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A Comparison of Emotional Processes in Patients with Dementia from Alzheimer-Type and Healthy Elderly. A Systematic Literature Review.

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Abstract

Currently, approximately 270.000 people in the Netherlands deal with dementia. The number of persons concerned is increasing and will be approximately 500.000 in the Netherlands in 2040 (Stichting Alzheimer, 2018). 70% of all dementias in the Netherlands are caused by Alzheimer's disease (AD), with high age as the biggest risk factor. The disease is characterized by brain atrophy, leading to the possibility of changes in the emotional system (Kensinger, Brierly, Medford, Growdon and Corkin, 2002). Brain structures of healthy elderly are also affected by changes, which leads to the question whether differences in emotional processing are caused by high age or AD. This thesis compares emotion expression, emotion experience, emotion regulation and the positivity effect in healthy elderly and AD patients by reviewing the existing literature.

Three databeses (Scopus, PsycInfo and PubMed) were searched and eight suitable articles were detected. Selection criteria were mainly the focus on AD patients, the inclusion of a healthy elderly control group (HEC), and specified measurements for either one or more of the chosen processes: emotion expression, emotion experience, emotion regulation, or the positivity effect.

All studies reported on detected subtle changes between the groups, but all in all there are little differences of emotional processes between patients mildly or moderately affected by AD and healthy elderly. Moreover, the positivity effect was detectable in AD patients. Parameters of measurement for all emotional processes were mostly the measurement of facial expression and self-report during emotional manipulation. The manipulation was mainly carried out via film clips and pictures.

The findings support the fact that the brain area affected mostly in AD is the neocortex which regulates cognitive functions. The limbic system, which is more responsible for emotions, is relatively spared in mild to moderate AD. Connections between these brain areas explain subtle changes in AD patients. These results can be used to improve the care for AD patients. Positive emotions can be induced to the patients by a positive mood of caretakers or visitors and remain to up to 30 minutes. In order to reduce medical treatments like antidepressants, additional therapy might be an advantage for patients. This review shows the need for further research in this area. There are not many studies on the emotions of demented people. No study was found that compared the emotions of severe demented patients with healthy elderly.

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1.0 Introduction

1.1 Differentiating Dementia and Alzheimer's Disease

The World Health Organization (WHO, 2012) states that in 2012, there were 35.6 million people diagnosed with dementia worldwide. In 2030 this number is estimated to be about 35.6 million and about 115.4 million by 2050. The term 'dementia' refers to a syndrome for more than 50 different illnesses. The meaning of the word 'dementia' can be translated from Latin and means "madness/insanity". The ICD-10 (DIMDI, 2018) differentiates four different causes of dementia. Alzheimer's disease, vascular dementia, dementia in other diseases classified elsewhere and unspecified dementia. This literature review will focus only on Alzheimer's disease. It is the most common cause for dementia (Förstl, 2011; Heuser, 2013, Payk, 2010). Hartmann (2012) states that the prevalence in western countries for people of 65 years and older is 5-10%. With regard to the growing and aging population, the prevalence for AD will double every 4.3 years. It counts as a primary degenerative dementia with a diffuse atrophy. At molecular level protein deposits (plaques and neurofibrillary) build up between and in nerve cells. The plaques between cells (known as beta-amyloid) block cell-to-cell signaling at the synapses and trigger inflammation. The neurofibrillary in the cells (known as tau protein) disintegrate the transport system so that nutrients and other essential supplies can no longer move through the cells, which eventually perish (Pantel, 2017).

Besides old age, there are a couple of risk factors for AD, which have been researched by Barnes and Yaffe (2011). They sorted the risk factors from strongest to lowest, beginning with low education (no mental stimulation) as the most influential risk factor. This was followed by smoking, physical inactivity, depression and diabetes. Women and men are equally prone to AD. Since women live on average seven years longer than men, about 70% of the AD patients are female.

Förstl, Kurz and Hartmann (2011) give an overview of the different stages of AD. A pre stage is "Mild cognitive impairment" (MCI). Patients notice memory loss, but do not feel impaired in their everyday life. 50 % of the people with MCI develop AD. In mild AD, cognitive impairment has increased and the patients feel overtaxed in their everyday life. They are for example impaired in reasonable judgement, planned action and organizational skills. In addition, speech becomes faltering and less precise. Patients often notice the decrease of brain functions and the chances to develop non-cognitive disorders such as depression increases. Approximately three years later, patients are in the stage of a moderate

dementia. The brain functions have decreased even more and the patients have mostly lost insight into their disorder. They are often in strong need of care and need assistance with for example eating and dressing them. About 20% of the patients have optical and acoustical hallucinations. The emotional control of the patients declines, which can result in verbal and physical aggressions. Aimless wandering, hoarding and sorting are typical activities. About six years after the diagnosis the patients are in the state of severe dementia. All cognitive functions are impaired and also the remote memory is not retrievable anymore. The patient's ability to talk is very impaired, but emotions are still recognized by the patients. Aggressive behavior can still occur when the patient for example feels threatened.

Förstl and Lang (2011) criticize that the International Statistical Classification of Diseases 10th Revision (ICD-10) does not refer to the psychological changes occurring with AD. Especially in the primary stages of AD, patients often show a lack of power and motivation, mood changes and changes in social behavior beside the cognitive impairments. The question arises whether changes in emotionality can be linked to brain regions affected by atrophy.

1.2 Brain Structures and Emotions

Simply put, brain functions can be divided into cognitive functions and emotional functions. The neocortex is responsible for cognitive functions, whereas the limbic system controls emotions (Fuji & Sasaki, 2009). This view of the limbic system, which includes the hypothalamus, cingulate cortex, hippocampi, and other structures, has first been introduced by Broca (1878), Papez (1937), and MacLean (1952). In more recent research it became obvious that on one hand not all limbic structures are related to emotions and on the other hand there are non-limbic structures that are relevant for emotions (Cambria, Livingstone, & Hussain, 2012). Moreover, there is interaction between neocortex and limbic system. Fujii and Sasaki (2009) for example state that projections in the limbic system could drive cognitive decisions in the neocortex. Likewise, social functions can be performed under the control of the neocortex.

