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Emotion Evaluation of Four Generations of Woman from a 104-Year Old Ancestress

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Abstract

Normal aging is associated with declines of perception and cognition. Inversely, emotions seem to be preserved compared to younger adults. Viewing, neutral, dramatic and comic films, emotions were evaluated in four generations of woman from a 104-year old ancestress. At the very old age, from this case report, emotions were differently expressed while arousal was still preserved. A constant emotion of scare was expressed during the viewing of these three films ($p < 0.001$) with significant higher level of disgust ($p \leq 0.01$). Only perceptual deficiency cannot explain this difference as cognitive tasks revealed a mild cognitive impairment detected by the Mini Mental State Examination and a substantial impairment on the executive functions by using the Delayed response tasks. These results emphasize that some emotions in a normal aging centenarian are still present, even if not appropriates, and different in comparison to a young adult control group. From this study, it is expected that emotion analysis in old adults viewing selected short films will predict longevity and could discriminate normal processes occurring during normal aging from neurodegenerative diseases.

Keywords

Emotion, Very Old Aging, Facial Analyses, 104-Year Old Case Report

1. Introduction

Although, normal age-related changes in cognition are not uniform across all cognitive domains or across all individuals, it is well known that basic cognitive functions most affected by age are attention and memory [1]. Perception also shows significant age-related declines attributable mainly to decline of sensory

capacities. Similarly, higher level cognitive functions such as language processing and decision making are also affected by age. Moreover, complex cognitive tasks may also depend on a set of executive functions, which manage and coordinate the various components of the tasks. Considerable evidence points to impairment of executive function as a key contribution to age-related declines in a range of cognitive tasks. All these age-related changes are now well documented in normal human aging. Inversely, few is known about age-related changes occurring in facial expressions when perception and cognition decline in normal aging. Indeed, facial expressions are conceived as biologically prepared response to emotional external signals involved in communications [2]. The main aim of the current study was to investigate facial expressions related to state emotional reactions by four generations of woman from an ancestress of 104-year old when viewing neutral, dramatic or comic films in comparison to a group of young adult graduate students.

The face expression images captured by a camera were coded by a software (Face Reader) providing emotion reaction quicker and equally reliable when compared with human raters [3]. In this system, facial analysis includes three successive stages. First, it is able to track the face of the subject that remains free to move within certain limits. The software then is able to represent accurately the face by a 500-points mesh. Finally, using an artificial neural network [4], the face is ranked into six classes of facial expressions of basic emotions: happy, sad, angry, surprised, scared, disgusted completed by a neutral class [5]. This classification is widely used and the categories represent clear concepts [6].

In addition, arousal and the global positive or negative valence were also evaluated knowing that aging could have significant effect on it. Indeed, prominent models of emotion identify valence and arousal as fundamental components of emotion [7]. Valence refers to the direction of an emotional response (negative or positive), whereas arousal refers to the magnitude of the response (exciting, agitating, or calming, subduing) [8]. Empirical evidence shows that these two emotional dimensions are not independent of each other [9] [10] [11] [12]. Quantification of facial expression triggered by emotion reaction is expected to match with the watching of categorized film. The results obtained on facial expressions will be associated with those obtained before with two tasks testing cognitive abilities: the Mini-Mental State Examination (MMSE) and the Delayed response tasks. Indeed the MMSE is a widely used psychometric test [13] for screening cognitive functions. In aging, despite the increasing number of functional disabilities, the MMSE scores decline very slightly in non-demented individuals [14] and Delayed response tasks is a very sensitive test dependent of the insults of the frontal cortex.

2. Materials and Methods

2.1. Participants

The four generations of woman were constituted from the younger to the older

woman respectively with PR, the youngest of 21 year old, DI, of 48 year old, JC, of 70 year old and the ancestress MJ D, of 104 year old at the time of the testing. Experiments were conducted at home in March 2017. To make comparison for the facial expressions a control group was added. This group was constituted of twenty female students at the University of Aix-Marseille took part at this study (M. age = 23.55 year, SD = 8.32; education = 15.25 years, SD = 5.8) in April 2017. All the participants were native French speakers and exclusion were a history of psychiatric or neurological disorders. The included participants were adult native French speakers from 25 to 40 of age and exclusion criterion was a history of psychiatric or neurological disorders. All participants were recruited on a voluntary basis and were debriefed following the studies. They were not under neurological medication and without significant apparent cognitive assigned pathology. MJ D was bedridden with significant visual and hearing sensory impairments corrected. JC and MJ D have less than 9 years of education.

