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The effects of creativity and crystallized intelligence on metaphor comprehension

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Abstract: The nature of the cognitive processes involved in metaphor comprehension has spurred ongoing debate, particularly concerning the relative contributions of general analogy versus language-specific categorization. One prominent proposal posits that metaphor comprehension necessitates analogical reasoning to establish a relationship between the target and the source. An alternative perspective posits that metaphors can be interpreted as categorization statements. This paper adopts an individual-differences approach to probe metaphor comprehension, encompassing both literary and non-literary metaphors. The research conducted a metaphor-comprehension study involving college students, measuring both creativity (using the Chinese Remote Association Test) and crystallized verbal intelligence (using the verbal subscale of the Wechsler Adult Intelligence Scale). The research findings revealed distinct predictive relationships between each measure and metaphor comprehension. Specifically, it had been observed that crystallized intelligence significantly influences comprehension across a wide spectrum of metaphor types, encompassing both literary and non-literary examples. Conversely, individual differences in creativity predominantly impact the comprehension of more cognitively intricate metaphors, notably those originating from literary sources.

Key words: creativity; crystallized intelligence; metaphor comprehension

1 Introduction

Metaphor, characterized by the use of language to describe one concept in terms of another that is conceptually distinct, has been an enduring subject of intrigue for various disciplines [1]. Given its evident significance in human cognition and language, a fundamental objective of cognitive science is to unravel the mechanisms through which individuals comprehend metaphors. Despite decades of research, a definitive consensus on the psychological mechanisms underpinning metaphor comprehension remains elusive [2]. Furthermore, while there is evidence indicating that individuals vary in their ability to process metaphors, the precise nature of these individual differences remains ambiguous. Consequently, this paper aims to investigate individual differences in the comprehension of metaphors and shed light on the pattern of metaphor comprehension.

2 Background

2.1 Individual-differences: creativity and crystallized intelligence

Only a limited number of studies have delved into the influence of individual differences in cognitive abilities on metaphor comprehension. The creative processes involved in generating complex linguistic outputs, such as irony, humor, and metaphor, encompass key cognitive abilities such as linguistic flexibility, fluency, and originality [3]. These

higher-level linguistic outputs share a common requirement of effectively processing, activating, and maintaining multiple meanings of a concept, including less common and weakly associated meanings, which is the key process of creativity. Surprisingly, there exists a paucity of research investigating the relationship between individual differences in creative abilities and the processing of high-level language products, such as metaphors [4]. Consensus has been reached regarding the correlation between creativity and metaphor comprehension, indicating that individuals with high levels of creativity outperform those with low levels of creativity in comprehending both novel and conventional metaphors [5][6].

On the other hand, crystallized intelligence involves the ability to reason, primarily using verbal skills, by drawing upon one's existing knowledge and experience. Consequently, it is likely to support semantic integration. Although a limited number of studies have investigated the influence of crystallized intelligence on metaphor comprehension, the findings have yielded inconsistent results [7]. Trick and Katz (1986) found positive correlations between people's scores on a test of analogical reasoning and their ratings of the comprehensibility of metaphors, especially when the source and target were drawn from dissimilar categories. A measure of vocabulary knowledge did not add any predictive power. Thus, the study did not provided support for a role of crystallized verbal intelligence in metaphor comprehension. Several studies have reported a positive relationship between crystallized intelligence and the comprehension of metaphors [8]. Considering these observations, our aim is to investigate the combined effect of both creativity and crystallized intelligence on metaphor comprehension.

2.2 The present study

The study involved evaluating college students' aptitude for comprehending two metaphor types-literary and non-literary metaphors-while correlating their performance with measures of creativity and crystallized intelligence. The primary objective was to ascertain whether and how individual differences in creativity and crystallized intelligence affect the metaphor comprehension pattern.

3 Method

3.1 Participants

A total of 140 undergraduate and graduate students from the Dalian University of Technology, China, aged between 20 and 27, participated in the study. Data from 38 participants were dropped from analyses, leaving a final sample of 102 participants was included for further analysis.