Whether AD has an influence on the patient's emotions has to be investigated. But it can already be stated that healthy aging affects emotions. In adults between 60 and 65 years old, a change in the brain can be detected. Gray matter (brain cells) and white matter (connections between brain cells and brain) decrease. The gray matter decreases primarily in the frontal lobe, but the white matter decreases in the whole brain. The connections are essential for thinking, thus the decrease results in decelerated speed of thinking (Geelen & van

Dam, 2016). Two additional changes in the brain also lead to changes in emotion regulation. The reaction of the amygdala is getting less intense at progressed age, resulting in weaker negative emotions. At the same time the activity of the frontal lobe decreases with negative emotions, resulting in a slowed-down amygdala. With progressing age and decreasing activity of the frontal lobe, the amygdala becomes less intense in reacting to negative emotions and attenuation if these still occur (Geelen & van Dam, 2016). The deceleration of the thinking process also entails in less impulsive and less intense reactions. So elderly seem to have more emotional control. A study by Carstensen et al. (2011) confirms that aging is associated with more positive overall well-being, greater emotional stability and more complexity. This effect in aging is called "positivity effect". The positivity effect can be psychologically supported by the socioemotional selectivity theory. This theory states that the limitation of lifetime directs the attention of elderly to emotionally meaningful goals (Carstensen, 1992). Further, it posits that increased attention to emotional goals results in greater complexity of emotional experience and better regulation of emotions experienced in everyday life.

A difference between AD and normal aging concerning emotions is that AD results in atrophy which might affect the old and new brain. Normal aging spares the limbic system, but affects prefrontal regions. Also the volume of the amygdala shrinks with AD, but it shrinks only slightly in normal aging (Kensinger et al., 2002). This gives reason to belief that emotionality is highly affected by AD. The goal of this literature review is therefore to shed light on changes of emotionality in AD patients. Since many AD patients are 60 years old and older, the factors age and AD might both influence their emotion processing. To be certain that deviant emotionality is caused by AD, AD patients will be compared with healthy elderly.

1.3 Defining Emotions

In order to conduct research on emotions, it is important to have a clear definition of the term 'emotion'. Intuitively every person knows what emotions are. But when compared to words such as 'affect', 'feeling', or 'sentiment' this becomes more challenging. Munezero, Montero, Sutinen and Pajunen (2014) differentiated these terms. They describe affect to be the most general of the terms, stating that it is a mechanism of the body to prepare itself in a given circumstance by adding a quantitative dimension of intensity to the quality of an experience. Zajonc (1980) states that affect reveals preferences, meaning that it informs the body about more and less valuable affairs. A change from a less valuable to a more valuable affair results in positive affect; a change from a more valuable to a less valuable state results in negative

affect.

According to Shouse (2005) a feeling consists of a sensation that has been checked against previous experiences and labeled. He differentiated between feelings and affects in infants, asserting that infants do not experience feelings because they lack language and biography. Therefore they can only experience affect. Gordon (1981) argues sentiments are socially constructed patterns of sensations, expressive gestures, and cultural meanings organized around a relationship to a social object, usually another person or group such as a family. A sentiment could for example be loyalty, parental love, patriotism or friendship. There are many theories that try to define emotions, but yet there is no general valid definition. Ekman and Cordaro (2011,) give the following definition: "Emotions are discrete, automatic responses to universally shared, culture-specific and individual-specific events" (p.1).

So all of the explained terms describe what is not characterizing for emotions. This study only focuses on emotions, so this definition might be the most important one. Ekman (1982) stated that there are six basic emotions that can be recognized through facial expression. These are fear, anger, enjoyment, sadness, surprise and disgust. In conclusion Munezero et al. (2014) define affect as a predecessor to feelings and emotions, feelings as a person-centered, conscious phenomenon, and sentiments as a partly social construct of emotions that develop over time and are enduring. Ultimately emotions are defined as preconscious social expressions of feelings and affect influenced by culture.

When it comes to the origin of emotions there are many different perceptions. Increasingly influential approaches are the appraisal theories (Smith & Pope, 1992). They imply that emotions occur because of certain appraisals or estimations that the person has. Emotions are inherently relational or interactional. They can be viewed as responses of the appraised person-environment relationship. There are different patterns of appraisal leading to different emotions. An appraisal is not a random evaluation. It unconsciously concerns the person's situation, object, event and eventually wellbeing.

1.4 Measuring Emotions

This thesis aims to measure the emotions of patients with AD and healthy elderly. Therefore, measureable criteria have to be found. The "Discrete emotions theory" (Izard, 1991; Izard & Malatesta, 1987; Magai & McFadden, 1995) states that there are a few basic emotions. This goes along with findings by Tracy and Robbins (2004). They assume that emotions partly evolved to communicate necessities that facilitate reproduction and survival. As a

consequence every basic emotion should have a unique nonverbal signal that refers to its evolutionary origins. Under this condition, emotions should be measurable through facial expression. Facial expression is therefore the first parameter to research emotional processes in AD patients.

Another important aspect of emotions is emotion experience. The question arises, whether AD patients are able to experience emotions the way healthy elderly do. Before this can be measured, emotion experienced should be defined. Frijda (2005) divided emotion experience into first order and second order experiences. Animals and infants can only experience first order emotions. This means that they can have a feeling, but they cannot be aware of having a feeling. However, when humans grow older they can be aware of the emotions they are experiencing. The latter describes second order emotion experience. When confronted with memory problems, it can be speculated that patients are only able to encounter first order experiences. Thus, emotion experience is a second parameter to measure emotional processes in AD patients.

Looking at existing literature, it can be assumed that emotion regulation is a third emotional process that is unbalanced. Gross (2002) states that when emotions seem to be ill-matched to a situation, people frequently try to regulate their emotional responses. Emotion regulation can occur unconsciously (exaggerating joy upon an unattractive present) or consciously (deciding to change an upsetting topic) (Cole, 1986). According to Parrott (1993) emotion regulation incorporates to increase, maintain, and decrease negative and positive emotions. In order to do this, cognitive capacities are necessary. Since the cognitive capacities are impaired in AD, emotion regulation is a third parameter to measure emotional processes in AD.

Emotion expression, emotion experience, and emotion regulation seem to be three main parts of emotionality. Therefore, this literature review will focus on them. Based on the information given above, it is expected that emotion expression, experience and regulation are impaired in AD patients, but not in healthy elderly. In addition, it will be investigated whether the positivity effect occurs in AD patients. Based on the finding by Kensinger et al. (2002) on the high shrinkage of the amygdala in AD patients, the positivity effect is not expected in AD patients. To structure this review, the following research questions are set up.

To what extend differs emotion processing between AD patients and healthy elderly?

a. Are there differences in emotion expression?
b. Are there differences in emotion experience?
c. Are there differences in emotion regulation?
d. Are AD patients also affected by the positivity effect?