2.2. Study Design

Cognitive Tasks:

1) Mini Mental State Examination (MMSE).

Where they are living at the time, participants were tested using MMSE as proposed by Tombaugh et McIntyre in 1992 [15]. MMSE assesses several cognitive domains such as orientation, immediate and short- and long-term recalls (memories), attention and writing skills and ability to follow a three-step command and is routinely used to test cognitive function in aging. The range scores are 0 to 30. Lower is the score, higher are the cognitive impairments.

2) Delayed Response Tasks.

Executive functions were tested using the delayed response task and slightly modified from procedure developed by Verin *et al.* 1993. Briefly, the women were seated in an armchair 50 cm away from a laptop screen (34 × 19 cm) where two symmetrically buttons on the keyboard were assigned to be pushed (one on the right side, the other on the left side). Two identical blue squares (6 × 6 cm) arranged horizontally, 10 cm apart, appeared at the top of the screen, on a small schematized cannon with a 2.5 barrel and a 2 cm wide base in the lower center. The examiner was stand still outside the visual field of the participant. In each of the task, the two squares disappeared for 15 sec. (the delay). After this delay, the two squares reappeared on the screen for the subject to respond. When the squares appeared on the screen, participant must to push one of the two buttons (left or right) as they indicated before to start the tasks. When the subject pushed the button, a circular projectile measuring 3 mm in diameter was shot from the cannon to the square on the chosen side. If the response was correct, the squares disappeared and the word "win" appeared in its place for a period of 2 sec. (the reinforcement). If the choice was incorrect, the squares disappeared and there was no reinforcement.

Experiment was internally driven knowing that the subject had to discover the

rule by deductive reasoning, guided by the distribution of reinforcement. There were two different rules to be discovered an alternation rule (Delayed Alternation task) and a non-alternation rule (Delayed Non-Alternation task), coupled with a reversal (Delayed Reversal task).

a) In the Delayed Alternation task, the subject had to learn to alternate his response (*i.e.* win-shift strategy), that is to choose the square opposite to the one he chose previously.

b) In the Delayed Non-Alternation task, the subject had to change his strategy and learn not to alternate his response (*i.e.* win-stay strategy) that is to always choose the same square, which correspond to the last correct choice of the alternation task.

c) In the Delayed Reversal task, the subject had to choose the opposite side to the correct response on the Delayed Non-Alternation task, this is to reverse the rule of non-alternation to the opposite side and to continue this choice.

The oral instructions given at the beginning of the session were: "In front of you are two squares and a small cannon. The two squares are the two targets. When the squares appear on the screen, you must fire at one of the two squares with the help of one of the two buttons. If you fire at the correct square, it will disappear and the word 'Win' will appear on the screen. If you fire at the wrong square, it will only disappear with no reinforcement. There is 15 seconds delay between each trial. It is possible to win each time but it is up to you to figure out the rule of the game. It is therefore by trying and perhaps by making mistakes that you will find the rule. Please note, you must win every time".

The three tasks (Delayed Non-Alternation task, Delayed Non-Alternation task coupled with Delayed Reversal task) were executed one after the others, rule changing automatically, without the subject being informed, as soon as the criterion of 10 consecutive successful trials was met on, failing that, after 80 trials. The individual score was recorded automatically by the laptop throughout the session.

2.3. Facial Expressions

1) Procedure

The four generations were tested in their living home and the control group in a quiet office at the Aix-Marseille University. All of them were asked to watch three video film extracts of 2.5 minutes of duration in succession. The first one should be regarded as neutral from preliminary studies and was about the life and death of butterflies ("Le temps des papillons": documentary film; film maker). The following, second one, was extracted from the dramatic film, Amadeus, made by M. Forman n 1984 and the sad effect was expected coming from the burying of Mozart. The last one was extracted from a funny French fil "le père Noël est une ordure" with comic effects, made by J Poiré.

