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HUMOR APPRECIATION IN ELDERLY PEOPLE AND ITS COGNITIVE DETERMINANTS

Recent years have witnessed a growing interest in humor appreciation exhibited by people from various age groups. There are still few data on how aging affects the perception of humorous contents. The literature suggests that elderly people exhibit increasing difficulties in understanding jokes. The aim of the study was to analyze and compare the level of humorous content comprehension in people in early and late old age and to identify its determinants. The participants were 109 individuals with physiological aging, divided into two age groups: group < 70 y.o. and group \geq 71 y.o. We used interview, Mini-Mental State Examination, and the Right Hemisphere Language Battery. In the Verbal Humor Appreciation test, older seniors gave significantly fewer correct answers than younger seniors. Women indicated more correct answers and fewer absurd ones than men. The ability to produce humor in old age is significantly predicted by the general state of mental functions and higher education. The scores on Verbal Humor Appreciation correlated with scores in Mini-Mental State Examination and with scores in the remaining tests on the RHLB battery. The ability to appreciate humorous contents appears to be dependent on age, gender, and the level of linguistic functions, conceptual thinking, sensitivity to prosodic elements, and discursive abilities. The results confirm the deterioration of processes significantly involving the right hemisphere with age.

Keywords: aging; cognitive functioning; humor; communication; right hemisphere.

INTRODUCTION

Humor plays an important role in human life, regardless of age. It performs numerous functions, particularly in the domain of social communication but also in other dimensions of human functioning. It may be a source of intellectual play, a method of self-defense in difficult situations, or an instrument of aggression (Tomczuk-Wasilewska, 2010). For elderly people it turns out to be a way of coping with stress, gaining social attractiveness, and improving the quality of daily life (Shammi & Stuss, 2003). Because the use of jokes and wit is frequent in social life, taking part in it requires correct understanding and interpretation of humorous contents: these are the skills that the efficiency of communication depends on. Due to the importance of humor in life, many studies have been conducted on the development of humor processing skills in various stages of life, but the smallest amount of data has been collected about changes in humor production and appreciation in elderly people (Greengross, 2013, Proyer, Ruch, & Müller, 2010).

The most frequently used theory in research on the processes of change in the sense of humor is the cognitive incongruity-resolution theory (Martin, 2007), which postulates that humor in a particular story stems from the combination of two initially incongruous and contradictory systems of information. However, when the seeming incongruity of contents is recognized, humorous overtones are perceived. This theory inspired many studies using various methods of assessing the appreciation and production of humorous contents. An example of a research situation enabling the assessment of the quality of joke appreciation is the task that consists in the participants explaining the reasons why they regard a given joke as funny, or in evaluating a number of sentences in terms of whether or not they are humorous and to what extent. The ability to produce humorous contents – which, naturally, includes the ability to comprehend and appreciate them – is assessed in tasks requiring the choice of an appropriate punchline for the content provided. The literature shows that, with age, elderly people exhibit increasing difficulties in functioning in humorous situations (Mak & Carpenter, 2007; Uekermann, Channon, & Daum, 2006). In tasks that consist in assessing the level of humor in humorous and neutral sentences, subjects from the group of seniors (aged over 60) perceived all sentences – both humorous and neutral – as more funny than young subjects. Both groups did similarly well in distinguishing neutral sentences from humorous ones. This means that elderly people not only did not exhibit slower emotional reactions to jokes, but they were actually more sensitive even to subtle humor. At the same time, the group of seniors made more

errors in the task of finding appropriate punchlines for the jokes provided – in both verbal and pictorial material (Mak & Carpenter, 2007).

Performance in humor production tasks correlated with a decrease in cognitive abilities in elderly people, but not with humor appreciation. This result was explained by the level of task difficulty – humor production involves the processes of abstract thinking, working memory, and language functions to a greater degree than making a decision on whether the task is humorous or not (Shammi & Stuss, 2003; Mak & Carpenter, 2007).

Humor appreciation, the ability to evaluate a joke as “good” or not, increases with age and begins to decrease around the age of 60. With age, humor appreciation becomes more difficult also due to high cognitive demands, including problems with mentalization, connected with the correct comprehension of the contents of jokes (Uekermann et al., 2006). According to cognitive theories, humor is an intellectual phenomenon (Tomczuk-Wasilewska, 2010), which makes it possible to predict the correlation between cognitive state and the quality of humor appreciation; consequently, humor research may shed light on the quality of functioning of complex cognitive processes in elderly people. Humorous content processing requires integrated activity of cognitive and affective processes.

