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正常老年人與阿茲海默病及其臨床前期病人對臉部情緒辨認之同年齡效應研究

An Exploration of the Own-Age Effect on Facial Emotion Recognition in Normal Elderly People and Individuals with the Preclinical and Demented Alzheimer’s Disease

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摘要

背景：同年齡效應之探討於近年逐漸獲得重視，然而，因方法學上的限制，過去研究同年齡效應是否存在於臉部情緒辨認能力之結果並不一致。除健康年長者，阿茲海默型失智症之病人具臉孔情緒辨認能力之受損，然尚未有研究探討同年齡效應是否存在於病人之臉孔情緒辨識能力。故本研究先解決過去文獻於方法學上之限制，再探討同年齡效應是否存在於健康年長者及阿茲海默型失智症病人。**方法：**本研究共納入 138 位受試者。實驗一納入 27 位健康老年受試者及 31 位健康年輕受試者；於實驗二納入 27 位健康老年受試者及 80 位記憶抱怨受試者(分為主觀認知衰退組、記憶型輕度認知障礙組及阿茲海默型失智症組)。每位受試者接受臉孔情緒辨認作業以測得其臉部情緒辨認能力。**結果：**實驗一，除年輕人組在看年輕臉孔之中性表情，在健康老年人組、健康年輕人組未呈現顯著之同年齡效應。除生氣之情緒辨認，本研究未發現顯著組間差異。不同年紀之臉孔依不同情緒具不同影響結果：在難過、悲傷之情緒辨認上，年輕人臉孔比老年人臉孔好辨認，而在快樂的情緒辨認上相反。實驗二，僅記憶型輕度認知障礙組、阿茲海默型失智症組於難過情緒辨認時呈同年齡效應之傾向，並易將年輕人的難過情緒誤認為生氣、將老年人的難過情緒誤認為中性。**結論：**僅在記憶型輕度認知障礙組、阿茲海默型失智症組發現同年齡效應之傾向，反映因病程進展而導致臉部情緒辨認能力之受損。本研究之低強度情緒—難過之臉部情緒辨認作業，可視為偵測早期阿茲海默症之指標。

關鍵字：同年齡效應、臉部情緒辨認、主觀記憶衰退、記憶型輕度認知障礙、阿茲海默型失智症、臉部情緒辨認作業

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Abstract

Background: The own-age effect, which may affect the accuracy of facial emotion recognition (FER), has been investigated over the last decade. However, due to methodologic limitations and differences, the results were inconsistent. Patients with Alzheimer's disease (AD) have been reported to show deficits in FER even in early phases. Nevertheless, no study has examined the own-age effect in AD patients. The present study, minimizing prior methodologic drawbacks, thus was to examine this issue in normal adults, and patients with subjective cognitive decline (SCD), amnestic mild cognitive impairment (aMCI) and very mild AD. **Methods:** The total of 138 participants was recruited in the present study. In experiment 1, 27 healthy older adults and 31 healthy young adults were recruited. In experiment 2, 27 healthy control (HC) and 80 patients with memory complaints, among 3 groups, SCD, MCI, and AD, were recruited. The facial emotion recognition function of all participants was evaluated through our Facial Emotion Recognition Task (FER Task) with Taiwanese facial emotion stimuli. **Results:** In experiment 1, the own-age effect was not observed

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in the older adults, but was found in younger adults when decoding neutral photos. No group difference in performing the FER Task was found, except for anger. The photo age effect of the FER on distinct emotions was significant. Younger faces are more accurate than older faces to decode difficult emotions in both younger and older adults. In experiment 2, a tendency of the own-age effect occurred in MCI and AD groups, who showed significant deficits when decoding sadness, and tended to mislabel sadness as anger in younger-face photos, neutral in older-face photos.

Conclusions: A tendency of the own-age effect occurred only in MCI and AD groups, but not in normal individuals and SCD groups can reflect the FER deficits in the progression of AD. The results displayed that our FER Task, especially for those items of low-intensity emotion (i.e., sadness), can be a sensitive index for early detection of early dementia.

Keywords: own-age effect, facial emotion recognition, subjective memory decline, amnestic mild cognitive impairment, Alzheimer’s disease, Facial Emotion Recognition Task

Contents

1. Introduction

Facial emotion recognition (FER), one of the essential components of social cognition (Adolphs, 2001), represents the ability to recognize facial emotional expressions. It enables individuals to sense their social environment and modify their behavior accordingly (McCade, Savage, Guastella, Lewis, & Naismith, 2013); it also contributes to more efficient social interactions (Sze, Goodkind, Gyurak, & Levenson, 2012). Thus, this ability is undoubtedly crucial for social behavior (Hargrave, Maddock, & Stone, 2002); furthermore, engaging in satisfying social interactions and avoiding social isolation are important to our health and well-being throughout life (Cacioppo, Berntson, Bechara, Tranel, & Hawkley, 2011). Consequently, deficits in this ability may contribute to difficulties in social communication, damage self-esteem, and even diminish the quality of life (Ciarrochi, Chan, & Caputi, 2000).

FER has drawn considerable attention in clinical and functional imaging studies recently. Studies have demonstrated that dissociable neural substrates are associated with the facial recognition of basic emotions (Hennenlotter & Schroeder, 2006; Schroeder et al., 2004). The occipital and posterior temporal cortices are responsible for the perceptual analysis of facial expressive features (Haxby, Hoffman, & Gobbini, 2000; 2002), and the extraction of emotional meaning from faces is linked to the orbitofrontal, ventral prefrontal cortex-related, and somatosensory regions (Adolphs,

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2002). However, these emotional circuits, including the hippocampus, amygdala, and frontal regions, were reported to show age-related neurological changes (Greenwood, 2000). In addition, certain types of neurodegenerative diseases, such as frontotemporal dementia (FTD) and Alzheimer’s disease (AD), can also damage these brain regions (Keane, Calder, Hodges, & Young, 2002; Pietschnig et al., 2016). Thus, deficits in decoding specific emotions have been reported in normal aging as well as in patients with neurodegenerative diseases (Keane et al., 2002; Torres et al., 2015). To help families realize the patients’ difficulties and improve their life quality, choosing an appropriate clinical assessment for early detection of deficits in FER is undoubtedly crucial.

