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Background noise moderates the link between cognitive styles and nonverbal creativity among undergraduate students

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ABSTRACT

Although cognitive style has long been considered a determinant of creative thinking, the moderating role of background noise is yet to be systematically examined. This study examined how cognitive style and background noise interact to influence nonverbal creativity among university students. Using a 2 x 2 factorial design, participants completed the Paper Folding Test (PFT) under noise and no-noise conditions. Data were analysed with the Hayes PROCESS Macro (Model 1) to test moderation effects. Results revealed significant positive relationships between cognitive style, background noise, and nonverbal creativity, with field-independent individuals showing higher creativity in the no-noise condition. These findings underscore the contextual nature of creative performance and suggest that aligning environmental conditions with cognitive preferences can enhance creativity and minimise maladaptive outcomes, offering practical implications for educators and psychologists designing optimal learning environments.

Introduction

Creativity is a multifaceted construct that involves realisations of the human potential to produce excellence and skilled performance in all spheres of life (such as nature, art, science, or everyday experience). In essence, creativity is a human phenomenon that helps individuals to achieve dignity and meaning in life, which Guilford (1950) sometimes referred to as creative potential or creative productivity. It may be either verbal or nonverbal (Torrance, 1966, 1974, 1998).

Nonverbal creativity is the ability to apprehend, associate, and mentally manipulate abstract spatial forms (Ekstrom et al., 1976; Mednick & Mednick, 1967; Torrance, 1966). In particular, nonverbal creativity is not just a cultural or social construct but is also seen as a root of creative cognition, mostly in arts and sciences (Baas et al., 2015). A nonverbal test of creativity in this context is intended to appraise the individual's ability to creatively deal with figural or spatial forms. Other researchers (e.g., Csikszentmihalyi, 1999; Gaut, 2010; Kaufman, 2009; Perlovsky& Levine, 2012; Sawyer, 2006) see it as an essential psychological and cognitive process. Consequently, many studies on nonverbal creativity have reported findings that often seem inconsistent. One of the major reasons for inconsistencies could be due to the wide range of experimental approaches in the domain of nonverbal creativity research and the immense diversity in measuring and interpreting creative performance (Abraham, 2013; Fink et al., 2007, 2014; Zhuet al., 2013), which creates a need for a study like this one.

Cognitive Style and Nonverbal Creativity

Cognitive style, according to Witkin and Goodenough (1981), is concerned with a form rather than content and refers to how one characteristically processes information. Research has established that individuals of various cognitive styles possess different creative strengths and weaknesses (Bloomberg, 1967; Zilewicz, 1986). Utilising the styles and strengths that individuals bring to a group empowers them to function more effectively and efficiently. Styles are pervasive and cut across diverse spheres of behaviour (Messick, 1976). That is, the style an individual possesses at school will most likely be the one he/she possesses at home or play. Individuals' cognitive styles are stable over time and, when measured over time, will remain relatively the same (Witkin et al., 1977). Therefore, cognitive style refers to an individual's preferred, consistent, and stable way of perceiving, organising, and using information, which directly influences their creativity and problem-solving patterns(Chen et al., 2015).

Cognitive style has been extensively studied. Numerous studies have focused on the relationships between cognitive styles and creativity (e.g., Chen et al., 2015; Dew, 2011; Giancola et al., 2022; He & Chiang, 2024; Yin & Childs, 2024), while other links are on academic performance (Al Salameh, 2011) and spatial experiences (Erkan Yazici, 2013). These studies suggest that different cognitive styles have effects on real-life creative behaviour. Field-dependent and field-independent cognitive styles have been widely studied in relation to creativity and learning.

Field-dependent individuals tend to rely on external cues, social contexts, and holistic processing, often excelling in interpersonal tasks but struggling with analytical independence. In contrast, field-independent individuals are more autonomous, analytical, and able to separate details from the surrounding context, which often supports problem-solving and creative performance (Witkin et al., 1977). For instance, the study by Kush (1996) reported that regardless of students' cognitive style, those taught by field-independent teachers achieved greater success than those taught by field-dependent teachers, underscoring the importance of instructional alignment with cognitive preferences.

Similarly, it has been observed that field-independent participants performed significantly better than their field-dependent counterparts in creative performance (Ndukaihe, 2016), memory systems (Mefoh& Eze, 2016), problem-solving ability (Mefoh et al., 2017), and academic outcomes (Nwafor et al., 2024). These findings, however, are contrary to the work of Roach (1988), who found that the degree of students' field dependence did not affect their ability to gain problem-solving skills using either method (field independence vs field dependence).