Studies on the determinants of changes in humorous content processing refer to the mechanisms of brain aging. One of the hypotheses explaining brain aging mechanisms posits that, with age, there is an observable weakening of those cognitive functions that depend mainly on the correct functioning of the right brain hemisphere (the hypothesis of quicker aging of the right hemisphere). Research also shows that the difficulties in humor processing observed in seniors can be related mainly to right hemisphere frontal cortex dysfunctions (Shammi & Stuss, 2003). The observed patients with lesions located in the right frontal lobe exhibited deficits in the correct selection of funny endings for stories and chose nonsensical endings (Shammi & Stuss, 2003). Goel and Dolan (2001) pointed to the neurobiological basis behind the processing of the affective aspect of jokes, more precisely defining the significance of medial ventral prefrontal cortex.

Despite the studies mentioned above, devoted to the quality of humor in seniors, there are still not enough data on how the dynamics of aging influences the perception of humorous contents. The largest number of comparisons have been made between young people and the group of elderly people not divided into age groups.

Research objective

The main aim of the presented research was to assess the differences in the level of humorous content production and appreciation in people in early and late old age. We also investigated the relationships of selected cognitive processes (such as abstract thinking, logical thinking, or linguistic and pragmatic functions) and demographic variables with humorous content processing in seniors. Moreover, when looking for explanations of the deterioration of the ability to produce jokes that is observed with age, we drew on the neuropsychological conceptions explaining the brain aging processes – the hypothesis postulating the quicker aging of the right brain hemisphere and the model of Hemispheric Asymmetry Reduction in Older Adults (HAROLD; Dolcos, Rice, & Cabeza, 2002).

The main problems of the presented research took the form of the following questions:

1. Are there differences in the characteristics of humorous content perception between people in early and late old age? If so, what do these differences consist in?
2. What relations between the level of humorous content appreciation and cognitive functioning are there in people in different stages of old age?
3. What are the predictors of humorous content appreciation in seniors?

In the present study we hypothesized that humorous content processing abilities decrease with age, and that, consequently, individuals in late old age would have greater difficulties in this area than those in early old age. We also predicted a different relationship in either of the two groups between the level of linguistic and communication skills and humorous content appreciation. Finally, we hypothesized that it was possible to predict the level of humor processing abilities based on selected personal variables (age, gender, education level, professional activity, health condition, and overall cognitive level).

METHOD

Participants

The participants in the study were 109 individuals (62 women and 47 men) with physiological aging, aged from 64;11 to 90 years ($M = 70.7$, $SD = 6.6$). We divided the participants into two age groups according to the old age periodization proposed by Golinowska and colleagues (1999), where the period up to the age of 70 is called early old age and the period after the age of 70 is referred to

as the time of gradual accumulation of changes in physical and mental fitness. The former group consisted of individuals aged 70 and younger (≤ 70 y.o.), 40 women and 26 men (mean age: $M = 66.3$, $SD = 1.7$), while the latter group was individuals aged 71 and older (≥ 71 y.o.), 22 women and 21 men (mean age, $M = 77.5$, $SD = 5.4$). Twenty-six participants had elementary education, 16 had vocational education, 32 had secondary education (Polish *matura*—roughly equivalent to A-levels), and 35 had higher education. The groups of participants in early and late old age did not differ significantly in terms of gender ($\chi^2 = 0.947$, $p > .05$) or education ($\chi^2 = 7.085$, $p > .05$). Among the younger seniors, 40 participants were retired or on a pension and 14 were still professionally active. In the group of older seniors there were no working (professionally active) people ($\chi^2 = 12.18$, $p < .001$).

None of the participants had been hospitalized during the previous year; interview revealed no diseases of the central nervous system (CNS) of psychiatric disorders; they had not suffered a head injury and were not found to be addicted to psychoactive substances. The participants had chronic somatic diseases such as diabetes, hypertension, or endocrinological and rheumatic diseases. The frequency of the reported diseases was similar in the two groups ($\chi^2 = 1.659$, $p > .05$).

The criterion of inclusion in the study was a normal level of cognitive functioning, assessed by means of Mini–Mental State Examination (MMSE; score ≥ 27 pts). In the group aged up to 70, mean MMSE score was 28.68 ($SD = 1.75$), and in the group aged 71 and above the mean score was 27.23 ($SD = 2.03$). The difference turned out to be statistically significant in favor of younger seniors ($t_{(83)} = 3.517$, $p = .001$).