Furthermore, studies have indicated that several characteristics of emotional stimuli could affect the accuracy and memory of FER, including cultural, gender-, and age-based factors (Bäckman, 1991; Hess, Blairy, & Kleck, 1997; Malpass & Kravitz, 1969; Wells, Gillespie, & Rotshtein, 2016). Indeed, the own-race bias refers to the tendency of recognizing and memorizing one’s own race or ethnicity relatively more accurately than another race or ethnicity (Malpass, & Kravitz, 1969). Gender has also been reported to have different effects depending on the type of expressions (Wells et al., 2016); for example, female faces are reported to be easier to recognize with regard to expressions of happiness (Hess et al., 1997), while male faces are better recognized

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in expressions of disgust, sadness (Hess et al., 1997), and anger (Becker, Kenrick, Neuberg, Blackwell, & Smith, 2007). To our knowledge, very few studies have examined the effects of photo age on FER. This is why studies conducted so far in the domain of age group differences in processing emotional expressions have mostly used younger faces (some included middle-aged faces) but did not systematically vary the age of the presented faces. However, the study by Lamont, Stewart-Williams, and Podd (2005) using neutral faces as stimuli found that observers of different ages recognize faces of their own age more accurately and rapidly as opposed to those of other ages (referred to as the own-age bias; Bäckman, 1991). Such findings suggest that the age of a face constitutes an important factor that influences how we attend to, encode, and remember faces. Evidence of the own-age bias challenges any interpretation of observed age group differences in FER, as older observers may have been at a disadvantage relative to younger observers when the stimuli consisted only of faces of young individuals.

The own-age effect (in most studies called own-age bias or own-age advantage, while we used the term “own-age effect” because we did not want to emphasize it as good or bad) is explained by two main theories: experience (or expertise) accounts (Rhodes & Anastasi, 2012) and social-cognitive accounts (Sporer, 2001). The former means that more experience and contact with own-age groups increases the

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individual’s familiarity with the expressive style of own-age faces, and thus, decoding of own-age faces is more efficient (Rhodes & Anastasi, 2012). The latter means that there is a greater motivation to process and attend to the characteristics of own-age faces (Sporer, 2001); thus, individuals who identify with an ethnic or social group will exert more effort when decoding the emotional expressions of the own-group (Thibault, Bourgeois, & Hess, 2006). The own-age effect was initially proposed in facial recognition memory studies, indicated that facial recognition memory is superior for own-age relative to other-age faces (Bäckman, 1991; Lamont et al., 2005; Wright & Stroud, 2002). Further studies have also observed the own-age phenomenon in tasks that involve recognizing facial emotional expressions across different fields. For example, participants tended to look longer at own-age faces, and this was thought to predict more accurate FER in own-age faces (Ebner, He, & Johnson, 2011). Functional magnetic resonance imaging studies also reported different activities for own-age and other-age faces regarding neutral and happy expressions (Ebner et al., 2013). In addition, studies that used electroencephalography reported partly own-age and own-race effects on the event-related potentials for neutral expressions (Melinder, Gredebäck, Westerlund, & Nelson, 2010). Based on these empirical evidence and theories, it may be assumed that own-age photos can enhance the accuracy of FER for observers. That is, the own-age effect might appear in FER.

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Indeed, this hypothesis has been proposed and investigated in several studies over the last decade, and some have confirmed this effect in older observers. For example, Riediger, Voelkle, Ebner, and Lindenberger (2011) used posed expression with multi-dimensional response format and found that middle-aged and older observers performed well in their target ratings of happiness and anger by the age of the own-age photos than did young observers. Another study by Riediger, Studtmann, Westphal, Rauers, & Weber (2014) which only used spontaneous and posed smile as the test material also supported that older participants could better identify older rather than younger faces.

However, contrary to the results of the above studies, most research that was carried out by modifying the age of the photographed or videoed individuals indicated that there was no own-age effect or that it was observed only for younger observers. For example, Borod et al. (2004) presented younger, middle-aged, and older female observers as stimuli, and the results showed that the expressions of older posers were rated significantly less accurately than those of younger posers for all groups. Further studies by Ebner and Johnson (2009), Murphy, Lehrfeld, and Isaacowitz (2010), and Hühnel, Fölster, Werheid, and Hess (2014) also reported similar patterns. In addition, Malatesta, Izard, Culver, and Nicolich (1987) found that this effect exists only in younger observers. Older observers were better at rating older faces than they were at

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rating younger faces, while the difference was not significant. A study by Richter, Dietzel, and Kunzmann (2010) also supported this finding in younger observers.

Nevertheless, the results of these studies were inconsistent, and it should be noted that some methodologic limitations existed in all these studies. First, the gender of the stimuli and observers in some studies was exclusively female (Borod et al., 2004; Hühnel et al., 2014; Murphy et al., 2010), even though it is known that gender can influence the accuracy of the results based on the type of emotion (Wells et al., 2016). Second, the numbers of photos and observers in some studies were too small (Borod et al., 2004; Ebner & Johnson, 2009; Hühnel et al., 2014). Third, the target emotions in these studies were inconsistent; besides, some examined the own-age effect by averaging the accuracy of emotions (Malatesta et al., 1987). These factors not only make it difficult to conclude the type of emotion which was reported consistently enough to show the own-age effect, but also make it hard to analyze the different effects of distinct emotions based on the finding that different types of expressed emotions have different effects on accuracy (Wells et al., 2016). Therefore, it is necessary to assess enough types of emotions and to examine their effects separately rather than as averages. In conclusion, gender imbalance, small stimuli and observer sample sizes, selecting incomparable types of emotions, and ignoring the effect of different emotions were existing methodologic problems in prior studies, and

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these might have resulted in inconsistent results. The present study sought to address these methodological limitations of earlier investigations.

Apart from the problems we have mentioned above, other methodologic differences existed might also cause inconsistent results, namely, the types of emotional expressions presented (dynamic or static and posed or spontaneous), measured approaches of response (the forced-choice approach and the multi-dimensional response format), and the stimuli database. First, dynamic spontaneous stimuli were reported to show more ecological validity; thus, they could increase accuracy (Bartlett et al., 2006; Murphy et al., 2010), while the results of examining the own-age effect were still inconsistent after controlling it (Murphy et al., 2010; Riediger, 2014) due to other methodologic problems. Besides, the dynamic spontaneous stimuli established so far did not include enough stimuli, and most were female faces only (Murphy et al., 2010; Richter et al., 2010). Thus, there are no appropriate stimuli that can be selected yet, even if we do not consider including the East Asian faces. Second, the multi-dimensional response format, the way that participants rate the percentage across all emotions within a photograph. And the responses were considered as accurate if the percentage of the target emotion was higher than the percentage on the remaining scales (Gunes & Pantic, 2010). It was developed based on the theory that emotional experiences are often multi-faceted

(Hemenover & Schimmack, 2007), and so it was thought to be more appropriate (Kreibig, Samson, & Gross, 2013). However, some studies that used the forced-choice approach still confirmed the own-age effect successfully; thus, it seems that different types of rating formats did not play an important role in the inconsistency of the results. In addition, Hühnel et al. (2014) indicated that the hit rates in their study were relatively low because of using the multi-dimensional response format. Although the multi-dimensional response format was reported to show more ecological validity, the forced-choice approach might be more appropriate for developing our task to a clinical measurement. Finally, most studies used the static posed expressions of the FACES database (Ebner, Riediger, & Lindenberger, 2010) as materials, while the remaining studies used stimuli (including photos and videos) developed by their respective laboratories (Borod et al., 2004; Hühnel et al., 2014; Malatesta et al., 1987; Richter et al., 2010; Riediger, 2014); thus, the stimuli in those studies are heterogeneous in nature. To control the influence of race on FER (Young & Hugenberg, 2012), we chose the stimuli from Taiwanese individuals (Tu, Lin, Suzuki, & Goh, 2018) and included a large number of static posed photos. In conclusion, we determined to use the forced-choice rating as our response measurement, emotion stimuli from Taiwanese individuals with static posed photos as stimuli.

