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Does mastering of abstract words decline with age?

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ABSTRACT

The aim of this study is to focus on the verbal stimuli of the Vocabulary subtest of the Wechsler Adult Intelligence Scale – Fourth Edition (WAIS-IV). To our knowledge, this is the first research to examine whether the abstractness/concreteness and the lexical category of the words in the WAIS-IV vocabulary subtest influence the ability to explain their meaning. In the first step, we collected ratings of the degree of abstractness/concreteness and the lexical category of the 27 verbal stimuli of vocabulary subtest. From the second step, the results showed that the ability to explain the meaning of words for 497 participants (aged 19–89) was better with concrete concepts than with abstract ones; and the concreteness effect, i.e., the advantage in the processing of the concrete over the abstract terms, does not disappear with age. More specifically, the ability to define the abstract words does not decline with age. Still, this ability is maintained likely because linguistic knowledge is preserved in healthy elderly. Besides, the correctness in defining nouns is always superior to that in defining adjectives and verbs across all age groups. The nouns are defined more correctly than adjectives in the all age groups. The verbs are defined more correctly than adjectives in the all age groups except for the groups over 60 years of age, although at 80–89 years of age the verbs are statistically more difficult to define than adjectives.

Introduction

Vocabulary knowledge is one of the few cognitive functions that seems to be relatively preserved in older people. Most of the literature about the word knowledge across the lifespan suggests little changes in vocabulary with aging (Alwin, 1991; Lövdén et al., 2004; Singer et al., 2003), or even better performance in older adults (e.g., Ben-David et al., 2014, 2015; Gold et al., 1995; Kavé & Yafé, 2014; Kavé & Halamish, 2015; Royle et al., 2019). Moreover, differences in vocabulary are independent of changes over time, suggesting that younger and older adults are similarly affected by changes in word usage (Ben-David et al., 2015).

Nevertheless, it should be considered that vocabulary tests are generally regarded as interchangeable indicators of vocabulary knowledge, regardless of the used format. Some test batteries also include more than one type of vocabulary test, but they are invariably treated as measures of the same lexical ability construct (e.g., Munoz-Sandoval et al., 1998; Woodcock et al., 1990). In his comprehensive studies of the factorial structure of human abilities, Carroll (1993)concluded: 'The precise format by which vocabulary knowledge is measured generally makes little difference in the factorial composition of the variables, to the extent that the underlying trait being measured is range of native-language vocabulary knowledge' (p. 158). Intelligence test batteries almost always contain at least one test described as a vocabulary test but vary widely in the format used.

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According to some studies, the general shape of the curve that relates age to vocabulary knowledge seems to be independent of the particular task used. Studies using various formats, including multiple-choice tests (Alwin & McCammon, 2001; Schaie, 1996), identification tests (McGrew & Woodcock, 2001), and production tests (McArdle et al., 2005), indicate that vocabulary knowledge increases in early adulthood, flattens out in middle age (40–60), then remains stable or gradually declines in late adulthood (Singer et al., 2003). The size of the increase in vocabulary capacity between early and middle or late adulthood is substantial. In a meta-analysis of 324 studies, Verhaeghen (2003) found that older adults (mean age = 70.4) score about 0.8 standard deviations above young adults (mean age = 21.4).

However, some results also indicate that scores on different types of vocabulary knowledge tests have different relationships with age (Sorenson, 1938; Verhaeghen, 2003). In the meta-analysis of Verhaeghen (2003) the production tests yielded smaller effects (0.68 SD) than multiple-choice tests (0.93 SD). More specifically, the results of Bowles and Salthouse (2008)obtained from 3512 persons showed that four types of vocabulary tasks (production of definitions, multiple-choice synonyms, multiple-choice antonyms and picture identification) have different nonlinear relationships with age, although they form one consistent factor of vocabulary knowledge. Specifically, age was positively related to scores on all four vocabulary tests, although the magnitude varied: correlations with age differed substantially, ranging from .14 for the produce-the-definition test to .30 for the picture identification test. The age differences were still apparent when considering the age trends as non-linear: in earlier adulthood, picture identification had the strongest growth and produce-the-definition the weakest; in later adulthood, picture identification had the strongest decline and multiple-choice synonyms the least. The formats also differ in their relation to other cognitive variables, including reasoning, spatial visualization, memory, and speed. Picture vocabulary was strongly related to spatial visualization and negatively related to speed, the multiple-choice antonyms test was more strongly related to speed; finally, the production of definition test was more strongly related to reasoning and memory. These results suggest that using a single indicator of vocabulary may yield incomplete and somewhat misleading results about the aging of vocabulary knowledge.

But what happens if we analyze the age effect on production of definitions by considering words differing in abstractness level (concrete vs. abstract words) and according to lexical category (nouns vs. verbs vs. adjectives)? Can we assume that, even within a vocabulary definition task, age-differentiated patterns are present?