Instruments

In our study we used clinical interview, Mini–Mental State Examination (MMSE; Polish adaptation by Stańczak, 2010), and the Right Hemisphere Language Battery (RHLB-PL; Łojek, 2007).

MMSE is a screening instrument measuring cognitive functions. It consists of 30 questions/tasks allowing for a quantitative assessment of various aspects of cognitive functioning, such as orientation to time and place, registration and recall, attention and calculation, or linguistic and graphic skills. A score above 26 suggests the correct course of cognitive processes. Reliability (internal consistency) coefficients for different clinical groups were high regardless of the participants' age or education and ranged from $r = .69$ to $r = .89$. MMSE has high

concurrent validity, both for the overall score and for most of the tasks (except Naming) (Stańczak, 2010).

The RHLB-PL was developed as an instrument intended especially for measuring deficits in language and communication in adults with lesions of the right brain hemisphere (Łojek, 2007). The battery consists of 11 tests (in the order of administration): Comprehension of Inferred Meaning (CIM, max. 16 pts) requires the comprehension of the texts read and inference based on the information hidden in them; Lexical Semantic Comprehension (LSC, max. 13 pts) requires the comprehension of the words heard and the identification of their designata; Verbal Humor Appreciation (VHA, max. 10 pts) allows for assessing the comprehension of complex linguistic material and the ability to appreciate the humor hidden in it; Commentaries Test (CT, max. 14 pts) measures impulsive reactions based on remarks and comments spontaneously made by the subject; Picture Metaphor (PM, max. 10 pts) requires the comprehension of commonly known metaphors and measures abstract thinking on the basis of visual information analysis; Written Metaphor (WM, max. 10 pts) requires the comprehension of well-known metaphors and abstract thinking based on linguistic material processing; Explaining Picture Metaphor (EPM, max. 10 pts) and Explaining Written Metaphor (EWM, max. 10 pts) measure the ability to understand metaphors and verbally express their meaning using one's knowledge; Emotional Prosody Test (EPT, max. 10 pts) provides the basis for describing the ability to understand the emotional intonation (joy, sadness, anger) that nonsensical sentences are uttered with, Linguistic Prosody Test (LPT, max. 10 pts) requires the comprehension of the mood that nonsensical sentences are uttered in (interrogative, affirmative, imperative), and Discourse Analysis (DA, max. 60 pts) reveals the subject's ability to establish and maintain interactions with other people, engage in conversations, ask questions, use polite phrases, take turns when speaking, etc.

The RHLB-PL test material is charts with texts of short stories, jokes, or metaphorical expressions together with questions and suggested endings, charts with drawings, and recordings of nonsensical sentences uttered with different kinds of emotional intonation (joy, sadness, anger) and linguistic intonation (question, statement, command). The quantitative indicators yielded by the battery are raw and scaled scores (sten norms for people with lesions of the right brain hemisphere) in specific subtests. The maximum raw RHLB-PL score is 185 points. The reliability coefficients of specific tests, assessed using the absolute stability method, range from $R = .26$ (statistically non-significant) to $R = 1.0$ for subjects with higher or secondary education and from $R = .26$ (statistically non-

significant) to $R = .87$ for the group with elementary or vocational education. The total RHLB-PL score and the scores in individual subtests have acceptable or high concurrent validity (Łojek, 2007).

From the perspective of the present study, the most important subtest was Verbal Humor Appreciation. It consists of 10 short unfinished stories and three variants of ending for each of them. These are: the actual punchline of the joke – appropriate to its content and funny, a wrong neutral ending – consistent with the story in terms of content but not making up a joke with it, and a wrong absurd ending – not consistent with the content of the story and therefore surprising. For example: Task 4. “*Honey,*” says the husband in a sleepy voice, “*turn off the TV, switch on the light, and give me tea.*” “*I can’t,*” replies the wife. 1. “*I’m talking on the phone.*” 2. “*We are in the cinema.*” 3. “*The store has just closed.*” The participant reads stories and their endings on his or her own, but at the participant’s request the test material may be read out by the investigator.