2.0 Method

This research followed the guidelines of the preferred reporting items for systematic reviews and meta-analyses (PRISMA) (Moher, Liberati, Tetzlaff, & Altman, 2009). The electronic databases Scopus, PsycInfo and PubMed were used in the systematic search performed in February 2018.

The search was conducted in three sessions. Detailed information can be seen in table 1. With the first session a global overview on existing literature was gained. It was searched for different parts of emotions combined with the Boolean operator 'OR', as well as 'Alzheimer's disease', combined with the Boolean operator 'AND'. Due to a high amount of articles detected, suitable articles were not easily filtered out.

In a second search, 'age*' and 'aging' were added to receive studies on elderly. The wildcard was used to find every word that contains 'age'. Moreover, the word 'emotion' was broadened by 'affect*', 'mood*' and 'feeling*', all supplied with a wildcard. In addition to that, the verbs were extended to 'react*', 'induc*', 'detec*', 'experien*', 'regulat*' and 'expressi*'. Instead of only 'Alzheimer's disease', the terms 'dementia' and 'Mild cognitive impairment' were added. Again not many telling articles were found.

More articles were detected in a third search, where strings were again changed. New strings were 'emotional reactivity', 'emotion induction', 'emotional experience', 'emotion expression', 'emotion suppression', 'positivity bias', 'positivity affect', 'resilience', 'emotional behavior' and 'emotional complexity'.

Table 1

Search Strings

Session	Database	Boolean/Phrase
1.	Scopus, PubMed, PsycInfo	(TITLE-ABS-KEY *"Alzheimer's disease"* AND TITLE-ABS-KEY (*"emotion expression"* OR *"emotional experience"* OR *"emotion regulation"* OR *"positivity effect"*)
2.	Scopus, PubMed, PsycInfo	(TITLE-ABS-KEY (*"mild cognitive impairment"* OR *dementia* OR "A*lzheimer's disease"*) AND TITLE-ABS-KEY (*"emotion*"* OR *"affect*"* OR *"mood*"* OR *"feeling*"* AND *"emotion react*"* OR *"emotion induc*"* OR *"emotion detec*"* OR *"emotion experien*"* OR*"emotion regulat*"* OR *"emotional expressi*"* AND TITLE-ABS-KEY(*age** OR *aging*))
3.	Scopus, PubMed, PsycInfo	(TITLE-ABS-KEY (*"mild cognitive impairment"* OR *dementia* OR "A*lzheimer's disease"*) AND TITLE-ABS-KEY (*"emotion regulation"* OR *"emotional reactivity"* OR *"emotion induction"* OR *"emotional experience"* OR *"emotion expression"* OR *"emotion suppression"* OR *"positivity bias"* OR *"positivity affect"* OR *resilience* OR*"emotional behavior"* OR *"emotional complexity"*) AND TITLE-ABS-KEY(*age** OR *aging*))

In Scopus the searches were performed in title, abstract and keywords. To enhance the chances of reliable and comparable studies, only articles and conference papers have been included. The date of publication was not an exclusion criterion. The languages were limited to English, Dutch and German. In PubMed the search was limited to 'journal articles' or 'clinical conference'. Also text availability was limited to 'Free full text'. Languages have also been limited to 'German', 'Dutch', or 'English'. Furthermore, 'species' was limited to 'humans'. In PsycInfo the search was limited to 'Academic Journals'. Additionally, the languages were limited to 'English'. There were no German or Dutch articles available.

In order of simplicity, only the last search session is reported in more detail. An overview can be seen in figure 1. The strings delivered 496 articles. As a first step, 119 duplicates were removed. As a second step titles were screened. Exclusion criteria were: No focus on AD, no HEC, only a medical view of the diseases. 57 articles were left. 19 articles that seemed useful that were found in earlier search sessions and reference lists were added. From these 76 articles, the abstracts were screened. Exclusion criteria were: Focus on emotional memory, focus on emotion recognition and not emotion expression, emotion experience, emotion

regulation, and positivity effect, focus on the caretakers/physicians view about the patient's emotions. This resulted in 36 eligible studies. They were screened and articles were excluded, if they were not fully available or used insufficient measurements of the emotion processes, for example only self-report.

At this point, some of the excluded studies are described in more detail. Studies that did not make use of a HEC were for example studies by Lee, Algase and McConnell, (2013) and Asplund, Jansson, and Norberg, (1995). An example for a study focusing on emotional memory is given by El Haj, Raffard, Antoine and Gely-Nargeot (2015). Bär, Kruse and Re (2003) and Magai, Cohen, Gomberg, Malatesta and Culver (1996) provide studies that focus only on the caretakers point of view. The study by Bucks and Radford (2004) focuses on the ability of AD patients to recognize emotions. The studies by Drago et al. (2010) and Smith (1995) are very suitable studies meeting almost no exclusion criterion, but could not be found in any database. The study by Gyurak, Goodkind, Kramer, Miller and Levenson (2012) did not differ AD explicitly as a target group, but included different forms of neurodegenerative disorders. The same applies for the study by Feinstein, Duff and Tranel (2010). Maria and Juan (2017) used the desired study set ups, but researched emotion identification and enhancement.

These studies have been selected out of many others to exemplify the study selection. Finally, it was chosen for studies that apply to none of the exclusion criteria. These studies made use of similar measurements, which is helpful in comparing them. Ultimately, eight studies were selected.