While the concreteness effect, i.e., the advantage in processing and recall of concrete over abstract words, is quite a sound effect, there is contrasting evidence as to the permanence of such an effect in the elderly (review in Borghi & Setti, 2017). For example, Peters and Daum (2008) found a decline in the memory of concrete words across age, whereas the decline was small for the memory of abstract words. The authors interpreted this phenomenon as consistent with the hypothesis of a reduced concreteness effect with age. A partially contrasting result is reported by Huang et al. (2012), who presented participants with concrete or abstract adjective-noun pairs (e.g., 'green book' vs. 'interesting book'). Both young and older adults showed concreteness effects with adjectives. Still, older adults did not reveal such effect with nouns, likely due to the difficulty in the online adjective-noun integration. Roxbury et al. (2016) tested younger and older adults (mean age 71) in an auditory lexical decision task. Younger adults were faster in RTs and accuracy than older adults, and the concreteness effect was preserved with age. However, fMRI showed that the neural under-pinnings of the effect changed, showing increased activity in the elderly of the left Inferior Frontal Gyrus (IFG), associated with phonological processes, and of the Left Fusiform Gyrus, generally associated with the retrieval of visual attributes. The activation of these areas is likely due to the use of compensatory strategies. Particularly relevant for us, the activation of IFG might testify that older adults need to focus more on phonological than semantic aspects of processing to preserve a good performance.

As this short overview suggests, whether concreteness effects remain with age is all but a clear-cut issue. In part, the differences can be related to the task: with age, the concreteness effect is reduced in recollection, while it seems to be maintained in lexical decision tasks, even if its neural underpinnings change with age. Here, we intend to test whether it remains in a definition task. Two scenarios are possible.

(1) If the capability to define words declines according to word frequency and Age of Acquisition (AoA), then the concreteness effect (i.e., the advantage in the processing of the concrete over the abstract terms), should increase with age. To clarify: more concrete words are more frequent and rated as acquired earlier than abstract words (early AoA), hence they should decline later. Therefore, the processing advantage of concrete over abstract words, present already in young adults, should be maintained and become stronger in the elderly.

(2) If compensatory strategies are working, then the concreteness effect should either decrease or at a minimum remain invariant with age. Abstract concepts should decline slower because they rely more on linguistic information, while concrete concepts should have a faster decline because they are more grounded on sensorimotor experience (Borghi & Setti, 2017). Notice that, while phonological processing declines with aging (Burke & Shafto, 2004), the elderly continue to rely on inner speech (Alderson-Day & Fernyhough, 2015), and semantic abilities are relatively preserved. As to perceptual properties, a decline in vision with age is documented, but compared to younger adults older adults seem to rely more on visual modality than other senses (Costello & Bloesch, 2017; Maguinness et al., 2013). If this is the case, then the concreteness effect should either decrease or remain the same across ages in healthy populations.

The present study focuses on the 27 verbal stimuli of the Vocabulary subtest of Wechsler Adult Intelligence Scale – Fourth Edition (WAIS-IV; Wechsler, 2008) and analyses them starting from the literature on conceptual representation. To our knowledge, no study has considered whether the 27 terms differ in degree of abstractness/concreteness and whether this influences the performance. Generally, abstract concepts (e.g., 'truth,' 'justice') are more difficult to process and to recall than concrete ones (e.g., 'bottle,' 'chair') (concreteness effect: Paivio, 1990; Schwanenflugel et al., 1992). Therefore, we collected ratings of the degree of abstractness/concreteness of the verbal stimuli in order to verify whether their higher abstractness influences the cognitive performance.

Before explaining the procedures we used in detail, we will first define abstract concepts and illustrate our hypotheses.

Abstract/concrete concepts and lexical categories

Abstract and concrete concepts are not in sharp contrast (Barsalou et al., 2018; Borghi & Binkofski, 2014). For a while, scholars have considered them as arranged along a continuum, ranging from the most concrete to the most abstract ones (Wiemer-Hastings et al., 2001). More compellingly, some proposals intend them as points in a multidimensional space, defined by various features and dimensions (Crutch et al., 2013; Harpaintner et al., 2020; Mazzuca et al., 2020; Troche et al., 2017; Villani et al., 2021). It is, therefore, possible to identify different dimensions along which concrete and abstract concepts differ.

Compared to concrete concepts, abstract concepts are typically more detached from the five sensory modalities (Barsalou, 2003; Connell & Lynott, 2012); they do not have a single object as a referent but more interrelated elements. They generally collect heterogeneous members (low-dimensionality categories: Lupyan & Mirman, 2013); they are more complex and are typically acquired later than concrete concepts (AoA, Age of Acquisition) and through language rather than through perception (MoA, Modality of Acquisition, Wauters et al., 2003).

In psycholinguistics, the most usual way to distinguish them is to use ratings of abstractness/concreteness. The most commonly used Italian databases either use a continuous abstractness/concreteness scale (e.g., Barca et al., 2002) or two separate scales (Della Rosa et al., 2010; Villani et al., 2019).

While most studies select concrete and abstract words on the basis of ratings of abstractness/concreteness, several other studies rely on imageability ratings rather than on abstractness/concreteness ones, in line with the classic dual coding theory of Paivio (1990). This theory, which dominated the camp until recently, explained the so-called concreteness effect in terms of imageability – abstract concepts would be less imageable than concrete ones.

Selecting the study items based on one or the other criterion has led to methodological problems: the results of the studies are not easy to compare because they rely on different criteria for item selections. Imageability and abstractness/concreteness are highly correlated, but they are not the same (Kousta et al., 2011).

In recent years new theories emerged, some of which take some insights and inspiration from the original dual coding theory of Paivio (1990); the most interesting and influential ones are multiple representation views (review in Bolognesi & Steen, 2018; Borghi, Binkofski et al., 2017; Borghi et al., 2018), according to which concrete and abstract concepts would differ in terms of grounding: the first would rely more on sensorimotor experience, while the second would evoke to a more considerable extent linguistic, social, emotional and interoceptive experiences (Borghi et al., 2018, 2019; Connell et al., 2018; Dove, 2014, 2016, 2018; Fini & Borghi, 2019; Mazzuca et al., 2021; Newcombe et al., 2012; Ponari et al., 2018; Vigliocco et al., 2013; Zdrazilova & Pexman, 2013). In particular, the Words As social Tools (WAT) view (Borghi et al. 2018, 2019) and the Language as an Embodied Neuroenhancement and Scaffold theory (LENS) theory (Dove, 2020) emphasize the importance of language for abstract concepts representation.