Statistical analysis methods

For intergroup comparisons we used Student’s t -test for two independent samples, and for intragroup comparisons in each category of answers in the Verbal Humor Appreciation test (neutral *versus* absurd) we applied the t -test for dependent samples in each group. In the assessment of associations between Verbal Humor Appreciation scores and the scores in particular RHLB-PL subtests, we used Pearson’s r correlation coefficient. We also performed multivariate regression analysis (with backward elimination), making it possible to identify the predictors of the ability to produce humorous contents. In the final stage we performed a mediation analysis in order to explain the complex nature of the relationship between age and humor appreciation. We adopted the level of $\alpha < .05$ in the calculations performed.

RESULTS

Having assumed that humorous content processing was a cognitive activity, we analyzed the quality of this processing against the background of cognitive functioning in the area of linguistic and communication functions (all RHLB-PL subtests) and general mental functions. The seniors participating in the study scored lower in all the tests of the RHLB-PL battery compared to the standardization sample of normal individuals below 65 years of age (see RHLB-PL man-

ual; Łojek, 2007). It can therefore be concluded that the functions involved in the performance of the tasks become weaker with age. Table 1 presents the results obtained by comparing the scores of younger and older seniors in each subtest of the RHLB-PL. In view of the formulated objective of the study, Verbal Humor Appreciation scores have been highlighted and the type of errors made has been indicated.

Table 1
Comparisons of Scores in RHLB-PL Subtests Measuring Communication and Linguistic Competencies for Groups of People in Early and Late Old Age

Subtests RHLB-PL	≤ 70 y.o. <i>n</i> = 66 <i>M</i> (<i>SD</i>)	71 y.o. <i>n</i> = 43 <i>M</i> (<i>SD</i>)	Student's <i>t</i> -test statistics	Significance	Effect size
CIM	14.23 (1.73)	13.51 (2.41)	1.8	> .05	–
LSC	12.44 (0.73)	11.60 (1.43)	4.01	< .001	0.74
CT	2.27 (2.54)	3.35 (3.12)	-1.97	> .05	–
PM	8.11 (2.05)	6.44 (1.94)	4.22	< .001	0.77
WM	9.08 (1.68)	7.81 (2.29)	3.32	.001	0.63
EPM	8.47 (1.62)	7.49 (1.94)	2.85	< .01	0.54
EWM	8.53 (1.71)	7.12 (1.84)	4.09	< .001	0.75
EPT	13.06 (1.61)	11.07 (2.90)	4.61	< .001	0.83
LPT	13.39 (2.04)	11.26 (3.72)	3.87	< .001	0.71
DA	56.65 (3.61)	55.70 (4.26)	1.26	> .05	–
Verbal Humor Ap- preciation – correct answers	7.94 (2.09)	6.44 (2.22)	3.57	.001	0.67
Neutral answers	1.7 (2.04)	2.58 (2.00)	-2.23	< .05	0.43
Absurd answers	0.36 (0.57)	0.98 (1.44)	-2.66	.01	0.60

Note. RHLB – Right Hemisphere Language Battery; CIM – Comprehension of Inferred Meaning; LSC – Lexical Semantic Comprehension; CT – Commentaries Test; PM – Picture Metaphor; WM – Written Metaphor; EPM – Explaining Picture Metaphor; EWM – Explaining Written Metaphor; EPT – Emotional Prosody Test; LPT – Linguistic Prosody Test; DA – Discourse Analysis.

In the Verbal Humor Appreciation test, older seniors gave an average of 6 correct answers, which distinguishes them significantly from the participants in early old age. Only 3 subjects in the group aged ≥ 71 and 20 subjects in the group aged ≤ 70 made no errors in this test. The subjects in late old age made significantly more neutral as well as absurd errors. In both groups, neutral answers were more frequent errors than absurd answers (in the group aged ≤ 70 , $t_{(65)} = 5.07$, $p < .001$; in the group aged ≥ 71 , $t_{(42)} = 3.91$, $p < .001$).

In the next stage of analyses, we sought a relationship between the state of linguistic and communication functions and the indicators of humorous content processing ability in subjects in different phases of old age (Table 2).