2) Analysis

An HD camera (Microsoft, Lifecam Studio, 1080p) allowed recording the experiments, after the consent of the participants. In front of, the camera, the par-

ticipants were filmed and later analyzed by the Face Reader v7 software. Once the analyses were done, the evoked emotions: happy, sad, angry, surprise, scare, disgust and neutral, were averaged and reported in a summary table for each film. Average of the positive (happy) or negative valence (which the average of happy minus averages of the sum of sad, angry, scare and disgust) were also reported as well the average of the estimated arousal.

3) Statistical analyses

Statistical analyses were performed with SPSS/PC + statistics 11.0 software marketed by SPSS, Inc. All data are presented as means ± SEM. Performance was analyzed using a repeated-measure MANOVA. Then, subsequent ANOVAs for each session were computed. The threshold for significance was set at $p \leq 0.05$.

3. Results

3.1. Cognitive Tasks

1) Mini Mental State Examination (MMSE).

MJ D obtained a score of 20/30 while the three others women performed above 25/30. With a score below 23/30, in agreement with recommendations of Tombaugh and McIntyre in 1992 only MJ D has a mild cognitive impairment. This impairment mainly comes from backward calculation (1/5) and short-term three words recall (0/3).

2) Delayed Response Tasks.

In the Delayed Alternation (**Figure 1**), all the four generation were successful on this task with less than 20 trials to reach the criterion of 10 consecutive correct trials. PR and JC found the rule right away at the start (**Figure 1(A)**, **Figure 1(C)**).

In Delayed Non-Alternation task again the four women found the rule but 46 trials were necessary to MJ D (**Figure 1(D)**) to reach the criterion, while for the three others women less than 17 trials were necessary.

In the Delayed Reversal task, for PR, DI and JC, it was even easier to found the solution to win every time and only 11 trials were needed to reach the criterion (**Figure 1(A)-(C)**). Inversely by 80^{th} trials MJ D did not reached the criterion (**Figure 1(D)**).

3.2. Facial Expressions

1) Neutral film

No significant arousal or valence levels were observed between all participants (*i.e.* PR, DI, JC, MJ D and the student control group) [MANOVA: $F(4, 19) = 0.3$; NS] (**Figure 2(A)**) inversely to facial expressions, [MANOVA: $F(4, 19) = 4075$; $p < 0.01$] when the neutral film was watched. This difference comes mainly from MJ D participant who expressed significant different scare and disgust expressions in comparison to the control group [ANOVAs: $F(1, 19) \geq 91.7$; $p < 0.001$].