To determine the degree of abstractness/concreteness of the 27 items of the Vocabulary WAIS-IV subtest, we decided to use a strategy that allowed us to combine the information from different ratings. As explained in more detail in the method section of this paper, because abstract concepts are typically less imageable, acquired later and through the linguistic modality, we asked 32 students of psychology to rate the 27 words on abstractness/concreteness, imageability, age of acquisition, modality of acquisition, body object interaction and social metacognition.

Obtaining evaluations based on the combinations of all ratings, using the indexes that are generally more correlated to concreteness and abstractness, allowed us to have very reliable measures.

The abstractness of words has often been associated with word lexical categories. Nouns, which refer to clearly bounded objects, are learned earlier than verbs (Gentner & Boroditsky, 2001) and are typically considered more concrete than verbs and adjectives. This rule is not always true: for example, a verb like 'to grasp' might be evaluated as more concrete than the noun 'truth.' To investigate the relationship between lexical category and ability to define terms, we also decided to divide the items of Vocabulary WAIS-IV subtest in function of their lexical category and to study of age effect.

In summary, the aims of the present work are the following:

(1) We intend to verify whether definitions differ with concrete, abstract, and intermediate items with a highly selected sample. Precisely, we predict that the ability to define would be better with concrete, then with intermediate, and finally with abstract concepts.

(2) We intend to verify whether the concreteness effect, if existent, changes depending on participants' biological age. Furthermore, we aim to test whether our data support research showing that the concreteness effect disappears with age or whether, given the higher selected abilities of our participants, the effect remains. Specifically, if frequency and Age of Acquisition (AoA) of words play a major role, performance with abstract concepts should decline; if the ability to define abstract concepts relies on linguistic networks preserved with age, then no decline should occur.

(3) We intend to verify whether the performance differs with nouns, verbs, and adjectives. The reason underlying the choice to investigate grammatical categories, beyond their intrinsic interest, lies in the relationship between abstractness and grammatical category. According to some proposals, abstract concepts typically have relational character – better, it is easier to find relational abstract concepts than concrete concepts (Asmuth & Gentner, 2017). Relational categories include members having a common relational structure rather than intrinsic properties, the meaning of which changes more across contexts (Gentner & Asmuth, 2019). Interestingly, the relational character is related to the grammatical category. Compared to nouns, verbs, and adjectives are more relational and mutable, that is, they assume different meanings across different contexts (Earles & Kersten, 2017; Ghandhari et al., 2020). However,

not all verbs are relational, and nouns can be relational (e.g., agreement and causation) – but relational nouns are often abstract ones. On this basis, we predict a higher ability to define nouns than verbs and adjectives at all ages.

In order to achieve the above objectives, we had to envisage two steps:

(1) A first step was to classify the 27 words of the Vocabulary WAIS-IV subtest in their concreteness (concrete, intermediate, abstract concepts) and their lexical category (nouns, verbs, and adjectives);
(2) A second step was to study the age effect on the production of definitions of words (controlling for the education years) according to the two classifications of words extracted from the first step.

Method

Participants, materials

First step of research: to categorize the 27 words of the Vocabulary WAIS-IV subtest
The Wechsler Adult Intelligence Scale – Fourth Edition (WAIS-IV; Wechsler, 2008) is the most common intelligence test used to test the cognitive capabilities of adults and older adolescents (Canivez & Watkins, 2010). The WAIS-IV provides a general intelligence composite score (Full Scale Intelligence Quotient, IQ) and four scores corresponding to first-order factors: Verbal Comprehension (VCI), Perceptual Reasoning (PRI), Working Memory (WMI), and Processing Speed (PSI). The Vocabulary subtest of WAIS-IV (that belongs to CVI) is composed of 30 items, that is, three visual stimuli and 27 verbal ones. Participants are required to name the first three pictures and describe the meaning of the 27 verbal stimuli.

In this first step of research, the 27 words of the Vocabulary WAIS-IV subtest were selected and presented on a paper questionnaire to 32 students of Psychological course. We considered only the words from the 4th to the 30th item since for the first three items, participants were required to name and not define the word.

Second step of research: to study the age effect on the production of definitions of words
The Vocabulary WAIS-IV subtest starts for each participant from item number 5; in case a participant does not obtain a full score of 2 for items 5 and 6, he/she will be submitted the preceding items in reverse order until when he/she obtains a score 2. The submission of the subtest will be interrupted when a participant has obtained 0 scores for three items in sequence. The scores assigned to the first three items are 0 (error) or 1 (correct). From item number 4 on, the responses are coded using three scores: 2 if the provided definitions are precise, correct, and complete, 1 if they are not complete, and 0 if they are completely wrong. For example, if at the question 'what does bed mean?,' the examinee answers 'furniture for sleeping' s/he gets 2 points, if instead s/he answers 'furniture' s/he gets 1 point, while if s/he says 'an iron thing' s/he obtains 0 points.