Apart from the changes in the brain in normal aging, abnormal cerebral atrophy

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and neuropathological changes occur in patients with AD, resulting in damage to the circuits related to emotions (McLellan, Johnston, Dalrymple-Alford, & Porter, 2008; Spoletini et al., 2008). Thus, AD has been reported to result in deficits in FER, with gradually increasing impairment, especially in specific emotions, as the disease progresses (Pietschnig et al., 2016), and changes may be evident even in the early phases (Virtanen et al., 2017). In addition, the onset of AD mostly begins at an age of over 65 years. If the own-age effect exists in AD or the preclinical and prodromal of AD patients, the clinical utility of the assessment protocol which uses younger faces only would decline and underestimate the ability of older patients. Therefore, in addition to healthy older adults, it is important to examine whether the own-age effect exists in those with AD, and moreover, in the preclinical and prodromal AD patients. However, no study has investigated whether the own-age effect exists in FER in the preclinical and prodromal of AD, and AD patients. Therefore, most studies that examined the FER performances in AD and the preclinical or prodromal AD patients used stimuli either without varied age of photos or did not provide exact information about the age and number.

As the preclinical and prodromal stages of AD respectively, subjective cognitive decline (SCD) and mild cognitive impairment (MCI) have recently received attention. The literature on the related neuropathological locations remains heterogeneous in

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individuals with SCD. However, the recent study found that people with SCD had higher amounts of neurotic amyloid plaques evident in the medial temporal lobes and neocortex regions (Studart Neto & Nitrini, 2016). Accordingly, it might be possible that the underlying neuropathologic changes have partially influenced the FER performances in individuals with SCD. However, only one study has investigated FER performance between adults with SCD and healthy adults, and the results showed no difference (Pietschnig et al., 2016). The study used the Vienna Emotion Recognition Tasks (36 pictures, including 6 individuals with anger, disgust, fear, happiness, sadness, and neutral facial expressions) (Derntl, Kryspin-Exner, Fernbach, Moser, & Habel, 2008; Gur et al., 2002) with an equal number of photos of both genders as stimuli but younger faces only.

Several studies have indicated emotion-specific deficits in patients with MCI; different stimuli were used in these studies. For example, Fujie et al. (2008) found that patients with MCI showed deficits in decoding sadness and anger, while Spoletini et al. (2008) indicated an impairment only in decoding low-intensity stimuli, especially in fearful faces. The former study used the Facial Expressions of Emotion: Stimuli and Tests (FEEST) (60 pictures, including 6 females and 4 males for six basic and neutral emotions) (Young et al., 2002) as stimuli. The latter used the Penn Emotion Recognition Test (ER40) (40 pictures, including 4 female faces and 4 male

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facial expressions of happiness, sadness, anger, fear, and neutral) (Gur et al., 2002) as stimuli. Both the FEEST and the ER40 have mentioned that their photos were controlled for the photo age, while no further information was presented. Moreover, Weiss et al. (2008) also used ER40 as stimuli and indicated that patients with single domain (sd)-MCI did not have significantly altered emotion recognition abilities, and only multiple domains (md)-MCI patients showed impairments in recognizing sad, fearful, and neutral faces. This observation of deficits only in md-MCI and not sd-MCI was also supported by Teng, Lu, and Cummings (2007) and Varjassyová et al. (2013), but the results of these studies did not examine distinct types of emotion; therefore, we do not know which types of emotions showed deficits. The stimuli used by Teng et al. (2007) was the Florida Affect Battery (FAB; 20 pictures, including 4 females of happy, sad, anger, fear, neutral) (Bowers, Blonder, & Heilman, 1998), and the stimuli used by Varjassyová et al. (2013) were only 4 faces (gender was not mentioned) for six basic and neutral emotions from FEEST; both studies did not mention the age in their photos.

From the above data, we find that these studies did not put much emphasis on the effect of photo age. As it cannot be said that the effect of photo ages was controlled in these studies, we can assume that the inconsistent results might be partly due to not considering the own-age effect. Besides, as we have mentioned that no research has investigated whether the own-age effect in FER exists in patients with SCD, aMCI, and very mild AD. Therefore, it is necessary to examine whether the own-age effect exists in these patients before investigating their performances.

The first aim of our study was to control the prior methodologic differences and limitations and then to investigate whether the own-age effect in FER exists in healthy elderly adults when considering the different effects of distinct emotions. The second aim extended to patients with SCD, aMCI, and very mild AD; we first questioned whether the own-age effect in FER exists in patients and then investigated their performances in FER in case of different types of emotions. Finally, we used the emotion stimuli from Taiwanese (Tu et al., 2018) individuals. As it is the first face emotion database from the Taiwanese population, we collected participants to rate the intensities and accuracies of these photos, and explored the clinical utility of this test for further study to develop a FER assessment.

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2. Methods

2.1. Participants

A total of 138 participants (20 to 85 years old) were recruited for the present study. In experiment 1, 27 older participants, ranging from 55 to 85 years old, were enlisted through notices advertising our study in their communities, and 31 younger participants with a range from 20 to 35 years old, who were either college students or working individuals, were recruited through notices advertising the study on the internet. In experiment 2, 27 older participants in experiment 1 were also used as control subjects, and 80 patients, ranging from 55 to 85 years old, with memory complaints were invited from the Neurology Clinic of the National Taiwan University Hospital.

Patients were interviewed, screened at the clinic, and diagnosed by neurologists and a clinical neuropsychologist. Individuals who performed normally in the clinical neuropsychological assessment with a reported subjective decline in memory within five years (Jessen et al., 2014) were classified into the SCD group. Individuals whose performances on the episodic-memory task was 1.5 standard deviation (SD) or more below the normative data with normal performance on other neuropsychological assessments were classified into the MCI group (Albert et al., 2011). Individuals who met the established criteria of the National Institute on Aging and Alzheimer's

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Association and had a clinical dementia rating (CDR) of 0.5 points were divided into the very mild dementia due to AD group. Twenty-seven community-dwelling volunteers without memory complaints were recruited into the healthy control (HC) group. Thirty-one younger volunteers were recruited into the younger group. Exclusion criteria included a current or past history of alcohol or substance abuse, intellectual disability, brain injury, stroke, endocrine dysfunction, neurological disorders, or psychiatric disorders. All participants had normal or corrected vision and hearing abilities. Patients with cardiovascular disease and its risk factors were excluded if their cardiovascular disease status exceeded 4 points on the Hachinski Ischemic Score (HIS) (Hachinski et al., 1975).