3.2 Design and materials

3.2.1 Parts of instrument

The study consisted of three sequential parts, completed in a predetermined order by the participants. The first two were assessments of individual differences in cognitive tasks, and the third and final part involved metaphor comprehension.

Part 1: Chinese Remote Association Test

The administered test comprises a total of 30 items, with each item containing sets of three clue characters derived from concepts that are distantly related. Participants are tasked with identifying a target character that, when combined with each of the three given characters, forms a valid two-character Chinese word. This task is to be completed within a time limit of 25 minutes. Creativity scores in this context are indicative of the cumulative number of items answered correctly by participants.

Part 2: Wechsler Adult Intelligence Scale

The second test administered in this study was the verbal subtest derived from the fourth version of the Wechsler Adult Intelligence Scale. The verbal subtest of the WAIS-IV encompasses six distinct subtests, namely, information, digit

span, vocabulary, arithmetic, comprehension, and similarities.

Part 3: Metaphor comprehension

The final task in this study encompassed a set of 36 Chinese metaphor comprehension items, 18 from literary sources and 18 from non-literary sources [9]. All metaphors were then converted to the form of "nominal is nominal" form, yielding the final list of 100 items. Subjects were asked to answer an open-ended question "Please write down the figurative meaning of this metaphor", which they were required to type their interpretation of 36 metaphors.

3.2.2 Scoring

For the metaphor comprehension task, responses provided by participants were evaluated by two independent raters, both proficient in Chinese and well-versed in rhetorical nuances. A 3-point scoring system was used, where responses were assigned scores of 0, 1, or 2. The final score is the average of the two raters' scores.

4 Results

Descriptive, correlation, and linear regression analyses of the study data were performed using SPSS 26.0 statistical software.

4.1 Descriptive statistics

Table 1 summarizes the descriptive statistics of the three measures we obtained (CRAT, WAIS-IV, and metaphor comprehension).

Table 1. Descriptive statistics for each test

Test	Mean	Max	SD
Creativity	16.56	25	3.153
Crystallized intelligence	92.18	103	6.085
Literary metaphors	22.36	32	5.005
Non-literary metaphors	26.14	33	2.564

4.2 Correlation and regression analyses

4.2.1 The effects of creativity and crystallized intelligence on literary metaphor comprehension

The results of the correlation coefficients revealed that creativity was positively correlated with literary metaphor comprehension scores at a statistically significant level. Similarly, significant positive correlations were found between crystallized intelligence and literary metaphor comprehension.

Table 2. Correlation analysis of creativity, crystallized intelligence and literary metaphor comprehension

		Creativity	Crystallized intelligence
Literary metaphor comprehension	Pearson correlation	.636**	.786**
	Sig. (2-tailed)	.000	.000

**Correlation is significant at the 0.001 level (2-tailed)

In order to further confirm the predictive power of creativity and crystallized intelligence on literary metaphor comprehension, a multiple linear regression analysis was conducted. Results showed that the creativity variable together with the crystallized variables explained a total of 69% of the variance in literary metaphor comprehension scores. The regression results revealed that crystallized intelligence could explain 62.4% of the variance of literary metaphor comprehension and creativity can explain 32.4%.

Table 3. Regression analysis of creativity, crystallized intelligence and literary metaphor comprehension

	Unstandardized coefficient		Standardized coefficient	t	p
	B	Std. Error	Beta		
Constant	-33.429	4.343		-7.698	.000
Creativity	.514	.103	.324	4.981	.000**
Crystallized Intelligence	.513	.053	.624	9.593	.000**

**p<0.01

4.2.2 The effects of creativity and crystallized intelligence on non-literary metaphor comprehension

Regarding non-literary metaphor comprehension, the correlation analysis revealed significant associations. Specifically, creativity exhibited a positive correlation with non-literary metaphor comprehension, indicating a constructive relationship. Furthermore, a robust positive correlation was observed between crystallized intelligence and non-literary metaphor comprehension, emphasizing the strong connection between these variables.