2173 participants (1072 males, 1102 females) aged between 16 and 90 years (mean age = 51.0, sd = 24.38) were used for the Italian Standardization of WAIS-IV (Orsini & Pezzuti, 2013) analyzing the Vocabulary subtest. Each Vocabulary' item received a score of 0, 1 or 2 depending on the accuracy of the definition given to the words. The administration of the subtest was interrupted after three items with a score of 0. The maximum score obtainable was 57. So, we decided to select a subsample of participants who had been submitted to all the items of the Vocabulary WAIS-IV subtest, and for which it was not necessary to apply the interruption rule (defined by three consecutive errors, or rather three items given a score of zero). Hence, the subsample was highly selected and had an overall high-performance level: the mean Vocabulary subtest score of this subsample was 46.84 (sd = 5.39), with a minimum score of 28 and a maximum score of 57. This selected subsample was composed of 497

participants (241 males and 256 females) among 19 and 89 years of age (mean$_{age}$ = 45.51, sd = 19.23) with an education level ranging from 5 to 23 school years (mean$_{education\ years}$ = 14.62, sd = 3.49). This was divided into eight age groups, as shown in Table 1.

In the selected sample as well as in the excluded sample the proportion of females and males is similar for each age group. Comparing the age means for the eight age ranges between two groups (selected and excluded) a null to medium effect of age emerged. The medium effect emerged only for the age group 70–79 where the excluded group had a lower age mean.

In the selected sample as well as in the excluded sample there is a difference in the level of education between the different age groups [respectively F(7, 489) = 15.77, $p < -001$. eta^2 = .18, F(7, 489) = 255.11, $p < .001$, eta^2 = .52], with the level of education increasing up to the 30–39 age group and then decreasing in both samples. When the differences in years of education between the two groups are analyzed for each age group considered, a small to large effect of education emerges. The level of education is always higher in the subsample and in particular for the age groups above 30 years. In light of these results in subsequent analyses, the variable years of education will be used as a covariate.

The two samples were also compared in performance on the WAIS-IV and the results shown in Table 2 indicate a wide difference between the two groups especially for the subtests and the Verbal Comprehension index, with the selected group having higher performance means.

The study was approved by the ethics committee of the Department of Clinical and Dynamic Psychology, and Health Studies of Sapienza University. They were collected in an anonymous format, despite having requested the informed consent signed by the participants.

Data analysis

First step of research: to categorize the 27 words of the Vocabulary WAIS-IV subtest

Because abstract concepts are typically less imageable, acquired later and through the linguistic modality, we asked to 32 students of psychology to rate the 27 words on abstractness/concreteness, imageability, age of acquisition, and modality of acquisition. Throughout the ratings, we used the formulations typically used in the literature. Differently from ratings of abstractness/concreteness, imageability, and modality of acquisition, Age of Acquisition (AoA) ratings require participants to rate at which age they have learned a given word. The peculiar way to address Age of Acquisition (AoA) deserves some justification. Notably, Age of Acquisition (AoA) norms are extensively used in psycholinguistics since the '80ies. The construct was deemed as quite important, and Morrison and Ellis (1995) even claimed that all frequency effects could be explained in terms of AoA. To assess it people are typically required to determine at which age a given word was learned. The ratings are typically collected among university students. The Age of Acquisition (AoA) norms were criticized because it was argued that the ratings might be influenced by the frequency of the words: people might evaluate a word as acquired earlier when it was more frequently encountered. To counter this criticism, Age of Acquisition (AoA) norms obtained through ratings of students have been compared with other more objective measures, like the age at which children learned these words at school, and the proportion of children who knew the meaning of each word. Importantly, the subjective and objective indexes were highly correlated and explained the same amount of variance (for a review of this literature, see Ghyselinck et al., 2004). Based on such evidence, we decided to use the question, which is typically employed in the literature, and submit it for ratings to a group of undergraduates together with the other dimensions. We also added two further ratings: Body Object Interaction (BOI – Tillotson et al., 2008) and Social Metacognition (SM – Borghi et al., 2018b). BOI is a measure indicating to what extent the item implies interaction with our body; high values generally correlate with concreteness values (Villani et al., 2019). Social Metacognition is a measure indicating that we are aware that our knowledge of a given concept is inadequate; thus, we need others to fill the gaps and complement it; high values generally correlate with abstractness values (Villani et al., 2019; Mazzuca et

Table 1. Characteristics of the two sample (selected and not selected).