Background Noise and Nonverbal Creativity

Noise refers to any unwanted or meaningless sound that exists in the environment (Mehta et al., 2012). It has been indicated that any unpredictable change in environmental input (including the task itself) may be one of the most significant sources of stress, which can affect creativity (Hillier et al., 2006) and individuals' cognitive performance on tasks (Kjellberg et al., 1996; Sailer&Hassenzahl, 2000). Noise exposures have gradually increased in both duration and intensity as a result of the existing presence of technological devices that provide auditory stimulation in the form of sound, speech, and music (Szalma& Hancock, 2011).

Noise has broad effects, ranging from interference with cognitive processing (Smith, 1983) to mental and physical health (Clark, 1984). However, Helton et al. (2008) reported that changes in the demand level of a vigilance task imposed greater levels of distress relative to conditions in which the demand remained constant. Existing evidence shows that exposure to noise causes not only auditory problems such as hearing loss, but also non-auditory health effects, which include annoyance, sleep disturbance, and cardiovascular diseases (Basner et al., 2014). Some researchers have proposed different reasons why noise affects creativity, such as arousal (Toplyn & Maguire, 1991), attention span (Kasof, 1997), creative cognition and performance (Cao et al., 2025; Massonnié et al., 2019; Mehta et al., 2012).

Moreover, the effect of background noise on creativity seems to depend solely on the type of creativity being studied. Loewen and Suedfeld (1992) observed that a continuous broadband noise presented at a moderate level will have no negative effects on performance. They further stated that it will positively affect performance and well-being, as it partly masks disturbing noises (e.g., colleagues' conversations, telephone ringing). There is also evidence that for highly original individuals, moderate noise may lead to improved creative performance (Toplyn & Maguire, 1991). On the contrary, others found that performance was significantly poorer in the presence of unpredictable office noise when compared to performance in silence on mental arithmetic and prose recall tasks (Banbury & Berry, 2011; Evans & Johnson, 2000). Marsh et al. (2018) further observed that background telephone conversations are distracting due to their semantic unpredictability. The apparent “need-to-listen” is pervasive: the half conversation captures attention from cognitive tasks, thereby impairing performance.

The Present Study

The field of creative cognition usually deals with the thoughtfulness of the cognitive processes underlying creative performance. But in recent times, expressions of creativity by students in most institutions of higher learning have been in doubt due to various forms of academic dishonesty practised by students, ranging from plagiarism to examination malpractice, among others (McIntire et al., 2024). This suggests that creativity is often neglected in most schools. It is expected that the institution's authorities should therefore ensure that students under their care and supervision conduct research works that can be viewed as original and useful.

Mednick's (1962) theory of creativity underpinned this study. The theory suggests that highly creative individuals can produce more word associations to a stimulus than their less creative counterparts.The theory was not directed to any specific field of application in the arts or sciences, but rather tried to define processes that underlie creative thoughts. However, Rossmann and Fink (2010) extended Mednick's theory by investigating the relationship between individual differences in processing associative information and various aspects of creativity. They proved that creativity is not just about having an unusual mental map; it is about the speed and efficiency with which the brain can travel across distant, unorthodox branches of that map to connect ideas.

Studies on nonverbal creativity focused mainly on the differential effects of gender and locality (Chauhan & Sood, 2018), links with intelligence (Hasan, 2017), and information processing (Mohanty, 2015). Research about how cognitive style and background noise can jointly predict or influence nonverbal creativity is scarce, especially in the Nigerian context. This study also incorporated the suggestion for further study made by Chamorro-Premuzic et al. (2009), who suggested that future work could improve on their design to control for possible between-group differences in noise level. It was their view that participants could be tested with earphones (this would also allow researchers to test the impact of volume on task performance).

The need to fill these gaps,as illustrated in Figure 1,becomes research imperative. This study, therefore, seeks to test the hypotheses that:(1) Cognitive style will predict nonverbal creativity among undergraduates.(2) Background noise will predict nonverbal creativity among undergraduates.(3) Background noise will moderate the link between cognitive style and nonverbal creativity.