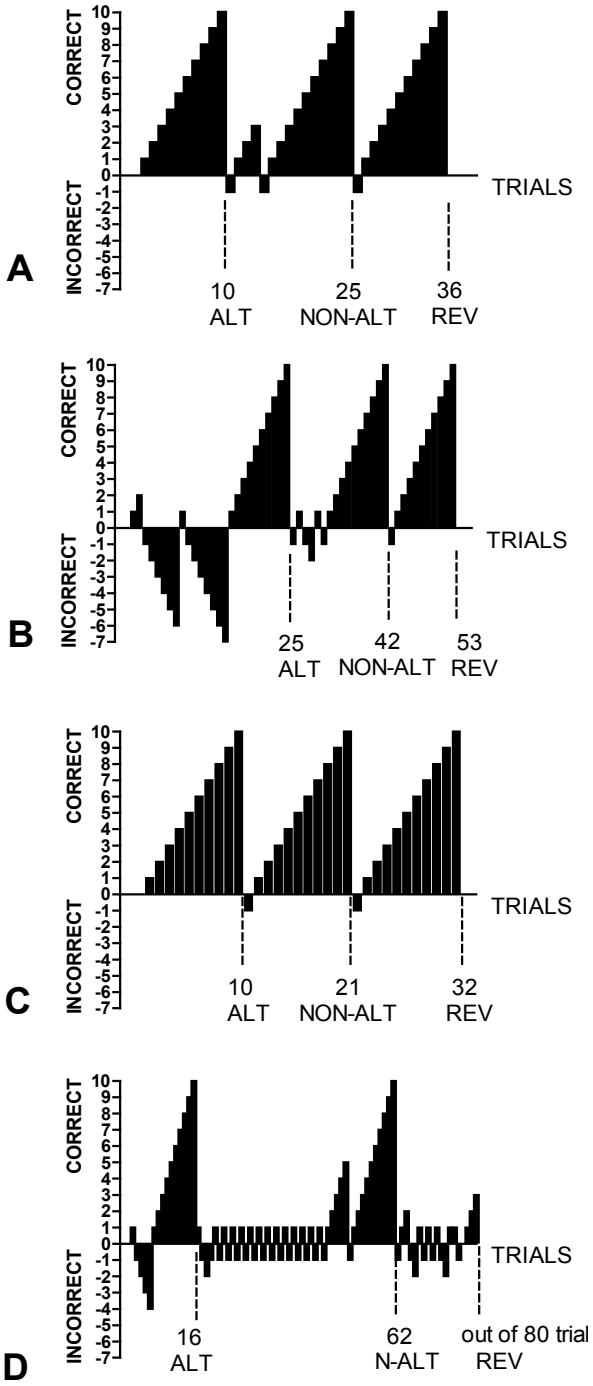

Figure 1. Scores performed to reach the criterion of 10 consecutive correct choices on delayed alternation, delayed non-alternation and delayed reversal tasks. A: PR. B: DI. C: JC. D: MJ D. Note only MJ D needed much more trials on delayed non alternation and failed on delayed reversal tasks after a session of 80 trials.

2) Dramatic film

When the dramatic was broadcasted (**Figure 2(B)**) a significant difference between participants appeared considering the arousal and valence levels [MANOVA: $F(4, 19) = 4.6$; $p < 0.01$]. Indeed, while no significant difference was