2.2. Measurements

FER Task. To assess the FER ability, we designed the FER Task. The stimuli were taken from the database of the East Asian face expression stimuli (Tu et al., 2018). The database consisted of 628 photos, including seven basic face emotion expression categories (happiness, sadness, anger, surprise, fear, disgust, and neutral). Forty-eight young (age range: 18–51 years; 23/25 males/females) and 42 older (age range: 58–86 years; 21/21 males/females) adults were included in this database. However, among these, 29 young individuals (15 males, 14 females) from Cheng,

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Chen, Chan, Su, and Tseng’s (2013) database were actors; besides, the background and brightness of their photos were different from those of the Tu et al. (2018) database. Thus, we excluded these photos and others that were incomplete or inappropriate. Finally, 406 photos (58 individuals with seven expressions each) were selected as the emotion stimuli in our pilot study. All selected individuals are Taiwanese and lived around Taipei; none of them are actors. They were instructed to move their facial muscles to produce prototypical expressions based on the Facial Action Coding System (Ekman and Friesen, 1978; Ekman, Friesen, & Hager, 2002). All photographs were colored, front-view head shots on white backgrounds.

Our Task used the multiple forced-choice rating, and the 5-point Likert scale to measure the accuracy and the intensity of each photo (ranging from 1: very slightly or not at all to 5: extremely), respectively. The response options appeared in black on a white background below the faces and were always presented in the same order. For reducing the practice effect, the presentation order of emotional faces was identical for each participant; besides, the lists were pseudo-randomized with the constraint that no more than two faces of the same face presenter or the same facial expression were repeated in a row. Stimulus presentation and response collection (accuracy and intensity) were controlled using E-Prime (Schneider, Eschman, & Zuccolotto, 2002) and were displayed on a 14-inch notebook.

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During the FER Task, participants saw one face at a time. They were asked to indicate the emotion of the face as soon as possible by pressing one of the response buttons on a button box. The photos and the response options (emotional category) were always presented for reducing the need of memory. After participants choose the emotion of the photo, they were asked to rate the intensity of the selected emotion presented in the photo. The instruction was, taking a happy expression for example, “how intense does this image look in terms of happiness?”).

A pilot test was designed to establish the applicability of the tools. An additional 20 younger adults and 20 healthy older adults were recruited to rate the accuracy and the intensity of the 406 emotional faces. The procedure and design were the same as in the normal experiment. After the pilot test, we found that disgust was highly mislabeled as anger thus showed lower accuracy. This pattern was similar to the previous results by Widen, Russell, and Brooks (2004); besides, they indicated that the categories of anger and disgust are overlapping, and the prototypical ‘disgust’ face may tend to be seen as a subtype of anger. As stated above, disgust was removed from our emotion category. In addition, we found that fear was highly mislabeled as surprise. However, fear has been reported to be the most difficult emotion to decode (Derntl et al., 2008; Wells et al., 2016). It is worthy for us to retain fear rather than surprise in our final emotion categories to examine the performances in both healthy individuals and in patients. Therefore, we removed surprise from category. Moreover, the photos from 21 individuals were also screened out because the accuracy of these photos was lower than 50% of the overall score. One hundred and fifty-five pictures, in which there are 9 old female and male, 6 young female, and 7 young male photos for each of the 5 emotion types and neutral, were finally selected as stimulating materials for the FER Task. The age of older pictures ranges from 55-80 years old; the age of younger pictures ranges from 20-30 years old.

Neuropsychological assessment. All the younger, HC, SCD, MCI, and AD participants underwent a neuropsychological assessment conducted by a neuropsychologist or a project coordinator. Mini mental status examination (MMSE) and screening for cognitive impairments were performed initially. To rule out the possibility that the intellectual ability might interfere with participants' FER ability, participants' intellectual quotient (IQ) performances on the Wechsler Adult Intelligence Scale-Third Edition (WAIS-III) or WAIS-IV were collected through the record of their recent neuropsychological examination. The Logical Memory Subtests I and II of the Wechsler Memory Scale-III (WMS-III) (Hua et al., 2005; Petersen & Morris, 2005) were performed to obtain the scores for episodic memory. For those who did not have previous record, full-scale IQ estimated by performances on the Similarities, the Arithmetic, the Matrix Reasoning, and the Digit Symbol Substitution

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subtests from the WAIS-III (Chen, Hua, Zhu, & Chen, 2008) and the Logical Memory Subtests I and II of the WMS-III were conducted by the project coordinator. To control for perceptually based face processing deficits, the Short Form Benton Facial Recognition Test (BFRT; Benton et al., 1994) was administrated. All older participants underwent the Taiwan Geriatric Depression Scale (TGDS) (Liao et al., 2004) test for emotional status evaluation. For patients with SCD, MCI, and AD, a neuropsychologist also interviewed their informant to complete the CDR.

2.3. Procedure

All participants were explained the purpose of the research and signed an informed consent form, which was approved by the institutional review board of the National Taiwan University Hospital. Detailed demographic data are shown in **Table 1**. Information regarding participants' age, education, medical history, current health status, and medication regimen was obtained through a semi-structured interview. For older participants, the TGDS and the HIS were presented to screen mood and cardiovascular disease status. BFRT was administrated to screen the ability of perceptually based faces, then the FER Task was presented. Following, the MMSE or/and neuropsychological assessment were administered to participants as the cognitive function screening instrument. At the end of the session, participants were debriefed about their general performances.

2.4. Statistical Analysis

All statistical tests were performed using the Statistical Package for Social Sciences (SPSS version 22.0). Demographics and clinical characteristics were compared using a one-way/two-way analysis of variance (ANOVA) or chi-square tests. As the results of ANOVA revealed significant between groups, Scheffe’s pairwise-comparison analysis was used for post-hoc pairwise-comparison analysis. To test whether the own-age effect existed in older adults in distinct emotions (experiment 1), and whether the effect exists in SCD, MCI, and AD patients in different emotions (experiment 2), two mixed-effects analysis of covariance (ANCOVAs) with three factors were utilized. To control any demographic and/or neuropsychological performance variables found to be significantly associated with individual emotion recognition measures, the factor of education was controlled in experiment 1, and age, education, and IQ were controlled in experiment 2. Dunn-Bonferroni pairwise comparisons were set for the post-hoc analysis following ANCOVAs, and the level of significance was fixed at < .05.

Effect sizes were analyzed with partial eta squared (η_p^2) reflecting the proportion of the total variance attributable to the effect. The value ranging from 0.01 to 0.06

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indicates a small effect size, 0.06 to 0.14 medium, and above .14 large. Moreover, to identify different performances to discriminate individuals who showed deficit in FER from the healthy elderly, we used the receiver operator characteristic (ROC) curve analysis with the Youden index (Youden, 1950) to determine the cutoff values. The point on the ROC curve closest to point (0, 1) was chosen to discriminate impaired from normal FER performances.

