in order to extract different

types of smiles it is not fully clear what makes up the smiles (smile time percentage, smile short expressions count and smile long expressions count). Since there are a lot of different forms of smiling, using an automatic software program is less transparent then using manual coding of smiles. All in all, software programs might benefit research in the way that they have the possibility to exclude researcher bias and are time efficient, but this might be at the cost of accuracy and reliability of recognizing certain facial expressions.

4.3 Recommendations

In the current research some proof has been found for the relation of valence and intensity on smile time percentage, smile short expressions count and smile long expressions count. This shows that there is indeed a relation of the negativity/positivity of a memory and the intensity of a memory on how often and how long people tend to smile. However, in contrast with literature no relation of valence and intensity was found with Duchenne-smiles and non-Duchenne-smiles. Apart from the different smiling characteristics that were looked at in this study, there are different categorisations of smiles in literature. An example is the categorization of smiles in felt smiles (spontaneous expressions of positive emotion), false smiles (deliberate attempts to appear if positive emotions is felt when it is not) and miserable smiles (acknowledgements of feeling miserable but not intending to do much about it) (Ekman, & Friesen, 1982). The action units that accompany felt smiles, false smiles and miserable smiles can be found in Ekman and Friesen (1982). It is recommended to look at different types of smiling that can be found in literature in order to extend the body of smiling recognition in healthy older people. It is advised to code these different smiles based on the FACS coding scheme by Ekman (1982). With the use of FACS not only the activation of the action units, but also the intensity of the movement, the laterality, the location (moment in time) and the timing can be included. Using FACS gives the advantage of having a more reliable measurement of different action units, especially the zygomaticus major (AU 12: lip stretch) that is included in different types of smiling. In addition, it is advised to look at types of smiling that include more than just the zygomaticus major, because there is evidence that this might not always be reliable (Kappas, 2003). The drawback form manually coding the different facial expressions is that it costs a lot of time and that there is a possibility of researcher bias.

Furthermore, in this study a self-report measurement of intensity was used that was related to the intensity of an emotion, because this was on a continuous scale from -1 to 1 there could have been confounding aspects between intensity and valence. However, apart from being an aspect of emotion, intensity can also be an aspect of autobiographical memories themselves.

In autobiographical memory studies it might also be important to look at intensity as a characteristic of the memory itself, in other words the intensity-level of a specific topic or life event that is discussed in the autobiographical memories. It is recommended to construct a more literature-based conceptualisation of intensity in order to be more conclusive in defining the concept of intensity. This might help to improve the construct validity of future studies. This could be done in the same way that the valence scheme was constructed by Tournier (2019), however it is advised to make a coding scheme that only includes a continuous scale that describes whether something is not-intense (for example close to 0) or intense (for example close to 1). It is advised to not include negativity or positivity in this conceptualisation, since this might overlap with the valence measurement.

Ultimately this study only looks at one certain emotion, happiness in the form of smiling, and the way it is related to valence and intensity in healthy older adults. In order to extend the groundwork of facial recognition of emotions in healthy older adults it is recommended to look at different expressions of happiness. Happiness, for instance can also be expressed in language or body posture. Future research could take those expression possibilities into account. This might then lead to a more conclusive way of describing happiness in healthy older adults. Future research could implement those expression possibilities by measuring the bodily arousal/ skin conductance to also measure arousal next to intensity and valence.

Because of the complexity of the results and the fact that this is a first attempt to study smiling expression in healthy older adults, no recommendations for future practice are given. It is recommended to first elaborate on the existing data by using different types of methodologies, such as the FACS coding in order to be able to draw conclusions about different types of smiles in healthy older adults with more certainty.

4.4 Conclusion

The present study was a first attempt to look at the relation of valence and intensity with the different smiling characteristics of healthy older adults. The findings show that valence and intensity partly have the same relation with facial expression and smiling in healthy older adults as for younger adults. However, some of the findings show a complex pattern where it seems that valence and intensity have a different relation with smiling in healthy older adults than they do have for younger adults. This could be due to the presence of the positivity-effect, that explains how elderly people tend to control their experiences of negative affect. However, other factors, such as research method, included types of smiling and reliability of the used software programs might also explain the complexity of the findings. The complexity of the findings

makes it difficult to discern a clear pattern in the way healthy older adults smile. For future research it is therefore advised to take the recommendations and weak and strong points into account to be able to provide a better answer to the question how intensity and valence relate to the way healthy older adults smile. It is important to conduct a follow up research regarding emotion expression in healthy older adults, since this can lay the groundwork for emotion recognition in older adults that are diagnosed with a form of dementia. Recognizing emotions in older adults that are diagnosed with a form of dementia, might lead to better and more personalized healthcare.

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Appendix A – Coding scheme valence (Tournier,2019)

Table 2. *Valence of Emotional Memories scale (VEM). Left: specifics are arranged on the basis of a common factor. Right: life events are sorted from low to high valence score.*

Life event	Specifics	Valence
Death	Child	1.14
	Grandchild	1.14
	Partner	1.17
	Sibling	1.33
	Parent	1.40
	Grandparent	1.60
	Friend	1.76
Neglected by children		1.50
War		1.56
First rejection		1.74
Serious disease		1.92
Divorce	Own	2.00
	Parents	2.08
Career failure		2.00
Infidelity		2.12
Financial troubles		2.21
In an accident		2.30
Operation		2.40
Family quarrels		2.45
Caring for parents		2.75
Psychological problems		3.00
Empty nest		3.83
Prepare for death		4.13
Move		4.13
Other child's milestones		4.20
Puberty		4.68
Military service		4.85
Hobby		4.86
Retirement		4.97
Youth		5.00
Leave home		5.22
Begin school		5.53
High school		5.55
First sexual experience		5.64
College		5.88
Birth	Sibling	5.40
	Child	6.34
	Grandchild	6.66
Achievement	First job	5.48
	Career success	5.94
	Buying a house	6.06
	Driver's license	6.24
	Big achievement	6.28
	The 'right' job	6.37
	Graduation	6.54

Life event	Valence
Child's death	1.14
Grandchild's death	1.14
Partner's death	1.17
Sibling's death	1.33
Parent's death	1.40
Neglected by children	1.50
War	1.56
Grandparent's death	1.60
First rejection	1.74
Friend's death	1.76
Serious disease	1.92
Own divorce	2.00
Career failure	2.00
Parents' divorce	2.08
Infidelity	2.12
Financial troubles	2.21
In an accident	2.30
Operation	2.40
Family quarrels	2.45
Caring for parents	2.75
Psychological problems	3.00
Empty nest	3.83
Prepare for death	4.13
Move	4.13
Other child's milestones	4.20
Puberty	4.68
Military service	4.85
Hobby	4.86
Retirement	4.97
Youth	5.00
Leave home	5.22
Sibling's birth	5.40
First job	5.48
Begin school	5.53
High school	5.55
First sexual experience	5.64
College	5.88
Career success	5.94
Buying a house	6.06
Travelling	6.14
Driver's license	6.24
Big achievement	6.28
Having friends	6.30
Own marriage	6.33
Child's birth	6.34

Travelling	6.14	Falling in love	6.34
Having friends	6.30	The ‘right’ job	6.37

Table 2. *Continued.*

Life event	Specifics	Valence
Marriage	Own	6.33
	Child	6.47
Falling in love		6.34
Child's college graduation		6.66
Family holidays		6.67
Celebrations		6.75

Life event	Valence
Child's marriage	6.47
Graduation	6.54
Child's college graduation	6.66
Grandchild's birth	6.66
Family holidays	6.67
Celebrations	6.75