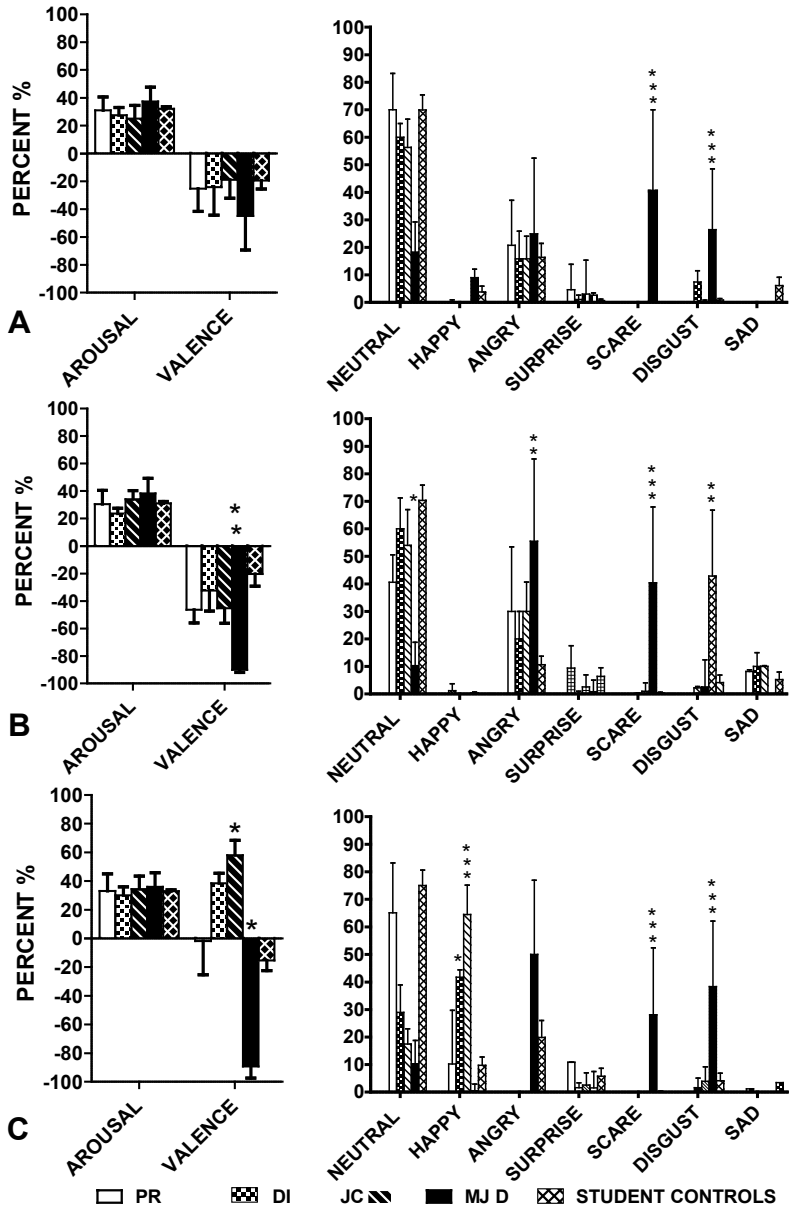

Figure 2. Facial expressions that were observed when broadcasting in succession, neutral (top), dramatic (middle) and comic films (bottom). The comparison were made between of student control group (N = 20) and PR or DI or JC and MJ D. Note that MJ D expressed significantly different emotions whatever the film with stronger scare, angry and disgust which explained the difference on valence deeply negative. DI and JC feel much more happy viewing the comic film (in graphs: *p ≤ 0.05; **p ≤ 0.01; p*** ≤ 0.001).

observed on arousal [ANOVAs: F (1, 19) ≤ 1.68; NS], the dramatic film elicited a subsequent negative valence for MJ D in comparison to the control group [ANOVA: F (1, 19) = 13.6; p < 0.01]. The facial expressions were not significantly different between participants [MANOVA: F (4, 19) = 1.4; NS], excepted for MJ D who was more angry, scared and disgusted [ANOVAs: F (1, 19) ≥ 9.5; p ≤ 0.01] with consequently a lower neutral expression level [ANOVA: F (1, 19) = 5.53; p < 0.05].

3) Comic film

Finally watching the comic film (**Figure 2(C)**) a significant difference was detected in arousal and valence levels between participants [MANOVA: $F(4, 19) = 2.5$; $p < 0.05$]. While again no significant difference was observed considering the arousal level [ANOVAs: $F(1, 19) \leq 0.42$; NS], a substantial difference appeared on the valence with a complete inversion from negative to positive valence for JC in comparison to control group [ANOVA: $F(1, 19) = 4.44$; $p < 0.05$] and a deeper negative valence for MJ D [ANOVA: $F(1, 19) = 4.48$; $p < 0.05$]. No statistically significant difference on facial expressions was observed between participants [MANOVA: $F(4, 19) = 0.4$; NS] and only DI [ANOVA: $F(1, 19) = 5.31$; $p < 0.05$] and JC [ANOVA: $F(1, 19) = 15.59$; $p < 0.001$] were significantly more happy to watch this film while MJ D was, like previously watching the others films, scared and disgusted [ANOVAs: $F(1, 19) \leq 67.78$; $p < 0.001$].

4. Discussion

As expected no significant difference was observed between student control group and PR, DI, and JC on both cognitive tests. Similarly no consistent difference was demonstrated on arousal, valence and facial expressions related to the watching of the neutral and dramatic films. Only the happy expression was much more present in DI and even more in JC participants regarding the comic film. It is to note, that the dramatic film related to Mozart's burying trigged angry expression instead of sad emotion.

Inversely for MJ D, the woman of 104 years of age, a mild cognitive impairment was detected by the MMSE and a substantial impairment on the executive functions was revealed by using the Delayed response tasks. The arousal was identical to all the others participants whatever the film broadcasted but the valence was strongly more negative at least watching the dramatic and comic films. In addition, a constant emotion of scare was expressed during the viewing the three films. As an explanation, the lack of understanding of "what's going on" could be translated by an increase of scare associated with, at a lower level, by angry and disgust emotions. It is interesting to note that the research of the meaning of the scene taking place was associated with a decrease of neutral emotion although a significant level was never reached.