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3. Results

3.1. Experiment 1:

3.1.1. Demographics and Clinical Characteristics

Table 1 presents group comparisons of demographics and clinical characteristics in experiment 1. A significant difference was observed with regard to education and age, which indicated that the education levels of younger groups were higher than those of the older groups (F(1, 56) = 18.61, $p < .001$, $\eta_p^2 = .249$). No statistically significant differences were found in gender ratio or IQ scores between groups.

3.1.2. Does the own-age effect of FER exist in normal aging?

To examine whether the own-age effect affects the accuracy of FER in different emotions, we conducted a mixed-effects ANCOVA with three factors: group age (between-subjects), photo age (within-subjects), and stimulus emotion (within-subjects). To control the possible effects of education, we included education as a covariate. The dependent variable was the proportion of correct classifications for each stimulus emotion in different photo ages (i.e., younger and older faces). The results are shown in **Table 2**.

No main effect of group age, photo age, and emotion was revealed. However, the results showed a significant two-way interaction of photo age × emotion (F(4, 220) =

5.086, p = .001, η_p^2= .85) and a significant three-way interaction of photo age × emotion × observer age (F(4, 220) = 2.532, p = .041, η_p^2 = .044). Thus, the effect of photo ages in FER appear to depend not only on different emotions but also on different age of observers.

To examine the three-way interaction in more detail, we further performed a simple interaction analysis, and the results revealed a significant simple interaction effect of photo age × emotion for both younger and older observers. We further conducted a simple simple main effect analysis. In decoding happiness, sad, and fear, there is a significant simple simple main effect of photo age for both younger and older observers. The younger faces were more accurate than the older faces for both groups to decode in fear and sadness expressions, while the older faces were more accurate than the younger faces for both groups in decoding happiness. In decoding anger, no significant simple simple main effect of photo age was observed for both younger and older observers. However, we found that the older observers generally seemed to perform better than the younger observers. We assumed that observer-age did not show the effect was due to analyzing in terms of total accuracy; thus, the effect of anger might be eliminated by other emotions. To confirm this suggestion, we conducted separate ANCOVAs for each emotion with education as a covariate. As we expected, the results in **Table 3** showed that a significant main effect of observer age appeared in decoding anger only (F(1, 55) = 5.604, *p* = .021, η_p^2 = .092).

In summary, the results showed no own-age effect in older and younger observers in distinct emotions. No group difference appeared while the older observers perform significantly better than the younger observers in decoding anger. Moreover, different photo ages showed different effects in different emotions—younger faces were significantly more accurate than older faces for both younger and older observers in decoding fear and sad expressions—however, the reverse condition happened in decoding happiness. The degree of discrimination in five emotions were presented in **Table 3**—for the older observers, from easy to hard was happiness, anger, neutral, fear, and sadness; for younger observers the order was happiness, neutral, anger, fear, and sadness.

3.2. Experiment 2:

3.2.1. Demographics and Clinical Characteristics

Table 4 presents group comparisons of demographics and clinical characteristics. The results showed main effects of age (F(3, 103) = 12.83, *p* < .001), education (F(3, 103) = 3.19, *p* = .027), IQ (F(3, 103) = 4.64, *p* = .004), and MMSE score (F(3, 103) = 10.41, *p* < .001) across four groups. Post hoc pairwise-comparison analyses using Scheffe’s method indicated that the age of the HC group was younger than that of the

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MCI and AD groups, and the age of SCD group was younger than that of AD group. The education level in MCI group was significantly lower than that in the SCD. Individuals in the HC and SCD groups showed higher IQ scores than did individuals in AD group, whereas MCI group did not differ significantly from other groups. HC, SCD, and MCI groups had higher scores on the MMSE than AD groups. No differences in terms of other demographics, clinical characteristics, or neuropsychological performance were found between HC and SCD groups.

3.2.2. Is the own-age effect evident in the patients while performing the FER?

To investigate whether the own-age effect exists in SCD, MCI, and AD groups, and to evaluate the FER abilities in these groups, a mixed-effects ANCOVA with three factors: group (between-subjects), photo age (within-subjects), and stimulus emotion (within-subjects), was conducted. To control the possible effects of age, education, and IQ, we included these factors as covariates. The dependent variable was the proportion of correct classifications for each stimulus emotion in different photo ages (i.e., younger and older faces). The results are shown in **Table 5**.

The results revealed a significant main effect of group ($F(3, 100) = 7.34$, $p < .001$, $\eta_p^2 = .180$) and significant two-way interactions of photo age × group ($F(3, 100) = 3.04$, $p = .033$, $\eta_p^2 = .083$) and emotion × group ($F(12, 400) = 2.12$, $p = .015$, η_p^2

= .060). A post hoc comparison using Scheffe's method revealed that both HC and SCD groups did significantly better than MCI and AD groups, while there was no difference between HC and SCD as well as MCI and AD groups (see **Figure 1**). For the interaction of photo age and group, further tests of simple main effect of photo age showed that SCD group performed significantly better in decoding younger face than in older face (F(1, 100) = 6.89, $p = .001$, $\eta_p^2 = .065$). For the interaction of emotion and group, further tests of simple main effect of group in decoding sadness indicated that HC and SCD groups performed significantly better than MCI and AD groups (F(3, 403) = 20.86, $p < .001$, $\eta_p^2 = .134$) in sadness expressions (see **Figure 2**), suggesting that the accuracy difference between groups was mainly from the discrepancy in decoding this category of expressions.

As the scores of sadness between groups could discriminate MCI and AD groups from HC and SCD groups, it means that sadness recognition presents a remarkable opportunity to discriminate patients who showed deficits in FER. Although the photo ages did not show the main effect or interaction with the group in ANCOVA, we still checked whether the own-age effect exists in sadness across groups to account for the possibility that the own-age effect in sadness might be diminished by averaging total emotion. We conducted a mixed-effects ANCOVA in sadness with two factors: photo age (within-subjects) and group age (between-subjects). No significant interaction

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between photo age and group (F(3, 100) = 1.261, p = .292) was found. However, the results showed a trend that HC and SCD groups performed more accurately in decoding younger faces compared to older faces (this trend also appeared for older and younger observers in experiment 1), while MCI and AD groups performed more accurately in decoding older faces than younger faces (see **Figure 3**). That is, it seemed to show that the own-age trend existed in MCI and AD, but not HC and SCD. To further explore which emotions tended to be mislabeled as from sadness by MCI and AD groups, two-way mixed ANOVAs were conducted in these two groups. Post-hoc analysis using the Bonferroni method found that the scores of judging sadness to sadness were not significantly different from the scores of judging sadness to anger and sadness to neutral. This means that MCI and AD groups tend to mislabel sadness to either anger or neutral. To further examine whether there were differences between mislabeling sadness as anger and as neutral under different photo ages between the four groups, we conducted separate one-way ANCOVAs between the four groups. The dependent variable was the proportion of wrong classifications from sad to anger and neutral in younger and older faces, respectively. The results showed a significant difference (F(3, 100) = 4.692, p = .004, η_p^2 = .123) in mislabeling sadness as anger in younger faces and a significant difference (F(3, 100) = 3.141, p = .029, η_p^2 = .086) in mislabeling sadness as neutral in older faces across four groups. Post-hoc

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analysis using the Bonferroni method confirmed that MCI and AD groups got higher mislabeling scores compared to HC and SCD groups.