Age groups	Selected subsample (n = 497)					Excluded sample (n = 1677)					Effect size for comparisons	
	Gender		Total	Age	Years of Education	Gender		Total	Age	Years of Education		
	F n(%)	M n(%)	n(%)	Mean (sd)	Mean (sd)	F n(%)	M n(%)	n(%)	Mean (sd)	Mean (sd)	Cohen' d for age	Cohen' d for years of education
16–19	17(51.5)	16(48.5)	33(6.6)	17.8(1.2)	11.8(1.8)	119 (49.0)	124 (51%)	243(14.5)	17.4(1.1)	10.8(2.1)	.35	.51
20–29	52(50.0)	52(50.0)	104 (20.9)	24.8(2.6)	15.6(2.4)	133 (51.8)	124 (48.2)	257(15.3)	24.4(2.7)	14.3(2.5)	.18	.53
30–39	48(54.5)	40(45.5)	88(17.7)	34.1(2.9)	16.6(2.7)	70(43.2)	92(56.8)	162(9.7)	33.7(2.9)	13.8(3.6)	.14	.88
40–49	30(50.8)	29(49.2)	59(11.9)	44.2(3.1)	14.8(3.2)	60(63.8)	34(36.2)	94(5.6)	44.2(2.9)	12.5(3.3)	.00	.71
50–59	43(64.2)	24(35.8)	67(13.5)	54.3(2.9)	14.1(3.6)	58(50.4)	57(49.6)	115(6.9)	54.2(2.6)	12.5(3.8)	.04	.43
60–69	30(44.8)	37(55.2)	67(13.5)	64.1(2.8)	14.7(3.3)	67(49.6)	68(50.4)	135(8.1)	65.2(2.6)	10.2(4.5)	.41	1.14
70–79	29(48.3)	31(51.7)	60(12.1)	72.8(2.4)	12.4(4.2)	171 (50.3)	169 (49.7)	340(20.3)	74.4(2.9)	6.4(3.3)	.60	1.59
80–89	8(42.1)	11(57.9)	19(3.8)	83.2(2.8)	12.2(5.3)	167 (50.5)	164 (49.5)	331(19.7)	83.9(2.9)	6.0(3.1)	.25	1.43
16–89	257 (51.7)	240 (48.3)	497(100)	45.6 (19.3)	14.6(3.5)	845 (50.4)	832 (49.6)	1677 (100)	52.6 (25.5)	10.0(4.6)	.31	1.12

For interpretation on Cohen's d effect size: small d = .20, medium d = .50, large d = .80.

Table 2. Differences between selected and excluded samples on performances to WAIS-IV.

Indices/subtest	Selected subsample (n = 497)		Excluded sample (n = 1677)		Cohen's d
	Mean	SD	Mean	SD	
Verbal Comprehension Index (VCI)	124.91	20.76	106.93	23.30	.79
Similarities	11.92	2.75	9.43	2.82	.89
Vocabulary	12.77	2.51	9.20	2.60	1.38
Information	12.27	2.97	9.35	2.63	1.08
Perceptual Reasonins Index (PRI)	144.73	55.13	126.17	51.02	.36
Block design	11.03	2.93	9.69	2.95	.45
Reasoning matrix	11.43	2.99	9.58	2.83	.65
Visual puzzle	11.09	3.21	9.69	2.75	.49
Working Memory Index (WMI)	97.77	20.90	90.44	16.36	.42
Digit span	11.34	3.07	9.60	2.85	.60
Arithmetic	11.32	3.09	9.57	2.76	.62
Processing Speed Index (PSI)	116.84	19.91	106.64	20.09	.51
Symbol search	10.88	3.19	9.72	2.85	.40
Coding	11.21	3.12	9.63	2.79	.55
Full Scale Intelligence Quotient	129.46	28.29	111.62	29.30	.61

For interpretation on Cohen's d effect size: small d = .20, medium d = .50, large d = .80.

al., under review). More generally, the measures we selected for the ratings came from a previous study (Villani et al., 2019) in which Principal Component Analysis led to the emergence of a 3-components solution.

In brief, the 32 students were required to evaluate the words on a 3-point scale on six dimensions that, according to previous work, are strictly related to abstractness (e.g., Villani et al., 2019): Abstractness/Concreteness, Imageability, Age of Acquisition, Modality of Acquisition, Social Metacognition. The instructions were as follows:

(1) Abstractness/Concreteness: "We ask you to evaluate how much a word is concrete, i.e., it refers to objects, living beings, actions or materials that can be experienced through the senses, or is abstract: score 1 corresponds to a concrete word, score 3 to an abstract word and 2 score corresponds to an intermediate word;

(2) Imageability: 'We ask you to evaluate how easily and rapidly a word evokes a mental image, a visual representation, a sound or some other sensorial experience: score 1 corresponds to a low imageable word, score 3 to highly imageable word';

(3) Age of Acquisition: "We ask you to estimate at which age you have acquired a word: score 1 = age 0–4 years, score 2 = age 5–10 yrs, score 3 = age +11 yrs;

(4) Modality of Acquisition: 'We ask you to evaluate how you think you have acquired the meaning of each word: through direct experience (e.g., somebody has shown you the object to which it refers), through language (e.g., somebody has explained to you the word meaning) or through a combination of the two modalities¸ score 1 corresponds to experientially acquired, score 3 to linguistically acquired';

(5) Social Metacognition: 'We ask you to evaluate how much you think that you need/have needed others to understand the meaning of each word: score 1 corresponds to never, score 3 to always';

(6) Body Object Interaction: 'We ask you to evaluate th easiness with which the human body can physically interact with the object/entity to which each word refers. Score 1 corresponds to easy, score 3 to difficult.'

In sum, words obtaining low mean scores (rounded to 1) across the different dimensions corresponded to more concrete words, words obtaining high scores (rounded to 3) to abstract words.

Second step of research: to study the age effect on the production of definitions of words

The linear Mixed Model has become more appealing for analyzing repeated data. It uses the generalized least squares method, which is generally better than the ordinary least squares used by general linear model (e.g., with ANOVA or MANOVA). The Mixed Model is considered superior to the conventional approaches to estimate and test the fixed effects in the model and random variation of individual growth parameters around the mean growth trajectory (Baayen et al., 2008; Kliegl et al., 2010; Pinheiro & Bates, 2000; Wang & Goonewardene, 2004).

We conducted a Linear Mixed Model with eight levels of age and three types of concepts of words (concrete, intermediate, and abstract words) as independent variables and fixed factors, intercept as random factor, and number of education years as covariate, on the dependent variables represented by the scores of mean correctness of the definition of concrete, intermediate, and abstract words. These statistical analyses were carried out using IBM SPSS software (version 25) and after restructuring londitudinal data from wide to long form, such that the three types of words (concrete, intermediate, and abstract words) appear in vertical format.

