CERN IdeaSquare Journal of Experimental Innovation, 2025; 9(2): 23-27
DOI: https://doi.org/10.23726/cij.2025.1752

ORIGINAL ARTICLE

The Effect of First and Second Language Use on Divergent Thinking in Problem Solving

Sofía Calvo Morales,[1*] Jop Goekoop[1]

[1]Delft University of Technology, Postbus 5, 2600 AA Delft, The Netherlands
*scalvomorales@tudelft.nl; jrgoekoop@tudelft.nl

ABSTRACT

This study aims to explore the relationship between the language used when solving a problem and the ability to find a creative solution for it. To investigate this relationship, participants completed a divergent thinking task in their first language and a similar task in their second language. Results were evaluated based on fluency, flexibility, and originality. The findings suggest that the use of a second language can be disadvantageous if the speaker does not use it fluently, while it can be advantageous for frequent users since it provides a separation from first language associations and conditioning effects.

Keywords: Language; divergent thinking; creativity; second language processing.

Received: September 2025. Accepted: November 2025

INTRODUCTION

In today's world and especially in the European Union, it is common for people to speak a second language. Four out of five young Europeans (aged 15-24) can hold a conversation in a foreign language, and 31% of Europeans who master a foreign language use it daily (EPALE, 2024). However, language is relevant not only for communication or international mobility. Studies have shown that language shapes thinking, influencing thought patterns, attention, and emotional responses (Boroditsky, 2001; Sapir, 1921; Whorf, 1956).

Thinking is the core of every human activity, including the creativity involved in the innovation process. There are many factors that affect the creative process. Studies have shown that creativity can be affected by environmental factors such as culture or education (Deng, L., Wang, L., & Zhao, Y., 2016), but also more transitory factors like sleep quality (Ritter et al., 2012). However, relatively little work has explored the intersection of language and creativity, specifically how the language in which one thinks may influence the creative process, and, therefore, the innovation outcome.

Given the breadth of both fields, this exploratory study focuses on two subdomains: first- and second-language usage for the language component, and divergent thinking in problem-solving for the creativity component. Divergent thinking was selected to evaluate creative potential, as it is considered a reliable and reasonably valid predictor of creative performance (Runco & Acar, 2012).

Accordingly, this paper aims to address the following research question:

How does the usage of first and second language affect divergent thinking in problem-solving tasks?

THEORETICAL BACKGROUND

The term divergent thinking was coined in 1950 by Guilford, who described it as the ability to generate multiple possible solutions to a problem (Guilford, 1950). Divergent thinking is seen as an important predictor of creativity, as it is the first step of the process, creating the pool of ideas that will be filtered and further developed (Runco & Acar, 2012). For measuring divergent thinking, researchers commonly use three criteria, developed by Reiter-Palmon et al., namely, fluency, flexibility, and originality. Fluency is the ability to give as many responses as possible, flexibility is the measure of how distinct answers are from each other, and originality is the capacity to provide ideas that no one or few people have found (Reiter-Palmon et al., 2019).

The other side of this equation is language and its effect on cognition. The relationship between language and thought has been a central topic in both psychological and linguistic theory. Vygotsky's Sociocultural Theory (Vygotsky, 1934/1962) is one of the fundamental theories that describes the interaction of the social environment and cognitive development. Vygotsky argued that language is not merely a tool for communication but also a primary instrument of thought. In his view, cognitive development occurs through social interaction. Children first use language externally to

communicate with caregivers and peers, and over time, this external speech becomes internalized as inner speech. This internalized language supports higher cognitive functions such as planning, reasoning, and problem-solving. He highlighted the interaction of linguistic and cognitive experience, pointing to language as a mediator of thoughts.