3.2.3. Clinical Utilities

From the above results, we thought sadness recognition presents a remarkable opportunity to discriminate patients who showed deficits in FER. Thus, we conducted the ROC curve analysis in sadness scores between SCD and MCI. The results indicated that the sadness accuracies in younger and older faces were different between SCD and MCI groups (area under the curve [AUC] of younger faces = 80%; AUC of old faces = 77%). According to the Youden index (Youden, 1950), the data showed that using a cutoff score of 0.35 for the accuracy in younger faces and a cutoff score of 0.36 for the accuracy in older faces yielded the most desirable combination of sensitivity (91%) and specificity (39%) in younger faces and sensitivity (81%) and specificity (39%) in older faces respectively for identifying significant differences between the SCD and MCI groups on the FER.

4. Discussion

The present study examined whether the own-age effect exists in healthy adults, and patients with SCD, aMCI, and very mild AD when performing the FER Task. Our discussion could be divided into two parts: the issue in healthy adults and patients, respectively.

4.1. Does the own-age effect of FER exist in healthy adults?

The own-age effect means that individuals showed better performances in recognizing the own-aged emotional expressions. Methodologically, studies on this issue need to involve in presenting different ages of photos to different ages of groups. Some studies included the young-aged, middle-aged, and old-aged faces and observers, others included the young-aged and the old-aged faces and observers. In other words, the own-age effect consists of two age-related factors, the cohort-effect and the photo-age effect.

Considering the cohort-effect, the present study did not find the group-age effect in terms of average accuracy of emotion recognition. Besides, having analyzed different emotion stimuli, we also did not find the group difference in decoding happiness, sadness, and fear. However, the old observers performed better than younger observers in decoding anger. Our results were inconsistent with those findings of previous studies that performances of older adults were inferior to those of

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their younger counterparts in decoding sadness, fear, and anger (Calder et al., 2003; Ruffman, Henry, Livingstone, & Phillips 2008; Isaacowitz and Stanley, 2011). The study discrepancy might be due to higher educational level in our healthy older participants. Although the effects of higher education on preventing MCI and AD remain equivocal, favorable study findings indicated that people with higher education not only performed cognitive tests better than those with lower-educated ones, but also delayed the onset of cognitive impairment (Lenehan, Summers, Saunders, Summers, & Vickers, 2015). Besides, Pietschnig et al. (2016) also reported that higher-educated individuals did have better performance on the emotion recognition task. Accordingly, it appears that higher education facilitates protective effects not only on the decline of cognitive function (Matyas et al., 2017), but also of emotional recognition.

In respect to the issue of the photo-age effect, the present study found a significant interaction effect between the photo ages and the emotion types. The younger-face was significantly easier than the older-face recognition for both younger and older observers in decoding fear and sad expressions; however, the reverse was observed in decoding happiness. For fear and sadness recognitions, our results were consistent with those findings of previous studies indicating that healthy adults decoding younger faces were more accurate than older faces (Ebner et al., 2010,

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2011). Such an outcome, as suggested by researchers (Albert, Ricanek, & Patterson, 2007; Porcheron, Mauger, & Russell, 2013) may be attributed to age-related changes of older faces (e.g., wrinkles and folds) that were more dissimulated, mixed, and fragmental than their younger counterparts' ones. However, for the happiness stimuli, our results were inconsistent with those findings of prior studies (Ebner & Johnson, 2009; Ebner et al., 2010, 2011, 2012; Richter et al., 2010; Riediger et al., 2011; Hühnel et al., 2014). The discrepancy might be due to two methodologic limitations in the present study: 1. our posed photo stimuli were less spontaneous in nature; 2. the intensities of our happy photos in younger faces were relatively low (the intensity was measured by the 5-point Likert scale, for more details see Methods). The posed photos were reported to be less ecological validity than the spontaneous photos (Bartlett et al., 2006; Murphy et al., 2010). Additionally, our results revealed that the intensities of our younger faces were significantly lower than those of the older faces in happiness (see **Table 6**). That is, the younger performers in our photos tended to present low-intense happy expressions than the older performers. Thus, in the younger faces, both of our younger and older observers tended to misrecognize happy expressions to neutral expression.

Taken together, the present study did not find the own-age effect on emotional-expression recognition in older observers. Likewise, it was also the case for

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younger observers, with the exception in decoding neutral photos. Given the present results consistent with most studies (Borod et al., 2004; Ebner and Johnson, 2009; Murphy et al., 2010; Hühnel et al., 2014), the own-age effect on the facial emotional recognition appeared not remarkable, irrespective of younger or older healthy people. However, the present results were inconsistent with other prior studies displaying the own-age effect evident in older adults when performing happiness and anger recognitions (Riediger et al., 2011; 2014), and in younger adults (Malatesta et al., 1987; Richter et al., 2010) performing the happiness, anger, and sadness ones. Three methodologic factors might attribute the inconsistent results. One factor was the unrepresentative sample in those studies (Malatesta et al., 1987; Richter et al., 2010). The other factor was limited stimuli (Riediger et al., 2014). The last possible contributor was the discrepancy of the emotional rating format. The forced-choice approach in our study has generally been used in most studies; however, the multi-dimensional response format (measuring the percentage across all emotions for every individual photo, for more details, see Introduction) was used to measure each of the photos stimuli in Riediger and coworkers (2011). In fact, the type of emotional experiences in real life is always multi-faceted (Hemenover & Schimmack, 2007); thus, this response format was more ecologically valid in nature. Nevertheless, whether this methodologic discrepancy can fully attribute to the inconsistent results

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remains further investigation.

4.2. Is the own-age effect evident in the patients while performing the FER?

The present study examined the FER performances in SCD, aMCI and very mild AD patients after minimizing the methodologic problems. The present study found that the MCI and AD groups showed FER deficits as compared to the HC and SCD groups in decoding sadness (see **Figure1**, **Figure 2**). Furthermore, the patients tended to mislabel sadness for anger and for neutral expression when perceiving younger and old faces respectively. Our results supported the previous findings indicating that FER deficits occurred in MCI and early-stage AD patients (McCade, Savage, & Naismith, 2011; Varjassyová et al., 2013; Torres et al., 2015), but not in SCD patients compared to healthy older adults (Pietschnig et al., 2016).