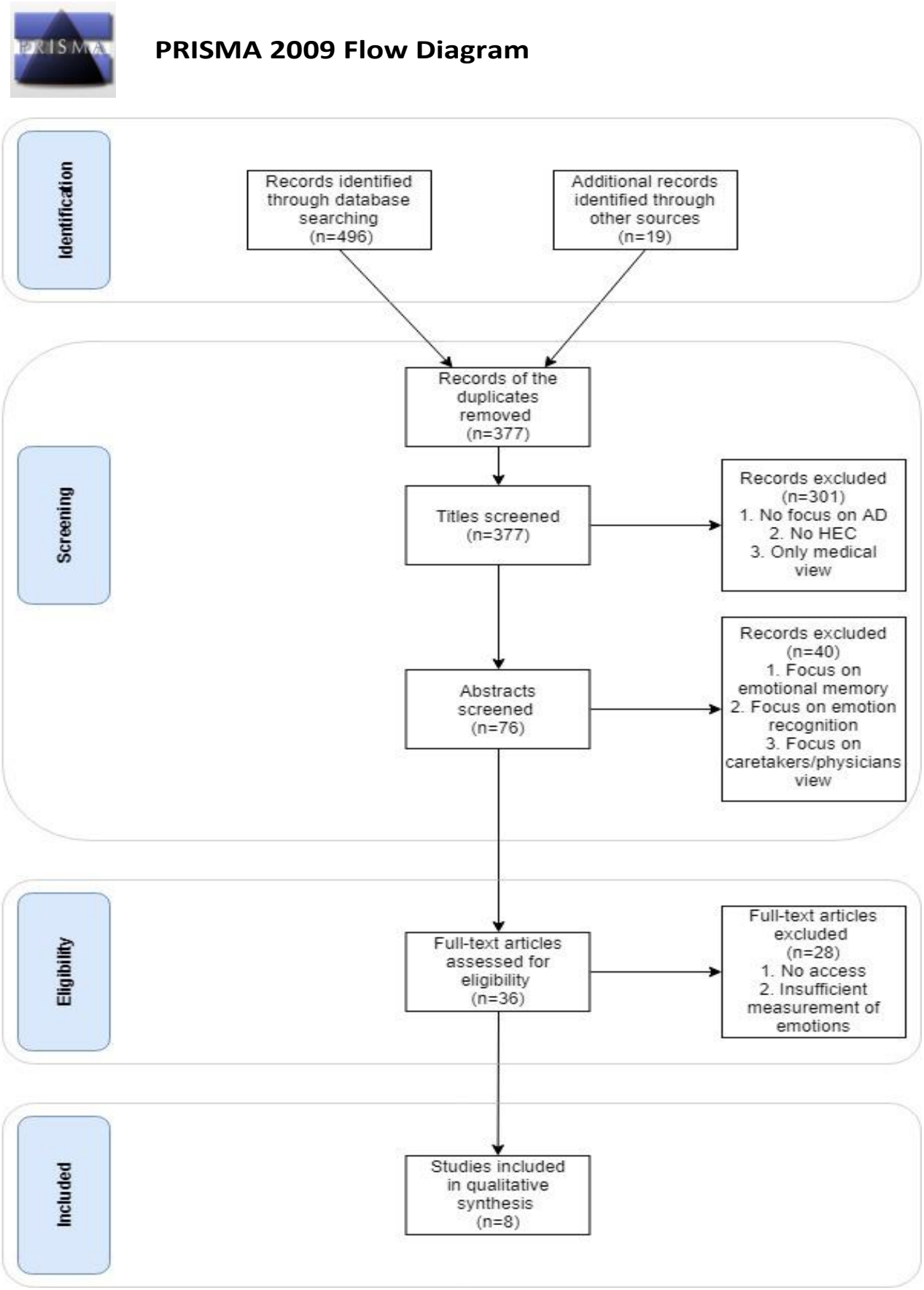

Figure 1. Flowchart Identification of Researches (Moher et al., 2009)

3.0 Results

This section provides an overview of the different study characteristics and outcomes. With regard to emotion expression the articles by Mograbi et al. (2012), Chen et al. (2017), Henry et al. (2009) and Goodkind et al. (2010) are taken into account. Emotion experience is examined with articles by Henry et al. (2009), Guzmán-Vélez et al. (2014), Chen et al. (2017) and Mograbi et al. (2012). Additionally, Henry et al. (2009), Burton and Kazsniak (2006) and Goodkind et al. (2010) provide an overview on emotion regulation. The studies by Hot et al. (2014) and Sava et al. (2017) are taken into account when looking at the positivity effect.

3.1 Participants' and Study Characteristics

Table 2 gives an overview of the study characteristics. The focus lies on patients with AD and the control group consisting of healthy elderly. Combining all eight studies, there are 376 patients in the AD group and the healthy elderly control group (HEC). These are 113 females with AD and 132 elderly females without AD and 86 males with AD and 83 elderly males without AD. Not included in this calculation are other participants. Thus additionally, Chen et al. (2017) included 45 neurodegenerative controls. These are patients that suffer from neurodegenerative diseases that primarily affect motor functioning instead of emotional functioning. Sava et al. (2017) also included 46 healthy younger controls. Moreover, Chen et al. (2017) and Goodkind et al. (2010) included 99 and 32 patients with frontotemporal dementia (FTLD) in their studies

The average sample size of AD patients is 24.75 ranging from 13 to 45. The average sample size of HEC is 26.8, ranging from 17 to 37. The mean age of participants with AD is 75.51 years, ranging from 62.2 years to 80.5 years. The mean age of participants without AD is 75 years, ranging from 67.2 years to 81.8 years. The study from Goodkind et al. (2010) reported that the control group was significantly older than the AD patients. As a consequence, age was included as a covariate in all analyses. The study from Chen et al. (2017) did not report on mean age. Years of education are also analyzed to make sure that they do not influence the outcomes of the experiments. Patients with AD had on average 11.46 years of education, the healthy elderly had on average 11.82 years of education.

In all studies the participant's stage of AD was tested, most commonly by the Mini-Mental State Examination (MMSE). This resulted in mostly mild to moderate dementia. Chen et al. (2017) measured the state of dementia by the Clinical Dementia Rating Scale, but the scores were not interpretable. Sava et al. (2017), Burton and Kazsniak (2006) and Guzmán-

Vélez et al. (2014) also screened for depression. Patients with depression were excluded in all three studies. The average year of publication is 2012, ranging from 2006 to 2017.

Table 2

Study Characteristics

Authors	**Year**	**Country**	**Participants**	**Female/Male**	**Mean age**	**State of Dementia**
Mograbi, Brown, Morris	2012	UK	AD: 23 HEC: 21	AD:14/9 HEC:15/6	AD: 80,4 HEC:78,6	mild to moderate
Guzmán-Vélez, Feinstein, Tranel	2014	US	AD: 17 HEC: 17	AD:11/6 HEC:11/6	AD:72,5 HEC:72,7	very mild to mild
Chen, Lwi, Hua, Haase, Miller, Levenson	2017	US	AD: 45 HEC: 37 FTD: 99 NC: 45	AD:22/23 HEC:22/15	AD:62,2 HEC:67,2 FTD:63,3 NC:67,3	undefinable
Henry, Rendell, Scicluna, Jackson, Phillips	2009	Australia	AD: 20 HEC: 20	AD:14/6 HEC:13/7	AD:80,5 HEC:81,8	moderate
Burton, Kaszniak	2006	US	AD: 13 HEC:21	AD:7/6 HEC:11/10	AD:72,3 HEC:71,5	mild
Goodkind, Gyurak, McCarthy, Miller, Levenson	2010	US	AD: 17 HEC: 25 FTLD: 32	AD:5/12 HEC:12/13	Controls significantly older than FTLD and AD patients	mild to moderate
Sava, Krolak-Salmon, Delphin-Combe, Cloarec, Chainay	2017	France	S1: AD: 17 HEC: 21 HYC: 25 S2: AD: 18 HE: 21 HYC: 21	S1: AD:10/7 HEC:14/7 S2: AD:10/8 HEC:15/6	S1: AD: 78,8 HEC:74,3 HYC:19,8 S2: AD:84,2 HEC:80,8 HYC:22,4	mild
Hot, Ramdeen, Borg, Bollon, Couturier	2014	France	AD: 29 HEC: 32	AD:29/9 HEC:19/13	AD:79,2 HEC:75,7	mild