Table 4. Correlation analysis of creativity, crystallized intelligence and non-literary metaphor comprehension

		Creativity	Crystallized intelligence
Non-literary Metaphor Comprehension	Pearson correlation	.462**	.819**
	Sig. (2-tailed)	.000	.000

**Correlation is significant at the 0.001 level (2-tailed)

The outcome of regression analysis demonstrated that the combined influence of creativity and crystallized intelligence accounted for 67% of the variance. Specifically, the results of the regression analysis revealed that crystallized intelligence exerted a dominant effect, surpassing that of creativity in influencing non-literary metaphor comprehension. For the simpler task of non-literary metaphor interpretation, crystallized intelligence emerged as a compelling predictor, explaining a substantial 78.4% of the variance. Conversely, creativity exhibited a much lesser influence.

Table 5. Regression analysis of creativity, crystallized intelligence and non-literary metaphor comprehension

	Unstandardized coefficient		Standardized coefficient	t	p
	B	Std. error	Beta		
Constant	-5.232	2.304		-2.271	.025
Creativity	.057	.055	.070	1.035	.303
Crystallized Intelligence	.330	.028	.784	11.636	.000**

**p<0.01

5 Discussion

5.1 The roles of creativity and crystallized intelligence in literary metaphor

Creativity and crystallized intelligence together account for a substantial portion of the variance in literary metaphor comprehension, underscoring the pivotal role of cognitive abilities in metaphor comprehension [10]. Our observation regarding the significant role of creativity in the comprehension of literary metaphors aligns with findings reported in previous studies [11]. This underscores the fundamental influence of creativity in the comprehension of novel metaphors.

This phenomenon can be elucidated from the perspective of the literary metaphor itself; literary metaphors possess distinctive characteristics that set them apart from non-literary counterparts: literary metaphors manifest considerably greater semantic distance between the target and source [12]. Moreover, there exists less notable presence of shared similarities between these two domains. Consequently, literary metaphors are always conceived as more novel, unexpected and complicated in meaning [13]. Collectively, these attributes imply that the comprehension of literary metaphors requires a more strenuous endeavor to establish mappings between elements.

In terms of the role played by crystallized intelligence, notably, this finding aligns with prior research. This phenomenon can be elucidated through the cognitive advantage inherent to crystallized intelligence. It can be argued that our findings are in complete accord with the formerly presented analysis of the essential components of metaphorical ability, which emphasizes domain-specific knowledge and analogical reasoning as the foundational skills for novel metaphor comprehension [14].

5.2 The roles of creativity and crystallized intelligence in non-literary metaphor

The limited predictive power of creativity in non-literary metaphor comprehension aligns with the earlier elucidation that the comprehension process for non-literary metaphors primarily hinges on a categorization strategy rather than heavily relying on analogical reasoning [15], a cognitive process closely linked with creativity. This reinforces the notion that non-literary metaphor comprehension is fundamentally driven by categorization mechanisms, emphasizing the importance of crystallized intelligence in this process. This observation is consistent with the career of metaphor model. It is noteworthy to highlight a consistent finding in our study - the consistent prominence of crystallized intelligence as a superior predictor compared to creativity. This underscores the crucial and essential role of crystallized intelligence as a prerequisite factor in the comprehension of metaphors.

6 Conclusion

In the present study reported here, we took an individual-differences approach to investigate the cognitive factors that impact comprehension of metaphors. Overall, the comprehension scores demonstrated a higher level of scores for non-literary metaphors compared to literary ones. This observation affirms the cognitive complexity of literary metaphors [16]. Besides, we found distinct and reliable correlations between both creativity and crystallized intelligence with the comprehension of literary metaphors. Notably, crystallized intelligence exhibited a strong correlation with the comprehension of non-literary metaphors, showcasing a significant predictive power in this domain. Conversely, creativity did not emerge as a robust predictor for the comprehension of non-literary metaphors. These results highlight the differential impacts of creativity and crystallized intelligence on the comprehension of metaphors in literary and non-literary contexts. Future research should strive to disentangle the contributions of these various dimensions of variation among metaphors. Such differences include variations in syntactic forms of metaphors. And it's imperative for future research to extend its focus beyond the Chinese language and delve into metaphorical processing across diverse languages.

Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

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