Building on this framework, there have been several lines of research focused on the role of inner speech in cognition. Alderson-Day and Fernyhough (2015) summarised and condensed conclusions on all recent work and provided empirical support for the idea that inner speech, or internal dialogue, is shaped by a person's external linguistic habits. Their work suggests that the structure, content, and frequency of inner speech often mirror those of the language a person regularly uses. For example, someone who frequently uses narrative or descriptive language externally may experience inner speech that is similarly detailed and elaborate, which can influence how they solve problems or reflect on personal experiences. This perspective reinforces the notion that language is not merely a medium for expressing thought but is also an active participant in shaping the form and content of cognition itself.

The mentioned differences in language patterns are unique per speaker. However, there have been studies that highlight these differences at a higher level, with distinctions among languages. The Sapir–Whorf Hypothesis of linguistic relativity proposes that the categories and distinctions present in a language influence how its speakers conceptualize the world (Sapir, 1921; Whorf, 1956). For instance, describing a third person in Dutch requires specifying their gender, whereas in Chinese, this is not necessary. In this sense, language does not rigidly determine thought, but it provides a "coloured lens" through which concepts are generated and a framework that guides perception, memory, and reasoning, subtly shaping creative and cognitive processes.

This is a valid argument for people who naturally use the language, truly experiencing inner speech in the given language. However, language itself can be a barrier if the speakers are not fluent enough. As pointed out by Tang et al. (2025), not having developed a sufficient understanding of a language to the point where speakers can truly speak and think in that language, can cause them to use translation strategies instead. That is, to bring the information to their first language, formulate a solution in it, and then translate back to the original language. This not only loses part of the original meaning of the words, but also consumes extra cognitive resources, limiting the capacity to think creatively.

Finally, it is important to discuss the emotional implications of language use. Pavlenko (2005) concluded that our mother tongue is associated with personal, emotional memories, while a second language is often perceived as more cognitive and less emotionally intense. That is, the emotional resonance or response that problems or ideas generate depends on which language they are conveyed in.

On top of this, Pavlenko found that using a second language can serve as a cognitive and emotional distancing mechanism, allowing people to regulate emotional involvement. This is particularly relevant in cases where the topic is sensitive or traumatic, where strong associations were formed during childhood. This mechanism allows for attenuation of emotional response during recall or reflection. In a more recent study, Schwanberg showed that bilingual individuals tend to rate the intensity of traumatic memories and symptoms higher when they retrieve those memories in their first language than when using their second language (Schwanberg, 2010). What is still unclear is whether this emotional distancing to problems or ideas is positive or negative for solution generation, that is, for divergent thinking tasks.

Table 1 provides a summary of the ideas discussed and highlights the main conclusions of each topic.

Table 1. Summary of divergent thinking and language usage theories.

Topic and authors	Main ideas
Divergent thinking (Guilford, 1950) and task grading (Reiter-Palmon et al. 2019)	Divergent thinking is the ability to generate multiple possible solutions to a problem. It is usually graded on fluency, originality, and flexibility.
Interaction of language and thought (Vygotsky, 1935; Alderson-Day and Fernyhough, 2015)	Cognitive development cannot be separated from the cultural and social environments. Therefore, language is one of the primary tools for thought, and it is influenced through inner speech. This inner speech mirrors the patterns of the language used externally.
Language Relativity (Sapir, 1921; Whorf, 1956)	Differences in languages themselves determine a framework on how ideas are conceptualised.
Cognitive constraints in bilingual processing (Tang et al., 2025)	Not having developed sufficient proficiency in a second language causes speakers to rely on translation strategies, which reduces cognitive performance.
Emotional implications of language use (Pavlenko, 2005; Schwanberg, 2010)	First language is usually related with emotionally charged environments, which causes it to have a higher emotional reaction. On the other hand, second language usage reduces emotional implication.

METHOD AND DATA

To answer the research questions, participants were asked to complete two similar tasks, one in their first language and another in their second language. The task consisted of a text that described a problematic situation, and asked participants:

"Suggest ideas to fix the problem, give as many answers as you can and be as creative as possible."