3.2 Study Set-Ups

All studies manipulated the emotions of the participants for example through video clips or picture presentation. Emotions are then for example measured via self-report questionnaires and facial expression. An overview of the set-ups of the studies can be seen in table 3.

To induce emotions the studies by Guzmán-Vélez et al. (2014), Chen et al. (2017), Henry et al. (2009) and Hot et al. (2014) used film clips. They all chose relatively short clips to enhance the chance that AD patients remember and understand the films. Guzmán-Vélez et al. (2014) and Chen et al. (2017) chose one happy and one sad film whereas Henry et al. (2009) and Hot et al. (2014) chose for an amusing and a neutral film. Additionally they all measured emotions via self-report.

Guzmán-Vélez et al. (2014) measured emotions on four occasions during the experiment. They also exposed participants to a memory test to check on how much they could remember of the films. Chen et al. (2017) analyzed the facial expressions of the participants while watching the clips using the Expressive Emotion Behavior Coding System (EEB). Just like in the study by Guzmán-Vélez et al. (2014), participants had to rate their emotions on several occasions via self-report.

Henry et al. (2009) instructed the participants with three different tasks while watching an amusing film clip. Participants were asked to spontaneously express their emotions, suppress their emotions, and amplify their emotions. Between each task they were presented with a neutral film to establish baseline emotional responding. After each clip participants rated their emotions via self-report.

Hot et al. (2014) researched the process of decision-making in AD patients. They randomly watched a neutral or a happy film clip. A manipulation check was carried out in form of five questions from the Dimensional Ratings Questionnaire. Afterwards, participants performed a computerized version of the Iowa Gambling Task (IGT). Here the participants were stimulated to maximize virtual 2000$ by avoiding bad decks and selecting good decks among four presented on the computer.

Burton and Kaszniak (2006) and Sava et al. (2017) both induced emotions through pictures. Burton used electrophysiological measures to detect corrugator and zygomatic EMG activity. The participant looked at 72 pictures that were positive, negative or neutral and the activity was measured. In addition, participants were required to rate their subjective feelings via a Self-Assessment Manikin.

Sava et al. (2017) researched the positivity effect and measured memory for faces with emotional expressions as well as emotion classification. They used pictures with either a

happy, sad or neutral expression. Participants were asked to do the "delayed matching -to-sample" task. Subsequently, the participants performed the emotion classification task. The authors hypothesized that a face showing a happy emotion would be more arousing for participants than a sad face or neutral face and therefore participants would memorize it better. Thus, a second study using angry faces instead of sad ones was designed with an otherwise identical experimental setting. The experimenters presumed that anger would be as arousing as happiness. This way the positivity effect could have been investigated.

Mograbi et al. (2012) used a unique approach and induced "failure" and "success". The participants completed two tasks on a computer, a reaction time tasked and a memory span task. These were manipulated so that a "failure"- and a "success"-group developed. Participants had to rate themselves on awareness of performance and rate their emotions via self-report. In addition to that, facial expressions were measured based on the Facial Action Coding System (FACS; Ekman & Friesen, 1978).

Goodkind et al. (2010) examined emotion regulation. They presented an acoustic startle stimulus to the participants three times. The first one was presented without a warning. The second time the participants were warned that the acoustic stimulus would appear at the end of a countdown. In the next trial, the participants were warned of the acoustic stimulus and provided with instructions to down-regulate (hide) their emotions. A transducer under the participant's chair measured overall body movement. Face and torso of the participants were recorded and facial emotional behavior was analyzed with use of the Expressive Emotional Behavior Coding System (Gross & Levenson, 1993). Furthermore, participants rated their emotions after each trial via self-report.

Table 3.

Set-Ups and Outcomes

Authors	**Study design**	**Manipulation**	**Measurements**	**Emotions (induced)**	**Outcome**	**Duration**	**Setting**
Mograbi et al. (2012)	Experiment	Two computer-based tasks	Awareness of performance: objective-judgement discrepancy Self-reported emotion: forced-choice measure Facial expression: FACS	"Failure" "Success"	Failure lead to greater emotional facial response in both groups	No information	No information
Guzmán-Vélez et al. (2014)	Experiment	Film material	Subjective experience: four Likert scales at four points during experiment Memory test: Free recall, verbal recognition, picture recognition	Happiness Sadness	States of emotion persisted beyond memory	One session (1,5 hours)	Laboratory
Chen et al. (2017)	Experiment	Film material	Subjective experience: three-point Likert scale Facial expression: EEB	Sadness Happiness	AD patients experienced more positive non-target emotions	No information	Laboratory
Henry et al. (2009)	Experiment	Film material	Theory of Mind: The Mind in the Eyes Test Subjective experience: nine-point Likert scale Facial Expression: Rating form based on the EEB	Amusement Neutral	AD and HEC had difficulties with behavioral amplification. AD patients were able to suppress emotions.	One session (2-3 hours)	No information

Burton and Kaszniak (2006)	Experiment	Pictures	Subjective experience: Self-Assessment Manikin Facial Expression: Electrophysiological measures	Positive Neutral Negative	Zygomatic activity was significantly different between AD and HEC. AD demonstrated invert pattern of activity.	One session (1,5 hours)	Temperature-controlled dimly lit room
Goodkind et al. (2010)	Experiment	Acoustic stimulus	Subjective response: three-point Likert scale Somatic activity: transducer under the chair Facial expression: EEB	Acoustic startle stimulus (Alarm 115 dB)	AD patients showed moderate impairment in down-regulatory ability when warned and instructed	Two sessions (One day)	Laboratory
Sava et al. (2017)	Experiment	Pictures	Emotional memory: Delayed matching-to-sample task Emotion recognition: Emotion classification task	Sad Happy Neutral Angry	AD patients had better memory for faces with positive expressions.	Both experiments were conducted in one session á 30 minutes	Both experiments were conducted in a quiet room
Hot et al. (2014)	Experiment	Iowa Gambling Task	Subjective experience: Five items adapted from the Dimensional Ratings Questionnaire Decision making: Iowa Gambling Task	Happiness Neutral	Happiness increased performance in AD patients and decreased uncertainty.	No information	No information

3.3 Emotion Expression

The first question is whether AD patients and healthy elderly show differences in emotion expression. In some articles emotion expression is also referred to as emotional reactivity. Five out of the eight studies have been selected measuring facial expression (Mograbi et al., 2012, Chen et al., 2017; Henry et al., 2009; Burton and Kazsniak, 2006; Goodking et al, 2010). A broad overview can be seen in table 3.