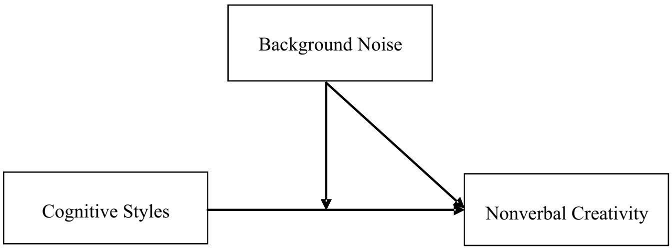

Fig. 1: Conceptual model

Method

Participants and setting

Ninety-six undergraduate students (48 men and 48 women), aged between 18 and 24 years (M_{age} = 20.79, SD = 1.90), who consented to participate in the experiment were randomly selected and requested to take part in the study. For the paper-and-pencil test, the participants were encouraged to provide all the required information in the form before returning the questionnaire. Participants received extra course credit for their participation in the study.

Measures

The Group Embedded Figures Test (Oltman et al., 1971) was completed by the participants. The GEFT is a group form of a scale for assessing field-independent and field-dependent cognitive style. The GEFT is a perceptual test that requires a person to locate a simple figure when it is embedded within a large, complex figure that has been organised to obscure the location of the simple forms. The GEFT contains three (3) sections. The first section, with seven (7) items, was used for practice, while the last two sections, with nine (9) items each, were scored. Any figure that was correctly located within the given geometric design was scored 1 and 0 when it was not located correctly.

Upon completion of the GEFTs, individual scores were categorised by field-independent or field-dependent orientations. Possible scores on the GEFT ranged from 0 to 18. In this study, the division between field-independent and field-dependent was set at a score of 12, as recommended by Witkin et al. (1971). Participants scoring 12 or above on the GEFT were classified as field-independent, as they could more easily complete the task of finding the "hidden" figures. Those scoring 11 or below were classified as field-dependent, as they could less easily disassemble the "hidden" figure from the surrounding pattern. So, the higher the score, the greater the field-independent; while the lower the score, the greater the field-dependent. However, because the GEFT was a speed test, internal consistency was measured by treating each scored section (sections two and three) as splithalves. Witkin et al. (1971) reported a corrected Spearman-Brown reliability coefficient of 0.82. A Cronbach's alpha reliability coefficient (α) of .80 was achieved by Ndukaihe (2010), after recoding reversed items, indicating that the scale has good internal consistency (Nunnally & Bernstein, 1994).

Nonverbal creativity was measured using the 20-item Paper Folding Test (PFT) (Ekstrom et al.,1976) as a measure of creative problem ability to encode and mentally manipulate abstract spatial forms. Each item in the PFT consists of successive drawings of two or three folds made to a square sheet of paper and a final drawing showing the folded paper with a hole made through it. The participants were told to select from among five drawings the one depicting how the paper would look when fully opened. They had three minutes each to complete the two parts of the test, and the scores were calculated by the Number of Correct Answers (NCA) minus the Number of Incorrect Answers (NIA) divided by four (that is, NCA – NIA/4). The reliability estimates in a normal sample for this task ranged from .75 to .84 (Ekstrom et al., 1976). A Cronbach's α of .89 was reported by Ndukaihe (2019), which indicates very good reliability.

Procedure

Participants were approached in the classrooms and asked if they were willing to participate in a research project "investigating relations between cognition and creativity". They were informed that participation in the research project was entirely voluntary and guaranteed anonymity. The GEFT questionnaire was administered in paper-and-pencil format with instructions given in writing.

In the second experimental session, out of 118 students who volunteered and participated in the GEFT task, 96 of the participants were randomly selected. Forty-eight participants from the field-independent cognitive style group (i.e., those scoring 12 and above on the GEFT) were further assigned randomly into two conditions of background noise (noise group and no noise group). The same random assignment was applicable for the 48 participants from the field-dependent cognitive style group (that is, those scoring 11 and below on the GEFT).

A background noise (such as an annoying yell, belch, censor beep, cough, door squeak, giggle, heartbeat, laughter, sneeze, and yawn) was introduced (played) and balanced for participants in the noise condition through an earpiece in a laboratory setting, which lasted for ten minutes (the period the experimental task was administered). Background noise was controlled for those participants in the no-noise condition, and the researcher ensured that conditions in the room of test administration were as quiet and comfortable as possible, devoid of any distractions by placing warning signs (like silence, an experiment in progress) on the corridors of the laboratory.