Davidson, Putnam, and Larson (2000) proposed that a neural network responsible for emotion involving the orbital prefrontal cortex, ventromedial prefrontal cortex, dorsolateral prefrontal cortex, amygdala, hippocampus, hypothalamus, anterior cingulate cortex (ACC), insular cortex, and ventral striatum. Based on the locationist hypothesis, each of the distinct emotions has its own underlying neural substrate (Barrett, 2006). In fact, a recent study found that the ACC plays an essential role in processing sadness-related information (Lindquist, Wager,

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Kober, Bliss-Moreau & Barrett, 2012). Accordingly, it appears feasible to speculate such sad recognition problems possibly due to the ACC dysfunction which might indirectly result from pathological changes of the hippocampal cortices and related regions commonly evident in early AD and aMCI (Hyman, Van Hoesen, Damasio & Barnes, 1984). Nevertheless, given that a small group of the patients (particularly early AD) was sampled in the present study, and the mechanism for the results of defective recognition of sadness remains unclear, further investigation on a large scale is necessary.

Regarding the issue of the own-age effect, the present study found that aMCI and very mild AD patients tended to have the own-age effect on the FER compared with the healthy compartments (see **Figure 3**). However, the effect was not significant, and the accuracy of FER in decoding the own-aged photos remained low.

In short, the present study found that aMCI and very mild AD patients showed defective FER in sadness with a tendency to mislabel it to anger and neutral in younger and older faces, respectively. Accordingly, it appears that a measure with low-intensity of FER (i.e., sadness) can be sensitive to detect patients with very mild AD and aMCI. Our results also revealed that a tendency of the own-age effect occurred in patients.

To our knowledge, our study is the first one to investigate several issues,

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including whether the own-age effect on FER exists in patients with aMCI and very mild AD, and is also one or two studies examining FER functioning in individuals with SCD. However, there were some limitations in the present study: 1. The educational level of all participants in this study was relatively high, especially in SCD group. 2. The measuring format (i.e., the forced-choice approach) and the type of photos (posed and static photos) were less ecological validity. 3. The aMCI participants were not classified into single or multiple domains. 4. Given the doctrine of "ZhongYong" responding style to the odd-level rating scale in most Taiwanese/Chinese people (吳毓瑩，1996; 黃金蘭、林以正、楊中芳，2012; 廖培珊，2010; Chen, Lee, & Stevenson, 1995), our participants might have a biased rather than a true rating on the 5-point Likert scale for the intensity of each emotional photo stimulus. 5. The confounding effect due to incomparable intensity of facial-emotion stimuli between younger- and older- individual photos in the present study might influence the results though currently adequate matching means remains unavailable. Further studies on these issues are thus requisite.

In summary, the present finding indicated that younger faces are easier than older faces to decode fear and sadness for both younger and older adults. Although the own-age effect was not evident in healthy adults, the tendency of such an effect appeared in patients with aMCI and very mild AD when decoding sadness. The present study elucidated the potential pathophysiological mechanism underlying the relationships between AD and the sad recognition problems. Nevertheless, due to small sampling in our study and still lacking neuroimaging evidence, future research with a larger sample size and regarding the neuroimaging confirmation is needed. Besides, even though different ages of photos did not affect the FER, using older faces as a clinical stimuli might increase the medical relationship and the mental caring of patients. Nevertheless, the hit rates of certain expressions in our stimuli database were low. Further research using the multi-dimensional response format and the dynamic and spontaneous photos might eliminate the problem.

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(Each reference in this part was translated to English from the original Chinese language listed right below).

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6. Tables

Table 1

Demographic Characteristics and Cognitive Status of Younger and Older Observers in Experiment 1

Group	Younger observers	Older observers	
Variable	*N* = 31	*N* = 27	
	Mean (*SD*)	Mean (*SD*)	Statistical comparison
Gender (% female)	55% (17/31)	74% (20/27)	$\chi^2_{df=1, N=58} = 2.31$, $p = .128$
Age (years)	26.1 (4.7)	62.5 (8.6)	F (1, 56) = 411.46, $p < .001$, $\eta_p^2 = .880$
Education (years)	16.4 (0.8)	13.4 (3.7)	F (1, 56) = 18.61, $p < .001$, $\eta_p^2 = .249$
IQ	118.16 (8.13)	116.59 (13.80)	F (1, 56) = .287, $p = .595$

Note. Values are expressed as mean and standard deviation or mean/maximum score and standard deviation with the exception of those denote percentage and number of individuals for gender. IQ = intelligence quotient.

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Table 2

Results of ANCOVA on Decoding Accuracy as a Function of Emotion, Photo Age, Group Age and Their Interactions in Experiment 1

`	Factors	*df*	*F*	*p*	η_p^2
Accuracy (overall)	Photo age	1, 55	.134	.716	
	Photo age * group age	1, 55	.566	.455	
	Emotion	4, 220	1.297	.272	
	Emotion * group age	4, 220	1.722	.146	
	Photo age * emotion	4, 220	5.086	.001	.085
	Photo age * emotion * group age	4, 220	2.532	.041	.044
	Group age	1, 55	1.176	.283	

Table 3

One-way ANCOVAs for Each Emotion Between Older and Younger Observers in Experiment 1

Accuracy	Older observers Mean (*SD*)	Younger observers Mean (*SD*)	Statistical comparison
Happy	0.91 (0.12)	0.93 (0.09)	F (1, 55) = .276, *p* = .602
Anger	0.81 (0.17)	0.74 (0.13)	F (1, 55) = 5.604, *p* = .021, η_p^2 = .092
Fear	0.61 (0.13)	0.65 (0.18)	F (1, 55) = .760, *p* = .387
Sad	0.54 (0.18)	0.47 (0.18)	F (1, 55) = 1.843, *p* = .180
Neutral	0.75 (0.16)	0.75 (0.24)	F (1, 55) = .019, *p* = .891
Total emotion	0.71 (0.08)	0.72 (0.08)	F (1, 55) = 1.448, *p* = .234

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Table 4

Demographic Characteristics and Cognitive Status of SCD, MCI, AD, and Normal Control Groups in Experiment 2

Group	HC	SCD	MCI	AD	
Variable	*N* = 27	*N* = 31	*N* = 31	*N* = 18	
	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	Statistical comparison
Gender (% female)	74% (20/27)	68% (21/31)	55% (17/31)	44% (8/18)	$\chi^2_{df=3,N=107} = 5.11, p = .164$
Age (years)	62.5 (8.6) [ab]	67.4 (6.9) [c]	70.0 (6.9) [a]	75.4 (4.8) [bc]	$F(3, 103) = 12.83, p < .001, \eta_p^2 = .272$
Education (years)	13.4 (3.7)	14.5 (2.5) [d]	12.2 (3.5) [d]	14.2 (2.6)	$F(3, 103) = 3.184, p = .027, \eta_p^2 = .085$
IQ	116.59 (13.80) [e]	117.26 (9.77) [f]	111.19 (10.57)	106.67 (9.12) [ef]	$F(3, 103) = 4.643, p = .004, \eta_p^2 = .119$
MMSE	28.63 (1.57) [eeg]	27.77 (5.28) [ff]	26.39 (2.29) [gh]	23.28 (2.32) [eeffh]	$F(3, 103) = 10.41, p < .001, \eta_p^2 = .233$