We conducted also a second Linear Mixed Model with eight levels of age and three types of lexical categories of words (nouns, verbs, and adjectives words) as independent variables and fixed factors, intercept as random factor, and number of education years as covariate, on the dependent variables represented by the scores on mean correctness of the definition of nouns, verbs, and adjectives.

All statistical analyses were carried out using the software IBM SPSS version 25.

Results

First step of research: to categorize the 27 words of the Vocabulary WAIS-IV subtest

In Table 3 we report the means of the ratings of the 32 students for the six dimensions, useful to determine the overall words concreteness/abstractness of the subtest Vocabulary of WAIS-IV.

The items were also classified by 32 psychological students according to their lexical category, distinguishing them into verbs, adjectives, and nouns. In Table 4 we report the number of the items of the vocabulary WAIS-IV subtest with the two classifications. It is not possible to write the words for royalty reasons, but the words can be easily reconstructed since, in the Italian version, the word order has not been changed.

We can see that all four concrete items are nouns, the 15 intermediate items consist of seven verbs, four adjectives, and four nouns, while the eight abstract items consist of four adjectives, three verbs, and one noun. Concrete items are thus entirely nouns; intermediate and abstract items include all lexical categories with a dominance of adjectives.

Second step of research: to study the age effect on the production of definitions of words

(a) From the results of the first Lineal Mixed Model, a significant effect for fixed effects about the age ($F_{(7, 489)} = 2.67$, $p < .01$), the three types of concepts ($F_{(2, 978)} = 662.54$, $p < .001$) and the interaction of age for the three types of concepts ($F_{(14, 978)} = 2.72$, $p < .01$) emerged. The results show also there is a random variability between the subjects (see significant effect of intercept: ($F_{(1, 489)} = 28534.26$, $p < .001$).

Analyzing the age effect by means of post-hoc tests comparing the performance of the eight age groups, both on the definition of concrete words and on the definition of abstract words, no statistically significant differences emerge: the ability to define such words is similar among the various age groups (see Figure 1). On the definition of intermediate words the statistically significant differences ($p < .01$) emerge between the three groups after 60 years of age compared to the two groups of 20–29 and 30–39 years.

Table 3. Means (rounded) of the ratings of the words of the Vocabulary WAIS-IV subtest (n = 32).

N° Item	Ratings on a 3 points scale							Classification of words
	C/A	Im	AoA	MoA	SM	BOI	Mean	
4	1	1	1	1	1	1	1	Concrete
5	1	1	1	1	1	1	1	Concrete
6	1	1	1	1	1	1	1	Concrete
7	2	2	2	2	2	2	2	Intermediate
8	2	2	2	2	2	2	2	Intermediate
9	1	1	1	1	1	1	1	Concrete
10	2	2	2	2	2	2	2	Intermediate
11	2	2	2	3	2	2	2	Intermediate
12	2	2	2	2	2	2	2	Intermediate
13	3	2	2	3	2	2	2	Intermediate
14	3	2	2	3	2	2	2	Intermediate
15	2	2	2	2	2	2	2	Intermediate
16	2	2	2	2	2	2	2	Intermediate
17	2	2	2	2	2	2	2	Intermediate
18	3	2	2	2	2	2	2	Intermediate
19	3	2	2	3	2	2	2	Intermediate
20	2	3	3	3	2	2	2	Intermediate
21	2	3	3	3	2	2	2	Intermediate
22	3	3	3	3	3	3	3	Abstract
23	3	3	3	3	3	3	3	Abstract
24	2	2	2	2	2	2	2	Intermediate
25	3	3	3	3	3	3	3	Abstract
26	3	3	3	3	3	3	3	Abstract
27	3	3	3	3	3	3	3	Abstract
28	3	3	3	3	3	3	3	Abstract
29	3	3	3	3	3	3	3	Abstract
30	3	3	3	3	3	3	3	Abstract

C/A = Concreteness/Abstractness; Im = Imageability; AoA = Age of Acquisition; MoA = Modality of Acquisition; SM = Social Metacognition; BOI = Body Object Interaction.

Analyzing the effect of the three types of concepts the mean performances with concrete, intermediate, and abstract words are different: in keeping with our hypothesis, the results of post-hoc comparison tests reveal that concrete words are defined more correctly than both abstract and intermediate words ($p < .01$). Additionally, abstract words, instead, are defined with more difficulty across all ages.

(a) A second Lineal Mixed Model has been conducted on the mean correctness of the descriptions to the verbal stimuli of nouns, verbs, and adjectives. From the results, a significant effect for the age ($F_{(7, 489)} = 3.273$, $p < .01$), the three types of lexical categories ($F_{(2, 978)} = 47.06$, $p < .001$) and their interaction ($F_{(14, 978)} = 2.112$, $p < .01$) emerged. The results show that there is a random variability between the subjects (see the significant effect of intercept: ($F_{(1, 489)} = 24647.80$, $p < .001$).

Analyzing the age effect by means of post-hoc tests comparing the performances of the eight age groups, both on the definition of nouns and on the definition of adjectives no statistically significant differences emerge: the ability to define such words is similar among the various age groups (see Figure 2). On the definition of verbs, statistically significant differences ($p < .01$) emerge between the three groups after 60 years of age in comparison with the group of 30–39 years old who show higher performance. The group of 80-year-olds also differs in reduced performance from the groups of 50–59, 60–69, and 70–79 years.