Data analyses

Data were entered into the Statistical Package for the Social Sciences (SPSS) version 22. The Hayes (2022) PROCESS Macro for SPSS (Model 1) was used in analysing the data and testing the hypotheses. The PROCESS Macro currently is a gold standard in the test of moderation hypotheses because, in addition to other advantages, it simultaneously tests direct and interaction effects (Hayes, 2013). It has also been used for similar statistical analyses in tests of the moderation hypothesis (e.g., Ayogu et al., 2025; Ndukaihe et al., 2022).

Results

Table 1

Mean, standard deviation, and inter-correlations among study variables (n = 96)

	Variables	Mean	*SD*	1	2	3	4
1	Age	20.79	1.90	-			
2	Gender	1.50	.50	-.18	-		
3	Cognitive Style	11.40	2.79	.00	-.01	-	
4	Noise	1.50	.50	.20*	-.08	.26*	-
5	Non-verbal Creativity	5.11	3.30	.10	-.05	.53**	37**

Note. **p<.05; ***p<.001*

Results of correlational analyses in Table 1 showed that none of the demographic variables was significantly related to nonverbal creativity. Cognitive style was positively related tononverbal creativity, while background noise was also positively related tononverbal creativity.

Table 2

Hayes PROCESS Macro regression results predicting the nonverbal creativity by cognitive style and background noise.

Predictors	*B*	SE	*t*	*p*	*95% CI*
Cognitive style	.55**	.10	5.42	.000	[.35, .75]
Background Noise (BN)	1.63*	.56	2.90	.005	[.51, 2.75]
Cognitive Style x BN	.44*	.20	2.14	.035	[.03, .84]

Note. *p< .05; **p< .001; R^2 = .37; ΔR^2 = .03.

Table 2 showed that cognitive style positively predicted nonverbal creativity(B = .55, p = .000). Background noise also positively predicted nonverbal creativity(B = .55, p = .005), indicating that for every one unit rise in background noise, nonverbal creativity decreases by 1.63 units. Background noise moderated the link between cognitive style and nonverbal creativity (B = .44; p = .035), given that the interaction effect between cognitive style and background noise on nonverbal creativity was significant.

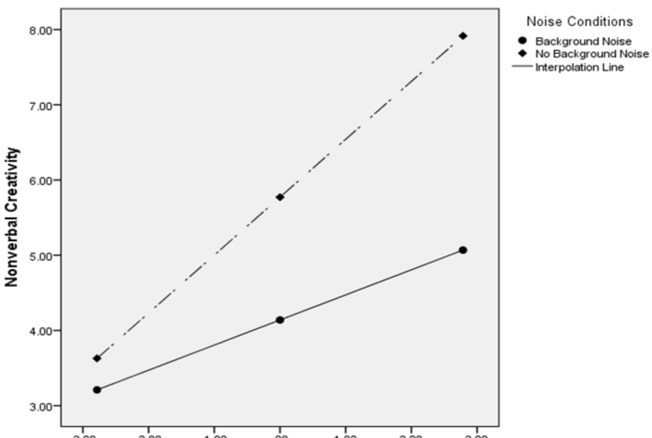

Figure 2

The relations between cognitive styles and nonverbal creativity as moderated by background noise conditions.

Cognitive styles, Noise and Nonverbal Creativity Further probing of the interaction (see Figure 2) showed that cognitive style was more strongly associated with nonverbal creativity for participants in the no background noise condition (B = .77, p = .000)compared to those who experienced background noise (B = .33, p = .021). In other words, those in the no background noise condition did significantly better in nonverbal creativity than their background noise condition counterparts (R^2-change = .03, p = .035).

Discussion

The inability of individuals to be nonverbally creative, typically, has far-reaching consequences on our ability to perform, with major implications for the environment and educational contexts. Understanding how to manage the effects of this on nonverbal creativity is crucial. Previous studies have tried to explore the link between some factors, such as cognitive styles and overall creativity (Ndukaihe, 2016; Yin & Childs, 2004). The present study examined the degree to which cognitive styles interact with background noise in predicting nonverbal creativity among undergraduate students, while controlling for most key confounding variables.

It was found that cognitive style positively predicted undergraduates' nonverbal creativity. This shows that students who have independent cognitive reported high non-verbal creativity. Such individuals with an independent style of achieving their academic responsibilities may easily complete a nonverbal creative task. This finding supports previous observations (e.g., Dew, 2011; Giancola et al., 2022; Kozhevnikov et al., 2013; He & Chiang, 2024; Yin & Childs, 2024)who observed links between cognitive styles and creativity. It has previously been observed that field-independent participants performed significantly better than their field-dependent counterparts, especially in general creativity tasks (Ndukaihe, 2016; Yin & Childs, 2024). These studies suggest that different cognitive styles have effects on real-life creative behaviour. If teachers and instructors become aware of their students' needs driven by cognitive style and teachers' impact on the teaching-learning environment, methods designed to address these diverse needs may lead to more nonverbal, creative, useful, and capable learning outcomes.