Mograbi et al. (2012) did not detect a difference between AD and controls regarding emotion expression. In both groups task failure led to the same extend to greater emotional facial response. So, emotional reactivity seems not impaired in early AD patients. The study by Chen et al. (2017) examined mixed target and non-target emotions in neurodegenerative diseases. AD patients did not display more non-target emotions than control groups. The study by Henry et al. (2009) showed that inhibitory mechanisms are likewise relatively preserved in AD patients since they were able to suppress emotions. Additionally, spontaneous expression of emotion was not impaired in AD patients. Yet the patients showed lower positive affect in amplification of emotions. A correlation between ToM and expressivity in the amplification groups has been found. Burton and Kazsniak (2006) detected corrugator activity changed on the same level in both groups when viewing negative images. A notable change occurred between groups in zygomatic activity. Contrary to HEC, AD patients showed less zygomatic activity while viewing positive images. Furthermore, zygomatic activity increases in either of the two groups while viewing negative images. In healthy young adults the zygomatic activity typically does not increase. The last study exploring emotion expression is the study by Goodkind et al. (2010). Their results showed AD patients had less emotional regulation when they were warned and provided with instructions to down-regulate. When the startle stimulus was presented without a warning and without instructions, there was no difference in emotion expression between AD and HEC. The groups also reacted similar when they were warned but not instructed.

In conclusion, emotion expression diverged between the AD and HEC group surprisingly only in a subtle manner. The first difference is that AD patients were impaired in the amplification of emotions. Second, AD patients were impaired in hiding their emotions when they had received a warning of the stimulus and a lot of instructions to hide their emotions. Third, positive images invoked less zygomatic activity in AD patients. Thus, the different studies detected different changes.

3.4 Emotion Experience

Referring to the second research question on whether healthy older adults and patients with AD differ in emotion experience, the articles by Henry et al. (2009), Guzmán-Vélez et al. (2014), Chen et al. (2017) and Mograbi et al. (2012) provide useful insights. A global overview is shown in figure 3.

Henry et al. (2009) detected that subjective emotion experience is relatively preserved in AD. In the study by Mograbi et al. (2012) AD patients also did not report different emotional experience than HEC. Both AD and HEC reported more negative emotions in the failure condition. Guzmán-Vélez et al. (2014) demonstrate that AD patients are impacted emotionally by events they cannot remember. Both AD patients and HEC reported significant increases in sadness and happiness immediately after watching the emotion-inducing film clips. In this regard, no significant difference between groups had thus been found. Patients that did not remember the content of the films or watching films at all still felt sad and happy even 30 minutes after watching the film. Moreover, a somewhat remarkable correlation surfaced: The fewer patients remembered about the sad film, the longer their sadness lasted. The study by Chen et al. (2017) indicated that patients with AD had fewer target emotions and more positive non-target emotions than patients with neurodegenerative diseases affecting primarily motor but not emotional functioning.

In sum, the articles again come to a surprising conclusion. The experience of emotions is not impaired in mild to moderate affected AD patients and healthy elderly. The research goes even further and it can be stated that AD patients experience emotions induced by already forgotten film clips.

3.5 Emotion Regulation

To answer the third question on whether healthy elderly and AD patients differ in emotion regulation between, the articles by Henry et al. (2009), Burton and Kazsniak (2006) and Goodkind et al. (2010) are taken into account (shown in table 3).

As described earlier, the study by Goodkind et al. (2010) shows that both groups, AD and HEC, were unable to hide their emotions when warned and instructed. In this case emotion expression and emotion regulation are connected and might influence each other. On the one hand patients were unable to perform the desired expression, which might be because of impaired emotion regulation. On the other hand, disturbed emotion expression might hide functional emotion regulation. But it can be stated that AD patients were not impaired in spontaneous emotional down-regulation. According to Henry et al. (2009) early AD patients

have difficulties when it comes to amplifying their emotions when looking at positive stimuli and diminishing emotions when looking towards negative stimuli. Burton and Kaszniak (2006) did not discover any significant difference between the AD and HEC groups concerning self-reports on emotion regulation and emotion expression. They suspect therefore emotion regulation might be preserved in early AD.

All in all, emotion regulation differentiates between AD patients and healthy elderly to a very small extent. The only certain difference was detected by Henry et al. (2009). According to the authors, AD patients are impaired in amplifying positive emotions and diminishing negative emotions.

3.6 Positivity Bias

The last question addresses whether AD patients are affected by the positivity bias in the same way as healthy elderly are. The articles by Sava et al. (2017) and Hot et al. (2014) contribute to this question. An overview is given in table 3.

The study by Hot et al. (2014) showed that participants who saw a pleasant film felt happier than those who saw a neutral film. The HEC control group revealed a linear trend in making advantageous choices, whereas the AD control group did not. The neutral 'control' AD patients more frequently chose disadvantageous decks. In contrast, happy AD patients did increase their frequency of good choices (linear trend). Their performance was similar to HEC groups. Also in comparison to AD patients who saw the neutral clip, AD patients who saw the funny clip had a reduced feeling of uncertainty.

Following Sava et al. (2017) the HYC group responded faster than the AD and HEC group in the emotion classification task of both experiments. Furthermore, in both experiments HYC scored higher in correct answers than HEC and AD patients. HYC were more accurate than AD and HEC when classifying neutral and negative faces. All groups were equally accurate in classifying happy faces. In the experiment with sadness, there was no difference between AD patients and HEC. But in the condition using angry faces the HEC scored higher in correct answers than AD patients, indicating that AD patients have more trouble with classifying anger than healthy elderly.