Table 2

Correlations of Verbal Humor Appreciation Scores With the Scores in the Remaining RHLB-PL Subtests Measuring Communication and Linguistic Competencies

		CIM	LSC	CT	PM	WM	EPM	EWM	EPT	LPT	DA
70 y.o.	VHA correct answers	.44**	.53***	.29	.47***	.42**	.42**	.39**	.36 ^c	.45**	.41**
	VHA neutral answers	-.26	-.30	-.16	-.20	-.20	-.20	-.03	-.16	-.11	-.21
	VHA absurd answers	-.33*	-.41**	-.23	-.45**	-.36*	-.37*	-.56***	-.34*	-.55***	-.33*
71 y.o.	VHA correct answers	.36**	.22	.01	.16	.48***	.26*	.47***	.17	.36**	.36**
	VHA neutral answers	-.26 ^a	-.24	.001	-.12	-.39**	-.26*	-.44***	-.13	-.30 ^a	-.30 ^a
	VHA absurd answers	-.30*	.05	-.02	-.14	-.38**	-.02	-.12	-.16	-.19	-.25 ^a

Notes. * $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$; VHA – Verbal Humor Appreciation; CIM – Comprehension of Inferred Meaning; LSC – Lexical Semantic Comprehension; CT – Commentaries Test; PM – Picture Metaphor; WM – Written Metaphor; EPM – Explaining Picture Metaphor; EWM – Explaining Written Metaphor; EPT – Emotional Prosody Test; LPT – Linguistic Prosody Test; DA – Discourse Analysis.

The analysis of the data presented in Table 2 led to several important observations. In the early old age group, the number of correct answers in the Verbal Humor Appreciation test correlated positively with scores in all RHLB-PL subtests except the Commentaries Test, and in the case of the number of absurd answers these correlations were negative. The significant associations tended to be moderate. Only correct answers correlated strongly with Lexical Semantic Comprehension scores, while absurd answers correlated strongly with Explaining Written Metaphor as well as Linguistic Prosody Test scores. No association was found in the case of neutral answers. In the group of older seniors the pattern of associations was somewhat different. Correct and neutral answers correlated with scores in the same subtests (Comprehension of Inferred Meaning, Written Metaphor, Explaining Written Metaphor, Explaining Picture Metaphor, Linguistic Prosody Test, and Discourse Analysis). We found moderate positive associations between scores in these subtests and the number of correct answers as well as weaker negative associations in the case of neutral answers. The number of absurd answers correlated weakly negatively with Comprehension of Inferred Meaning and Discourse Analysis and moderately with Written Metaphor.

In the last stage of analyses, we performed regression analysis with backward elimination. We tested the predictive value of the overall level of cognitive functioning, age, education, professional activity, gender, and health condition for the level of humorous content production ability.

Table 3
Results of Multivariate Regression Analysis With Backward Elimination for Verbal Humor Appreciation Scores in the Sample of Seniors (N = 109)

Model	Beta (standardized value)	<i>t</i>	Significance	<i>R</i> ²	<i>F</i>
1 Intercept		-0.68	.496	.36	5.15***
gender	0.12	1.14	.257		
professional activity	-0.01	-0.08	.938		
level of cognitive functioning (MMSE)	0.41	3.52	.001		
age	-0.10	-0.81	.420		
health condition	-0.09	-0.80	.428		
higher education	0.23	1.97	.053		
secondary education	0.02	0.20	.842		
2 Intercept		-0.73	.467	.36	6.10***
gender	0.12	1.18	.244		
level of cognitive functioning (MMSE)	0.41	3.56	.001		
age	-0.10	-0.84	.406		
health condition	-0.08	-0.80	.426		
higher education	0.23	2.03*	.047		
secondary education	0.02	0.21	.837		
3 Intercept		-0.71	.480	.36	7.42***
gender	0.12	1.19	.237		
level of cognitive functioning (MMSE)	0.41	3.58	.001		
age	-0.10	-0.89	.378		
health condition	-0.09	-0.81	.421		
higher education	0.22	2.13	.037		
4 Intercept		-0.84	.407	.35	9.16***
gender	0.12	1.19	.237		
level of cognitive functioning (MMSE)	0.43	3.85	< .001		
age	-0.11	-0.96	.339		
higher education	0.23	2.25	.028		
5 Intercept		-2.761	.007	.34	11.91***
gender	0.12	1.186	.240		
level of cognitive functioning (MMSE)	0.48	4.720	< .001		
higher education	0.24	2.365	.021		
6 Intercept		-2.737	.008	.33	17.06***
level of cognitive func- tioning (MMSE)	0.48	4.798	<.001		
higher education	0.23	2.269	.026		

Note. *** $p \leq .001$.