Among the progressive functional declines in cognitive function in aging, executive control impairment seem to be a primary contributor [1] and is related to theories focuses on process-specific accounts of aging [16]. One of them distinguishes between tasks that involving executive control process, such as selecting information to be attended to or switching between sources, and tasks in which these demands are negligible. Indeed, age related deficit will be specific to particular executive processes, such as inhibitory control [17], coordination ability [18] [19], or task-switching [20]. It was this last specific task which was particularly altered in MJ D. Experimental studies have shown that in human and non-human primates, delayed alternation and delayed response tasks are de-

pendent of the integrity of the frontal lobe [21]-[26]. The frontal lobe activity was demonstrated to be responsible for the ability to solve complex problems that retain internal representation of a visuo-spatial stimulus during a delay (delayed response task), and the ability to shift set (reversal). These highly cognitive processes constituting one part of the executive functions are impaired in normal aging [27] [28] [29] and obviously revealed in MJ D in delayed response tasks.

Arousal and valence ratings in young adults and older adults showed that in young adults both pleasantness and unpleasantness increased with emotional arousal, whereas in older adults low-arousing stimuli were experienced as most pleasant, and high-arousing ones as most unpleasant [30]. Another study investigating age-differences in emotional reactions to stimuli differing in arousal and age relevance [31] showed that older adults rated unpleasant low-arousing pictures as less unpleasant compared to young adults, while there were no-age related differences in unpleasant ratings for unpleasant pictures that were high in arousal. Some others behavioral studies [32] [33] [34] and neuroimaging studies [9] [35] [36] [37] showed that negative stimuli engage more attention and induce more brain activity in regions involved in emotional and visual processing, relative to positive or neutral stimuli. Finally, in normal aging, the preference for the negative stimuli tends to disappear and, sometimes, to shifts towards a preference for the positive stimuli compared to both negative and neutral stimuli. The aging brain model [38] supposes an atrophy of cerebral structures involved in emotional processing, such amygdala. This atrophy would alter the processing of negative stimuli and could lead to the positive effect. Such effect was seen considering the happy ratings of student controls and PR (young adults) in comparison to DI and JC (older adults) but not for MJ D; although it will be difficult to make comparison between spontaneous stimulus responses and percentage of facial expression from extracts of films. Indeed, for facial expressions MJ D seems to be in another category. The three different emotional contents were viewed quite similarly with an increase of scare associated with, at a lower level, by angry and disgust emotions. Perception related to sensory capacity declines could explain these unexpected emotions but altered higher level cognitive functions cannot be excluded too, as demonstrated the results on Delayed response tasks. Moreover, emotions depend on a complex circuitry of brain regions interacting with neurotransmitter system and stress and sex hormone. All of these basic mechanisms and contextual factors change in normal aging and so it is not surprising that emotional experience and processes change with age as well (for a recent review: [39]) nevertheless, in general for observed results, it is concluded that emotion is a domain in which older adults fare surprisingly well [40] [41], which true in this study for JC aged of 70 years but not for MJ D aged of 104 years. Several studies reported mixed preserved [42] [43] or impaired effects [40] [44] in normal aging and mild Alzheimer's disease on emotional memory. Thus, from our observations, when mild memory deficits appeared in

very old subjects, broadcasting selected extract of films, without testing demand in turn, will allow to discriminate normal very old adult behavior in which arousal and specific emotions are still presents, even if they are not adapted, from patients developing diseases like Alzheimer disease where such emotions will disappear or are not expressed any more.

5. Conclusion

In conclusion, this study based mainly on a case where some emotions in a very old normal woman are still present, even if not appropriates, should be reproduced with some other very old adults or with Alzheimer patients at different stages to figure out, how changes in emotional responses could be affected by extreme aging or dementia. This testing method, easy to carry and apply, could allow to discriminate normal processes occurring during normal aging from pathological processes occurring in neurodegenerative disease.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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