Note. Values are expressed as mean and standard deviation or mean/maximum score and standard deviation with the exception of those denote percentage and number of individuals for gender. IQ = intelligence quotient; MMSE = the Mini-Mental Status Examination; HC = healthy control; SCD = subjective memory decline; MCI = mild cognitive impairment; AD = Alzheimer’s Disease. [a] $p < .001$; HC versus MCI. [b] $p < .001$; HC versus AD. [c] $p < .001$; SCD versus AD. [d] $p < .05$; SCD versus MCI. [e] $p < .05$, [ee] $p < .001$; HC versus AD. [f] $p < .05$, [ff] $p < .001$; SCD versus AD. [g] $p < .05$; HC versus MCI. [h] $p < .05$; MCI versus AD.

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Table 5

Results of ANCOVA on Decoding Accuracy as a Function of Emotion, Photo Age, Group, and their Interactions in Experiment 2

	Factors	*df*	*F*	*p*	η_p^2
Accuracy (overall)	Photo age	1, 100	3.502	.064	
	Photo age * group	3, 100	3.037	.033	.083
	Emotion	4, 400	1.159	.329	
	Emotion * group	12, 400	2.121	.015	.060
	Photo age * emotion	4, 400	.493	.741	
	Photo age * emotion * group	12, 400	.503	.913	
	Group	3, 100	7.342	< .001	.180

Table 6

One-way ANCOVAs for The Intensity of Our Photos Between Older and Younger Faces

Intensity	Older photos Mean (*SD*)	Younger photos Mean (*SD*)	Statistical comparison
Happy	3.41 (0.45)	2.77 (0.29)	F (1, 60) = 38.904, $p < .001$, $\eta_p^2 = .393$
Anger	3.76 (0.45)	3.48 (0.42)	F (1, 60) = 5.929, $p = .018$, $\eta_p^2 = .090$
Fear	3.46 (0.43)	3.14 (0.46)	F (1, 60) = 7.899, $p = .007$, $\eta_p^2 = .116$
Sad	3.00 (0.41)	2.76 (0.33)	F (1, 60) = 6.233, $p = .015$, $\eta_p^2 = .094$

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7. Figures

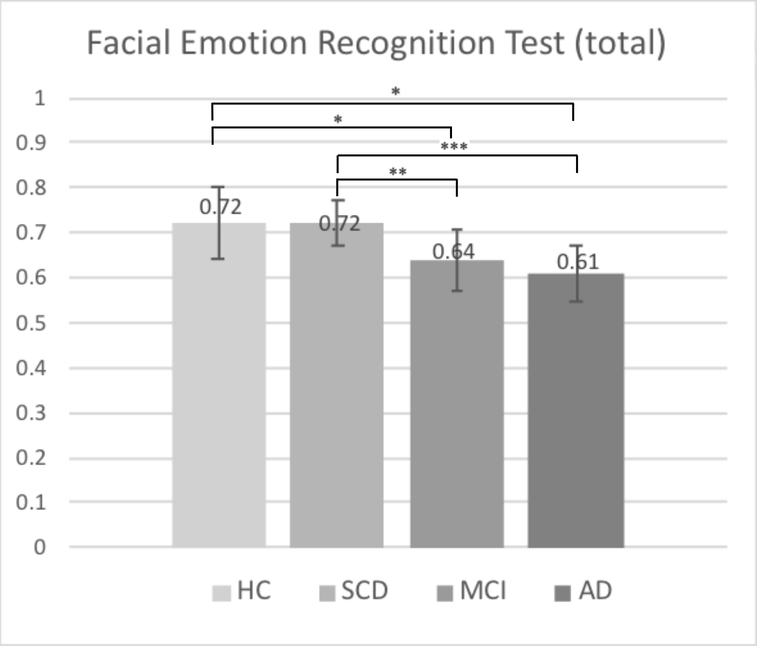

Figure 1. Total accuracy of the FER Test across the Group.

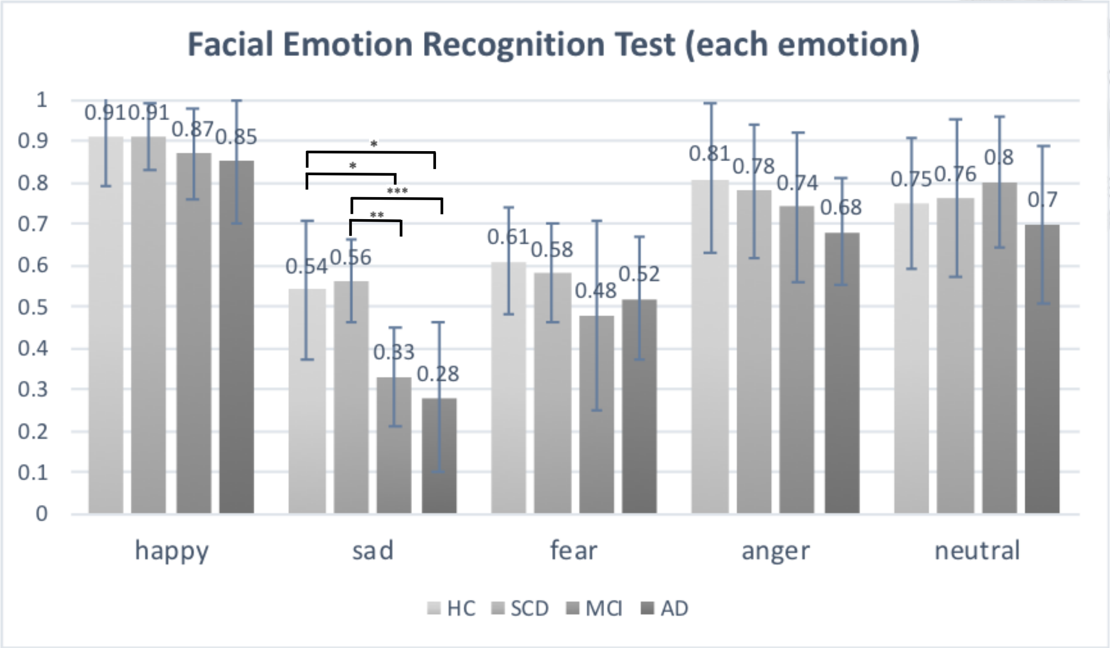

Figure 2. FER accuracy of different emotions across the Group.

Figure 3. FER accuracy of sadness for different age of photos (older faces and younger faces) across the Group.

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