Based on regression coefficients, we found that the significant predictors of humorous content production and appreciation in seniors were the overall cognitive level ($\beta = 0.48, p < .001$) and higher education ($\beta = 0.23, p < .05$). Standardized beta coefficients indicate that the higher the overall cognitive level and the higher the education, the better the humorous content appreciation. The model turned out to be well fitted to the data ($F = 17.06, p < .001$) and explains 32% of variance in the dependent variable. The remaining variables do not have significant influence on humor appreciation.

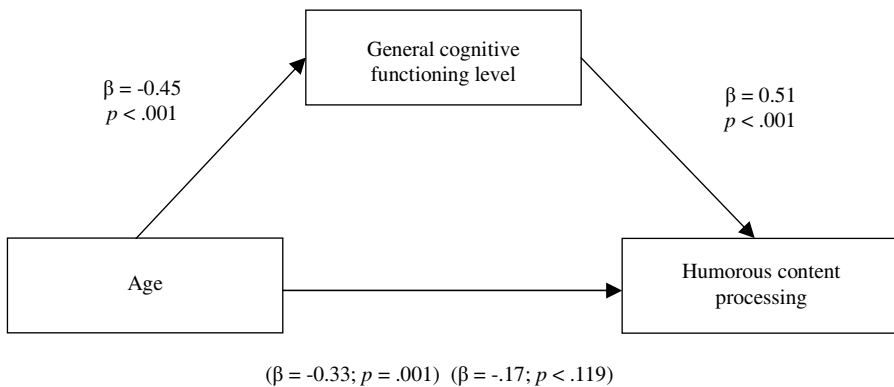


Figure 1. Model of the mediating role of general cognitive functioning level between age and humorous content processing in elderly people.

In the light of the existing analyses, confirming the significance of the age variable for Verbal Humor Appreciation scores, the result obtained in multivariate regression analysis showing that age is not a significant predictor of humorous content processing seems to be surprising. Therefore, looking for the explanation of this result, we performed a mediation analysis in the model of regression with age as the independent variable, MMSE as the mediator, and Verbal Humor Appreciation (VHA) score as the dependent variable. When testing the interrelations between the variables, we found significant associations between age and VHA ($\beta = -0.33, t_{(107)} = -3.58, p = .001$), age and MMSE ($\beta = -0.45, t_{(107)} = -4.63, p < .001$), as well as MMSE and VHA ($\beta = 0.51, t_{(107)} = 5.47, p < .001$). In further analyses, we entered two predictors for VHA into the regression model: age and MMSE. We obtained results showing that age ceased to

have predictive significance ($\beta = -0.17$, $t_{(107)} = -1.58$, $p > .05$), and MMSE score turned out to be the only predictor ($\beta = 0.44$, $t_{(107)} = 4.20$, $p < .001$; for the model: $F = 16.44$, $p < .001$). The Sobel test confirmed the non-significant effect of age on VHA ($z = 3.11$, $p < .001$). This means we can speak of total mediation here, since the relationship between age and Verbal Humor Appreciation score ceased to be significant after MMSE had been entered. To sum up, the overall level of cognitive functioning is a mediator in the relationship between age and humorous content processing ability.

In the total sample of elderly people, gender was not a significant predictor of correct answers in the Verbal Humor Appreciation test. However, further analyses, with the sample divided into groups, revealed that in the younger group women generated more correct answers ($t_{(32.4)} = 2.17$, $p < .05$, $d = 0.64$) and fewer absurd answers than men did ($t_{(26.6)} = -2.82$, $p < .01$, $d = 0.81$). We found no significant differences in the case of neutral answers. In the group of older seniors we found no differences between women's and men's results in any category of answers.

DISCUSSION

The dynamics of cognitive weakening in the period of physiological aging is determined by biological changes in the central nervous system, taking place in interaction with factors of broadly understood environment and personal activity. For this reason, the picture of cognitive processes in seniors in different ages is not the same (Ardila, 2007; Treder & Jodzio, 2013; Gawron & Łojek, 2014). The present study confirmed that physiologically aging people are not a homogeneous group in terms of general cognitive and communication abilities, including humor processing. In the late period of life, abstract thinking processes based on the processing of linguistic and pictorial material, the recognition of prosodic elements in utterances, and the comprehension of concepts deteriorate with age. No deterioration of scores with age was only found in the case of text-based inference, control of impulsive reactions, and discourse aspects.