In summary, the reviewed studies show that the positivity effect is also detectable in mild AD patients. Happy AD patients felt more secure and achieved higher scores in the gambling game. Also AD patients classified happy faces on the same level as the HEC, whereas they scored lower when classifying angry, neutral and negative faces.

4.0 Discussion

What conclusions can be drawn from differences in emotion processing between AD patients and healthy elderly? An interesting finding of this literature review is that emotion expression and emotion regulation only differentiate in a subtle manner between AD patients and healthy elderly. Furthermore, emotion experience is likewise relatively preserved. AD patients are even able to experience and be aware of emotions triggered by events that they are unable to recall. Thus, AD patients are able to sense second order emotion experience, as defined by Frijda (2005).The positivity effect was detectable in mild AD patients. Yet, there are a couple of conspicuities when AD patients are compared to healthy elderly. Moreover, unresolved and contradictory conditions are detected. In order to discuss the findings, additional literature is analyzed. These studies did not meet the inclusion criteria and could therefore not be implemented in the search. However, they introduce interesting explanatory approaches.

Since emotion suppression is still working in moderate AD patients, Henry et al. (2009) speculate this was something that people had carried out so long that it became an automatism. An impairment in exaggerating emotions was interpreted with a correlation to decreasing Theory of Mind. This touches on the capacity to understand the other's emotions, motivations and thoughts. The authors state that effective use of amplification may require an intact understanding of how one's behavior will be interpreted by others to a far greater extent than suppression. In 1998, Stone et al. found proof that patients with bilateral damage to the orbito-frontal cortex are unable to perform moderate social reasoning. On the contrary, patients with unilateral damage in the left dorsolateral prefrontal cortex did not show any deficits in this regard.

The findings by Goodkind et al. (2010) were peculiar, because AD patients were able to manage spontaneous emotion regulation, but not instructed emotion regulation. An explanation for this is given by Davis, Gendelman, Tischler and Gendelman (1982). From their perspective the startle response is mediated by the brainstem circuits. Hidgon et al. (2004) state that brainstem circuits are not affected in the early stages of AD. The brainstem counts as part of the old brain and it is also accountable for emotions. Therefore it is not impaired in early AD. When patients are provided with instructions to hide their emotions, the new brain (neocortex) gets involved. This part of the brain is affected by atrophy, so patients are too cognitively impaired to handle and follow all the instructions. Goodkind et al. (2010) also apply their findings to emotion expression. Considering facial expressions, Rinn (1984) states that the primary motor cortex is responsible for voluntary control on facial expressions while subcortical structures are

responsible for spontaneous emotional facial expression. This stands in line with the findings of Goodkind et al. (2010) stating that spontaneous facial expressions are not impaired, whereas voluntary facial expressions are.

The outcomes of the study by Chen et al. (2017) are interesting and will therefore be discussed in more detail. According to their findings based on facial expressions, AD patients do not express more non-target emotions than HEC, but according to self-report they experience fewer target emotions and more positive non-target emotions. The authors consider neurodegeneration in brain regions critical for creating subjective emotional experience. Therefore, those affected might not be able to label their emotional experience correctly and might not have experienced fever target emotions and more positive non-target emotions. Another hypothesis is set up by Burton and Kaszniak (2006). They observed AD patients showing less zygomatic activity while viewing positive images. Their explanation for this is based on the fact that AD patients suffer from atrophy in the frontal cortex and disruption of frontal-subcortical connections (Double et al., 1996). Thus, the areas responsible for positive emotions are compromised in AD. This lends support to the hypothesis that subjective emotional experience is impaired.

A main finding on emotion experience is that the AD patients experience emotions triggered by events that they cannot recall. Here, the patients having the worst memory of the films experienced the most prolonged states of sadness. Authors explain this by pointing to fact that being sad without knowing why is harder to process than doing so knowing a reason. In the beginning of this review it was hypothesized that the emotion experience of AD patients is impaired. This was based on the findings by Kensinger et al. (2002). They declare that AD causes the limbic system and especially the amygdala to shrink, which is not confirmed by this review. The hippocampus, which is also part of the limbic system, is one of the first areas affected by AD. But after that the atrophy affects more neocortical structures. This has been confirmed by Guzmán-Vélez, Warren, Feinstein, Bruss, and Tranel (2016). They carried out MR scans with AD and healthy elderly. As expected, AD patients had significantly smaller hippocampal volume. Amygdala volume did not significantly differ between the groups. Yet, a positive correlation was detected between amygdala volume and sustained happiness. Moreover, a negative correlation was detected between amygdala volume and sustained sadness.

Sava et al. (2017) and Hot el al. (2014), detected the positivity effect in mild AD patients and the ability to improve their feelings and skills. These findings coincide with the study by Werheid, McDonald, Simmons-Stern, Ally and Budson (2011). Here, 18 mild AD patients showed a recognition bias for positive faces.

In sum, the results are not distinct. Some phenomena are contradictory and there are no clear explanations yet.

4.1 Limitations and Strengths

This review has revealed several limitations and strengths of the existing literature on emotional processes and differences between AD patients and healthy elderly. A first limitation is that patients with severe AD have not yet been examined in detail. Studies were detected focusing on severe AD patients, but no comparative study with healthy elderly was found. A reason for that might be that patients in this stage are very impaired and do not have the cognitive capacities to participate in extensive experiments. Burton and Kaszniak (2006) name the possibility that patients at more advanced stages of the disease may process emotions differently. A first research in this direction has been carried out by Magai et al. (1996). In their study, family members reported on the patients' emotions. They included 82 mid-to late stage AD patients in this study. They found that only one emotion is lower and the end stage of the disease than at earlier stages. That is the emotion of joy. Some patients showed an intact and functional emotion system even during the last stage of the disease.

A strength is the measurement used in the chosen articles. According to Barrett (2016) the best way to measure emotions is via perceiver independent tools like facial electromyography, measures of autonomic nervous system activation, or brain imaging. These measures should be correlated, because all signals have a common cause. Self-report brings in a second level of measurement. They are sometimes seen as a fallible way of measuring, because people may not always be conscious of their emotions. As a consequence the selected articles all used at least two sorts of measurement; with exception of Sava et al. (2017) and Hot et al. (2014), they all measured facial expression and subjective experience which guarantees a high level of objectivity and reliability.