In addition, the findings of the study showed that background noise was positively predicted by nonverbal creativity. Students who were tested for nonverbal creativity in the no background noise condition did better than those tested in the background noise condition. This finding aligns with some past studies (e.g., Banbury & Berry, 2011; Evans & Johnson, 2000),which reported that performance was significantly poorer in the presence of unpredictable office noise when compared to performance in silence on mental arithmetic and prose recall tasks. It was also demonstrated in an earlier study that stress induced by a high level of white noise is responsible for reduced performance on a nonverbal creative task (Hillier et al., 2006).Marsh et al. (2018) further observed that background telephone conversations are distracting due to their semantic unpredictability. Exposure to noise causes not only auditory problems such as hearing loss, but also non-auditory health effects, which include annoyance, sleep disturbance, and cardiovascular diseases (Basner et al., 2014).On the contrary, Loewen and Suedfeld (1992) observed that a continuous broadband noise presented at a moderate level had no negative effects on performance. The finding suggests that maintaining an absolutely quiet environment during examination or test-taking aids the nonverbal creativity of students at the right time. Therefore, rehearsing and practising in a quiet environment could be a key to excellence, especially when faced with non-verbal creative spatial problems.

Background noise moderated the association between cognitive style and nonverbal creativity. It was observed that participants with more were more independent cognitive style tested for nonverbal creativity in the no background noise condition performed better in nonverbal creativity tasks compared to their counterparts in the background noise condition. Helton et al. (2008) reported that changes in the demand level of a vigilance task imposed greater levels of distress relative to conditions in which the demand remained constant.

The background environment contributes to nonverbal creative ability, but when individuals have a better and more independent cognitive style, it will also improve their nonverbal creative ability.

Limitations and Suggestions for Further Studies

This study is limited by its cross-sectional design, which prevents conclusions about causality between cognitive styles, background noise, and nonverbal creativity. The use of undergraduate students from a single institution may also limit the generalisability of the findings to other populations or age groups. The undergraduate students are often aged 18 – 24 years old, which is from a restricted range in measuring nonverbal creativity, neglecting other age brackets. In addition, reliance on self-report measures of cognitive styles may introduce response bias, while the experimental manipulation of background noise may not fully reflect real-life environmental conditions. Other factors, such as personality traits, mood, attention span, and prior creative experience, were not controlled and may have influenced creativity outcomes.

Future studies should employ longitudinal or experimental designs to better establish causal relationships among cognitive styles, background noise, and creativity. Researchers may also include participants from diverse educational, cultural, and occupational backgrounds to improve generalisability. Such future research on this study should consider people in other age brackets, especially adolescents (secondary school students) and even adults (teachers). Further studies could examine different types and intensities of noise (e.g., music, white noise, urban noise) and explore additional moderating or mediating variables such as stress, emotional regulation, or personality traits. Using mixed methods approaches and more ecologically valid creativity tasks may also provide deeper insights into how environmental factors influence creative performance.

Summary and Conclusion

This study investigated the moderating role of background noise on the link between cognitive styles and nonverbal creativity among undergraduate students. A total of 96 male and female students participated in this study. The result of this study revealed a significant positive association between cognitive style and nonverbal creativity. There was also a significant positive association of background noise with nonverbal creativity. Finally, background noise moderated the association between cognitive style and nonverbal creativity, such that the field-independent cognitive style was most strongly related to nonverbal creativity in the no background noise condition than in the background noise condition.

The study's findings imply that the creative advantage associated with a field-independent cognitive style depends partly on the surrounding environment. Specifically, undergraduate students with a field-independent cognitive style appear to perform better in nonverbal creativity tasks when there is little or no background noise. This suggests that quiet environments may enhance the ability of field-independent individuals to process information analytically, focus attention, and generate creative ideas effectively. Conversely, the presence of background noise may weaken the positive influence of field-independent cognitive style on creativity, possibly because noise interferes with concentration and cognitive processing. Practically, the finding highlights the importance of designing learning and work environments that minimise distracting noise when creativity and independent thinking are required. It also suggests that environmental conditions should be considered when assessing or fostering creativity among students.

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