Comparing the three types of words for each age group, the correctness in defining nouns is always superior to that in defining adjectives and verbs across all age groups. Nouns are defined more correctly than adjectives in the all age groups except for the groups over 60 years of age, although at 80–89 years of age the verbs are statistically more difficult to define than adjectives (see Figure 2).

Table 4. Classification of the words of the WAIS-IV Vocabulary subtest.

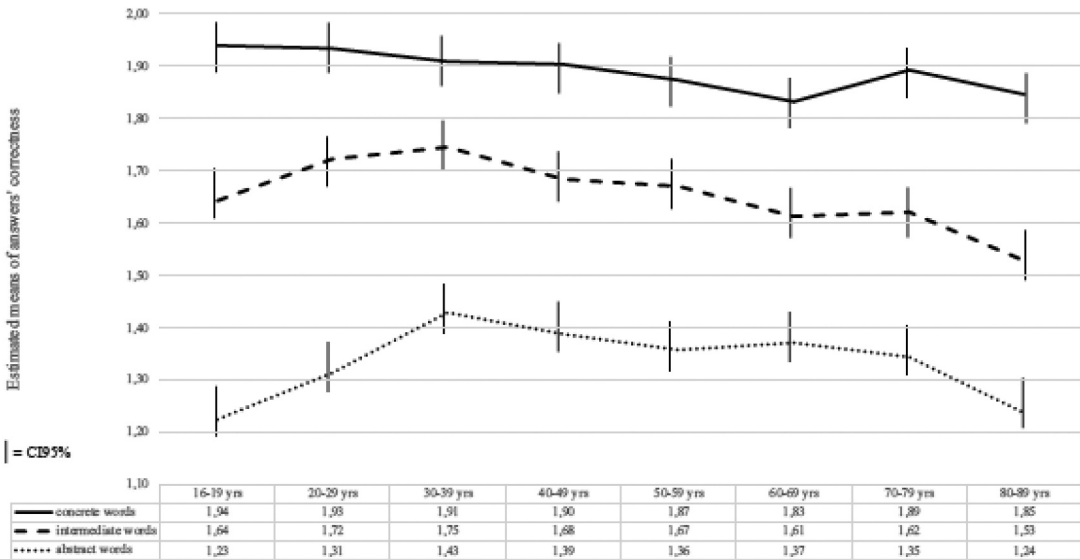| Number of WAIS-IV Vocabulary Items	Classification: Concreteness/Abstractness	Classification: Nouns, Verbs, Adjective
4	Concrete	Noun
5	Concrete	Noun
6	Concrete	Noun
7	Intermediate	Verb
8	Intermediate	Verb
9	Concrete	Noun
10	Intermediate	Adjective
11	Intermediate	Verb
12	Intermediate	Adjective
13	Intermediate	Noun
14	Intermediate	Noun
15	Intermediate	Verb
16	Intermediate	Adjective
17	Intermediate	Noun
18	Intermediate	Noun
19	Intermediate	Verb
20	Intermediate	Verb
21	Intermediate	Verb
22	Abstract	Verb
23	Abstract	Adjective
24	Intermediate	Adjective
25	Abstract	Verb
26	Abstract	Noun
27	Abstract	Adjective
28	Abstract	Verb
29	Abstract	Adjective
30	Abstract	Adjective

	16-19 yrs	20-29 yrs	30-39 yrs	40-49 yrs	50-59 yrs	60-69 yrs	70-79 yrs	80-89 yrs
concrete words	1,94	1,93	1,91	1,90	1,87	1,83	1,89	1,85
intermediate words	1,64	1,72	1,75	1,68	1,67	1,61	1,62	1,53
abstract words	1,23	1,31	1,43	1,39	1,36	1,37	1,35	1,24

Figure 1. Estimated means of correctness of definitions for concrete, intermediate and abstract words as a function of age.

Discussion

Vocabulary knowledge is one of the few cognitive skills that remain relatively unimpaired in adulthood, appearing to peak around age 50 or maybe later, and decline only slowly, if at all, in old age. However, these results are based on the assumption that only a single dimension of vocabulary knowledge is tested in any given vocabulary test. In fact, Bowles et al. (2005) have assumed that
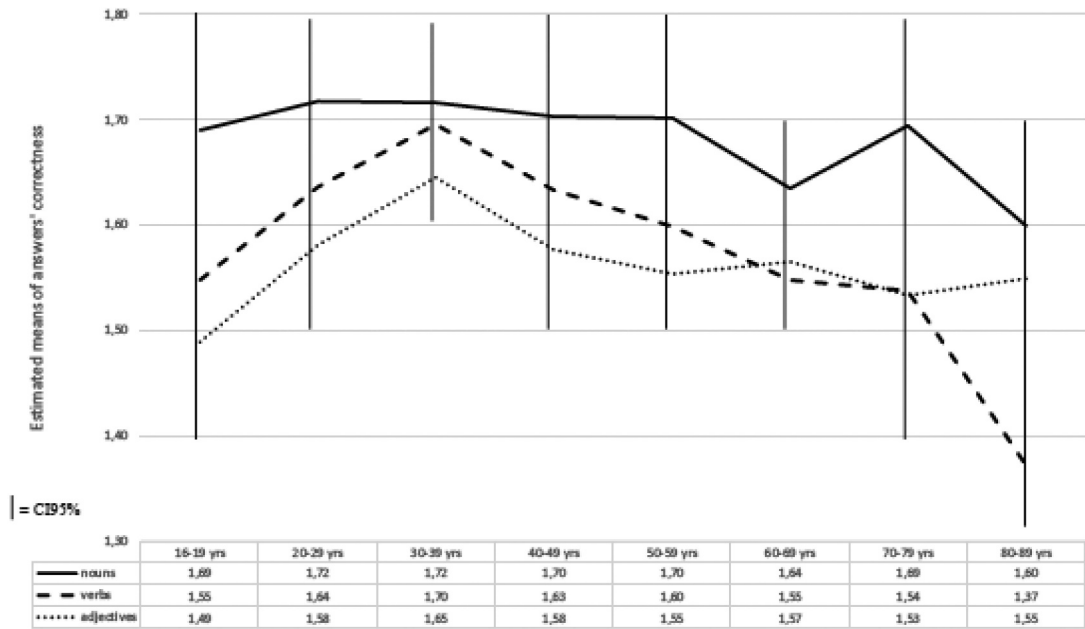
Figure 2. Estimated means of correctness of definitions for nouns, verbs and adjectives as a function of age.