In addition it can be seen as a strength that the two groups of participants were very similar to each other, concerning factors like age, education, and gender. A limitation is that some studies did not report on setting and duration. All of the other studies were controlled experiments. This design includes some limitations, e.g. low ecological validity. The findings cannot be transferred one-to-one into a real life setting. Also participants might have been influenced by demand characteristics and experimenter effects. The studies by Goodkind et al. (2010) and Chen et al. (2017) also report on possible habituation effects due to a fixed order. Moreover, the results of the studies by Guzmán-Vélez et al. (2014), Chen et al. (2017) and Burton and Kaszniak, (2006) may be biased. They all induced sadness and happiness. Guzmán-

Vélez et al. (2014) state that happiness cannot be as easily induced as sadness. Therefore, often the sad stimuli are more effective. But all of the eight chosen articles can be seen as promising works in the field of emotions in AD. Only eight suitable studies were mainly referred to here, but this gave the opportunity to scrutinize them.

In addition to limitations and strengths of the existing literature, the most important limitations and strengths of this research are discussed. The search for suitable articles has been carried out stepwise in three sessions. The search strings were broadened with every session. So the search was extensive. But carrying out the search in three different sessions was not the most efficient way. Most of the chosen articles were already found in the first session via search strings and via screening of references. On the one hand, certain search criteria were entered in the data bases that led to a more efficient search, but on the other hand some useful articles might have been missed out. These are for example articles not written in Dutch, German, or English.

During this literature review, the author kept in mind that the expression, experience and regulation of emotions might change in elderly people independently from dementia. Therefore, an inclusion criterion was that the study consisted of an AD group and a HEC group. This excludes many other studies that only focus on the AD group. But a strength is that it is possible to compare the process of healthy aging and AD.

4.2 Conclusion

The findings of this literature review suggest that there are only small differences in emotion experience, expression and regulation between mild to moderate affected AD patients and healthy elderly. Additionally, the positivity effect is still detectable in both groups. In a study carried out by Karger (2016) it is shown that to caregivers, physicians and scientists of AD patients, next to memory loss emotionality is the most important characteristic retained during the disease. A literature review by Zhang, Ho and Fung (2015) confirms the findings of this literature review. They state that amygdala and orbital frontal cortex are spared during the early stage of AD and therefore patients should remain emotional functional. Guzmán-Vélez et al. (2016) point out that, even though hippocampal functions are impaired, the amygdala regulates and sustains emotions independently. Until today, the positivity effect has only been found in mild AD patients, which possibly diminishes right after-wards. The same applies for emotion expression, experience and regulation.

The current review may emphasize the need for more research in this area. Also it may help to raise awareness for adjustments in dementia care. Caretakers may be trained to keep in mind that the patients are able to regulate their emotions very well, as long as they are not

overstrained with other cognitive tasks. Also they are able to express their emotions and to experience emotions. Nowadays, patients are often treated with antidepressants. Ishizuaka et al. (2012) state that this treatment is very expensive and has many negative side-effects. The authors came up with positive emotional stimulation to the limbic system as a working treatment instead of antidepressants. They state that in dementia treatment, too much weight is put on the neocortical area whereas the limbic system is neglected. According to Ishizuaka et al, (2012) "the real value of a human is not the neocortex but the passion or willingness to do something, which belongs to the limbic system" (p.3). This quote corresponds perfectly with the outcomes of this review. The authors recommend for caretakers to express delight and fun while taking care of the patients. This confirms the results of this review. It highlights the importance of emotions that caretakers show and trigger in the patients, since the patients stay in emotional states for up to 30 minutes. As a consequence, a negative attitude of the caretaker has also a lot of influence. A study by Sturm, Yokoyama, Seeley, Kramer, Miller and Rankin (2013) shows that AD patients report greater emotional distress when they are exposed to the negative emotions of other people. So, in addition to motivated caretakers and visitors, special positivity therapy may be a useful addition to dementia care. Here any activity related to positive emotions may be helpful. This could be for example music therapy, animal assisted therapy, or mindfulness exercises. Even in extreme cases of neocortical atrophy, patients often smile or chuckle when their limbic system is positively stimulated (Butler et al., 2012).

Since it was shown that mild AD patients also experience the positivity effect, patients can learn to take advantage of this. It means that they remember emotional information better than neutral information and positive information better than negative. To help them retain important memories, patients could for example invent their own (positive) mnemonics. This may also be trained in therapy sessions. This can be supported by the findings of LaBar and Cabeza (2006). They state that affective influenced information is better memorized than neutral information. The basal forebrain with its cortical and nuclear parts assimilates the preprocessed emotional evaluation. In particular, the medial part of the basal forebrain seems particularly suitable for this because of its extensive bidirectional connections to amygdala and hippocampus.

Future research should fill the gap of knowledge on emotions of severe AD patients. A study by Ready, Carvalho Green, Gavett and Stern (2011) shows that mild AD patients experience more negative emotions than healthy controls and patients with mild cognitive impairment. In this study the most experienced negative emotion was confusion. To observe whether this changes in later stages of the disease might be an interesting topic. To enhance the chances of finding a

suitable study, the search parameters can be broadened. For example books and reviews could have been included as well. It is very likely that all eight studies discussed in this review took place in a laboratory. For future research it would be useful to conduct experiments closer to real-life conditions. As an addition to neuropsychological dementia screenings the Mini-Emotional State Examination for dementia patients (MESE) can be established. It was developed by Butler, Fujii and Sasaki (2012) as an addition to the Mini-Mental State Examination (MMSE). They carried out both of the tests on 40 dementia patients. A rough relationship has been detected between cognitive and emotional functions, but it can be concluded that cognitive and emotional functions are independently affected in dementia. Whether it helps has to be proven, but it might give more insight into the emotions of AD patients.

This literature review can be seen as a clear signal to integrate therapy in AD care. Especially positive psychology might bring surprising improvement in the quality of life of patients and caregivers. It was shown that there are only subtle differences in emotion expression, experience, and regulation between mild to moderate affected AD patients and healthy elderly and the positivity effect is also detectable. The findings can be attributed to the mechanism of neocortex and limbic system. As stated before, AD leads to atrophy of the neocortex, but relatively spares the limbic system (Ishizuaka et al., 2012). Interaction between those regions often occurs, for example to regulate or express emotions. This explains mild impairments. The capacity of preserving emotions should no longer be unused. Besides the outlined limitations of this review, there are many strengths. It only includes eight studies that all researched diverse processes of emotions and AD. But the low number of studies allowed deepened reflections of the outcomes and supported to a high quality of this review. The results feature high potential for further research, especially in the group of severe demented patients.

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