The main aim of the present study was to characterize and compare the quality of functioning with regard to humor appreciation and production, which are abilities based on complex cognitive processes, in individuals in different stages of old age and to identify the determinants of these abilities. The obtained results confirmed earlier reports on the deterioration of humorous content processing abilities with age, but they also provided additional information (Mak

& Carpenter, 2007; Uekermann et al., 2006; Greengross, 2013). We found that subjects aged above 65 scored significantly lower on Verbal Humor Appreciation than the group of younger participants in the RHLB-PL normalization study (Łojek, 2007). However, the essence of investigations in the present study was to show the internal differentiation in the group of elderly people. We found that older seniors do worse in tasks requiring the production of humor than seniors in the early phase of old age. This means that the studies published to date and reported in the literature of the subject comparing young people (aged 18 to 35) with elderly ones (aged over 65) are insufficient and do not reflect the changeability of the processes occurring within the group of seniors (Mak & Carpenter, 2007; Uekermann et al., 2006; Greengross, 2013).

The analysis of the types of errors made when producing jokes reveals that neutral errors dominate regardless of the phase of old age, although individuals in late old age exhibit greater difficulties in humorous information processing and make more neutral as well as absurd errors. This may indicate that, with age, there is an increase in difficulties in recognizing the emotional element and a decrease in sensitivity to the surprise element in humorous linguistic contents. Shammi and Stuss (1999) obtained similar results when testing patients with focal lesions of the anterior part of the right frontal lobe. Mak and Carpenter (2007), however, obtained a different pattern of answers in a group of elderly people, with neutral endings dominant over humorous and absurd ones.

Looking for the determinants of humorous content production and appreciation abilities, we performed two stages of analyses. In the first stage, we took into account the levels of linguistic and pragmatic functions, abstract thinking, and inference. The effectiveness of humorous content processing depends to a significant degree on the above processes, but the pattern of these relations is different in groups representing different phases of old age. The results seem to be consistent with those reported by Mak and Carpenter (2007), who point out that cognitive processes are a predictor of humor appreciation but none of the isolated cognitive functions has sufficient predictive power.

The fact that in early old age there are correlations between humorous answers (correct and absurd) and the processes involved in the performance of all RHLB-PL subtests may attest to a significant role of the right hemisphere in humorous information processing at this age. In late old age, also neutral answers – not correlated with right-hemisphere processes in the earlier stages of old age – turned out to be related to them. The degree of involvement of the processes regulated by the right hemisphere in humor production tasks decreases with age, which seems to be consistent with the HAROLD model (Dolcos et al., 2002).

The model posits a decrease in functional asymmetry of brain hemispheres, particularly the prefrontal areas, in elderly people. This phenomenon concerns situations in which in tasks that, in earlier periods of life, involve mainly processes regulated by one of the hemispheres the functions connected with the activity of the other hemisphere is also registered in later stages. Also studies using the method of event-related potentials, in which the participants were healthy individuals, confirmed the involvement of the right brain hemisphere in humorous content processing (Coulson & Williams, 2005).

In the second stage, investigating the determinants of humor appreciation and production, we took personal variables into account: age, general level of mental functioning, higher and secondary education, professional activity, and health condition. The obtained results show that humorous content processing abilities can be predicted based on the overall cognitive level and higher education. This means that these two factors can be regarded as protective against the limitations appearing with age in the analyzed processes. Thus, higher education and high cognitive level make it possible to predict better humor processing abilities in old age. People with these characteristics have higher abilities of using humor in daily life, which significantly improves their quality of life (Radomska, 2011). The remaining variables did not turn out to be significant predictors.

An interesting result was the non-significance of the age variable. Detailed analyses have shown that, due to the interactions between age and the general level of cognitive functions, age becomes a less significant predictor of humor-related competencies, while cognitive level remains a significant one. This means that there is no simple and direct relationship between the subjects' age and their humor processing abilities: this relationship is mediated by mental state.

Gender turned out to be a variable differentiating performance in Verbal Humor Appreciation only among younger seniors. Women performed this task better than men, which confirms the research reports of women's higher sensitivity to humorous stimuli (Kohn, Kellermann, Gur, Schneider, & Habel, 2011). Research also shows that in the elderly population humor is a way of coping with difficult situations – but only in women, not in men. Unfortunately, still little is known about the mechanisms of this differentiation (Greengross, 2013). By contrast, humor understood as a strong point of personality is described more often in men (Ruch, Proyer, & Weber, 2010).

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