The task was phrased to encourage participants to provide many answers, and to think of uncommon ideas. In total, 20 participants completed the experiment.

The answers were evaluated according to the three metrics described by Reiter-Palmon et al.: fluency, originality, and flexibility. As suggested by the creators of the scoring method, the phrasing of the task explicitly asked for fluency (as many as you can) and originality (as creative as possible), but contrary to their recommendations, we did not explicitly ask about flexibility. It was excluded from the task phrasing because we anticipated this last factor to emerge naturally as a combination of both fluency and originality, since many and original answers should reflect a wide variety of ideas. The scoring of the mentioned parameters was done as follows:

- Fluency. The number of distinct valid answers was taken as the participant's score.
- Originality. The answers were manually read and counted. The originality score of individual answers was inversely proportional to the number of times different participants had given that answer. The participant's originality score was the average of the originality of their responses.
- Flexibility. The answers were grouped into different categories, and the participant's flexibility score was the number of distinct categories that appear within their responses.

Afterwards, all scores were normalised on a scale of 1-10 for evaluation purposes. Based on previous studies of the effect of language on personality and cognitive processes, we did not expect a very strong and obvious correlation. Therefore, to obtain more reliable data, we minimised possible factors that might also affect the responses or their evaluation.

Text difficulty

Two texts were used in this experiment. They were chosen to be as similar as possible, while still presenting different problems to solve. Therefore, both texts were given to participants, one as a first language and another as a second language task. This way, if one of the texts presented difficulties to participants, the effects would be visible on both first and second language results.

Task fatigue

Participants completed the second task immediately after completing the first task to avoid a change in their mental state. While the tasks were not long, and took only around 5 minutes, they required mental effort. Therefore, participants might have been tired and less motivated when they started the second task. To avoid order-related bias, the order of the tasks was not fixed, but rather half of the participants completed the first task in their first language and the other half started with their second language.

Access to the subconscious

We wanted to maximise the effect of language on the responses. Based on Pavlenko (2005) and Schwanberg (2010)'s theories, we aimed to achieve this by involving subconscious thinking in the tasks. This way, emotional aspects of language are more likely to have an effect, and we expect this to influence the results. For this purpose, we incorporated sensing verbs and abstract ideas into the text, to involve imagination in the thinking process, increasing the subconscious's involvement in the tasks.

Language fluency and use

While some people rarely use their second language, there are other groups of people who rarely use their first language in their day-to-day life, especially in international environments. Therefore, we recorded information about participants' level and usage frequency of both their first and second language. This will be used in the data post-processing to draw clearer conclusions.

Distractions from the environment

To minimise the impact of any external factors, we aimed to isolate participants from their surroundings. For the in-person experiments, participants were taken to a separate room. For online answers, participants were requested to perform the tasks in a relaxed environment. However, we had no control over whether this instruction was followed or not.

RESULTS

This experiment was conducted on two major groups of participants. The first group consisted of international bachelor students who have English as a second language and use it on a regular basis. The second group consisted of bachelor students who have a good level of English, but do not use it regularly.

The average scores for fluency, originality, and flexibility in participants' first and second languages are presented in Table 2 (rounded to one decimal).

Table 2. Divergent thinking scores, all participants

	Fluency	Originality	Flexibility
1st language	5.9	5.9	5.3
2nd language	5.6	6.4	5.9

When analysing all participants' data, first and second language responses yielded very similar results. However, the results change substantially when considering only participants who reported using their second language daily or almost daily. This data is presented in Table 3.

Table 3. Divergent thinking scores, frequent second-language users.

	Fluency	Originality	Flexibility
1st language	5.8	6.5	5.6
2nd language	6.1	6.8	7.6

For this subgroup, there is a notable increase in flexibility for second language use (+2.0). A possible explanation for this is that when using one's first language, automatic emotional responses or thought patterns are triggered. This may cause a more rigid stream of thoughts, resulting in participants finding responses in the same categories.