	16-19 yrs	20-29 yrs	30-39 yrs	40-49 yrs	50-59 yrs	60-69 yrs	70-79 yrs	80-89 yrs
nouns	1,69	1,72	1,72	1,70	1,70	1,64	1,69	1,60
verbs	1,55	1,64	1,70	1,63	1,60	1,55	1,54	1,37
adjectives	1,49	1,58	1,65	1,58	1,55	1,57	1,53	1,55

vocabulary knowledge may be multidimensional and there may be age-differentiated patterns for different aspects of vocabulary (Bowles et al., 2005). In particular, their results indicated that the vocabulary test is not unidimensional but bidimensional, with Basic Vocabulary and Advanced Vocabulary factors. An analysis of age differences indicates that basic vocabulary is highest around the age of 30, with a negative relation to age in late adulthood; in contrast, advanced vocabulary is unrelated to age between ages 35 and 70. However, the factors were directly related to difficulty of items: one factor consisted of the easy items (basic vocabulary), whereas the other factor consisted of the difficult items (advanced vocabulary).

In this study, we evaluated the structure of the WAIS-IV vocabulary subtest by analyzing the words to be defined by distinguishing them according to a conceptual classification (concrete, intermediate, and abstract words) and to a lexical classification (nouns, adjectives, and verbs). The results are quite clear. Firstly, they showed that concrete concepts of the WAIS-IV vocabulary subtest were easier to define than intermediate and abstract concepts for all age groups, as expected. Similarly, the results indicate that nouns are easier to define than verbs and adjectives. Notably, we obtained these results even though we examined the performance of a sample with high abilities since all subjects answered all items of the vocabulary subtest.

As to the relationship between abstractness and age of participants, our results extend those on concreteness effect. They indicate that this effect is also present in a definition task in the adolescent and adult population (see also Barca et al., 2017, for a study on children). Importantly, our results indicate that the concreteness effect remains across age groups, despite having assessed a group with the highest cognitive efficiency in this vocabulary ability.

As anticipated in the introduction, there are controversial data in the literature as to the permanence or decline of the concreteness effect with aging. There could be many reasons why we found that it was preserved. First, we used a definition task: differently from other studies here, we did not test online processes in which knowledge has to be rapidly used, but a kind of knowledge, the verbal one, that is relatively stable across the lifespan. Second, our sample was a highly selective one, with outstanding cognitive capabilities: we tested participants whose performance was very good, independent of age. From the results, the effect of age is particularly evident after age 60 yrs for intermediate

vocabulary definition and verbs. One possible explanation could be that there was a higher rate of cognitive impairment and preclinical dementia in the latter age group; even though all participants performed well on the vocabulary test, their general cognition might be somewhat impaired.

In any case, our results obtained with a large sample support the hypothesis that the ability to define abstract concepts does not decrease markedly with age, as the frequency and Age of Acquisition of abstract words would lead one to expect. Instead, the difference between the performance with concrete and abstract concepts remains substantially invariant across age groups. The absence of a decline in definition ability of abstract concepts despite their late Age of Acquisition and low frequency is likely due to the fact that they rely more than concrete ones on linguistic experience, which is relatively preserved in the elderly, as proposed by multiple representation views (e.g., Dove, 2020) and in particular by the Words As social Tools (WAT) proposal (Borghi et al., 2018).

Different complementary hypotheses have been offered to explain why the vocabulary is resilient to age-related decline. Although general connectivity in the semantic network seems to decrease with age (Craik & Salthouse, 2011), everyday experience potentiates words previously learned in different contexts, increasing memory traces (Burke et al., 2000). Consequently, older adults' life experience produces enriched word knowledge that can serve as an alternative pathway to word meaning (dual representation theory of knowledge; McGinnis & Zelinski, 2000). According to dual representation theory, there are two cognitive representations of vocabulary knowledge, an exact detailed definition and a generalist one (Brainerd & Reyna, 1992). Otherwise, there may be a continuum of specificity in multiple representations (McGinnis & Zelinski, 2003). Older adults are less able to generate and access the detailed definition (McGinnis & Zelinski, 2000) and compensate by relying more on the generalist representation (Botwinick & Storandt, 1974; Tun et al., 1998). Further research is necessary to investigate the content of the definitions and investigate the effect of abstractness and word category in a less selected sample of older people and with cognitive impairment.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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