It is also worth noting that flexibility in the second language for frequent users is 1.7 points higher than in the mixed group. A possible explanation is that participants who do not regularly use their second language rely on translation strategies. This would take up cognitive capacity and therefore limit the resources for idea generation or finding new lines of thought. The small sample size of the subgroup means that the observed variations in fluency and originality are not significant enough to draw conclusions.

The explanations provided for the variation in flexibility score are further confirmed by experiences of participants, who, after performing the tasks, wanted to share their experience in their way of thinking in first and second languages. One frequent second-language user mentioned that

"Words in my second language seem to have less weight. When I have to say hard things to say out loud, it is more comfortable to do it in my second language, like, for example, an embarrassing anecdote."

This described experience highlights the importance of the effect words have on our way of thinking, and how conditioning and learned behaviours shape the way we interact with the world.

By contrast, a participant with low second-language use commented,

"I just think I'm funnier in my first language, everything flows just naturally, speaking in my second language is more of an effort."

This supports the interpretation that participants who do not use their second language regularly are making an effort to speak it, suggesting that the actual thinking process is being done in their first language, and the extra effort comes from translation strategies.

DISCUSSION AND CONCLUSIONS

In this paper, we examined the relationship between divergent thinking and the language used in a problem-solving task. The findings suggest that the use of a second language can either be positive or negative, depending on the frequency of use. It can function either as a barrier or as an advantage.

Our results indicate that, when using a second language, non-frequent users tend to give more clustered ideas compared to frequent users, who produce a broader range of responses. This difference may be explained by limited vocabulary access, reliance on translation strategies, or lower comfort levels when using the second language, all of which can constrain idea generation.

In contrast, the use of second language for frequent users, who perceive, think, and express themselves more directly in their second language, seems to have the opposite effect, resulting in more diverse and distinct ideas compared to their first language. This finding is particularly notable given that, although they are fluent, their second-language proficiency does not surpass that of their first language, suggesting proficiency alone cannot explain the substantial difference in results.

A plausible explanation is that thinking directly in the second language mitigates the influence of conditioning and associations formed during childhood in the first language, allowing more flexible and creative thought. This point is especially relevant considering that most of the frequent second-language users in our study only began using their second language regularly in their adulthood, in an academic environment.

While the present results are not statistically significant, due to the limited sample size of 20 participants, the comparison between frequent and non-frequent users remains meaningful. It highlights the potential benefits of second-language usage for frequent users in divergent thinking.

This is a key finding that can be further developed in several directions. First, expanding the sample size would strengthen the reliability of the results, adding more participants and languages into the experiment so it can be further generalised. Another promising path would be to examine the translation effect: for instance, by presenting two tasks in the second language but requiring one to be answered in the first language and the other in the second. Such a design would provide clearer

insights into the cognitive cost of translation compared to direct second-language processing.

Additionally, future studies could more directly investigate the conditioning effect of language by exploring sensitive topics such as sex or death, or ethical problems, such as moral dilemmas, which are more likely to evoke language-based conditioning and barriers. Another way of testing this theory, is by adding individuals who grew up using both languages equally, thus producing conditioning patterns in both tasks.

Finally, we believe that being aware of the effect of language on cognition has the potential to bring new unexplored paths and solutions into any field. We encourage students, researchers, and anyone who uses two languages regularly to try using a different language when stuck on a problem. While there is no guarantee that it will provide a solution, using a different language will bring different ideas that might be the spark for a great solution.

ACKNOWLEDGEMENTS

I want to thank Myriam for helping me bring out all my potential and for providing guidance and insights on such an unexplored topic for us. I want to thank Ash and Maria for providing help and emotional support while writing this paper. Finally, I want to thank the teachers at IdeaSquare, Caterina and Ole, for being so fun and inspiring during the course.

CONFLICTS OF INTEREST

None to declare.

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