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THE EFFECTS OF ANIMATED VISUAL STIMULI ON THE PROCESS OF CONCEPTUAL BLENDING IN RIDDLE SOLVING

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Abstract. *The paper attempts to evaluate the importance of visuo-spatial elements in the process of conceptual blending by investigating the effects of animated visual stimuli on riddle solving. Our respondents (90 first and second year students enrolled in the English Department, Faculty of Philosophy in Niš) had the task of solving "The Riddle of the Buddhist Monk", a well-known example in the world of conceptual blending. Our results indicate that animated visual stimuli speed up the course of riddle solving, as the respondents who had visual stimuli were roughly 1.85 times quicker when providing the answer. At the same time, the presence of an animation accompanying the riddle, particularly one which involved the meeting point, seemed to facilitate the correct outcome in the process of riddle solving. We can thus conclude that visuo-spatial stimuli do have an impact on how well or how quickly we mentally run the blend present in the tested riddle.*

Key words: *conceptualization, conceptual blending, vision, animation, riddle solving*

1. INTRODUCTION

Conceptual blending represents a basic mental process, and its workings have been explored across various domains and in many activities. However, thus far, there have been no studies conducted relating conceptual blending to visuo-spatial cognition. The present study aims to change this by exploring the effects of animated visual stimuli on the process of blending in riddle solving. It aims to corroborate the theory in an effort to answer the following question: *Can animated visual stimuli aid the process of riddle solving in those cases where the riddle is closely based on conceptual blending?*

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2. Theoretical Framework

The present study was motivated by the ideas presented in Mark Turner's *Blending Box Experiments, Build 1.0* (Turner 2010), and operates within the framework of *conceptual blending theory* (Fauconnier and Turner 2002), which accounts for the human ability to integrate two or more conceptual arrays, so as to produce an emergent outcome in the blend, along the lines of "on-line, dynamical cognitive work that people do to construct meaning for local purposes of thought and action" (Fauconnier and Turner 2006: 312). Conceptual blending theory was developed on the grounds of the *theory of mental spaces*, originally proposed by Fauconnier (1985), which, among other issues, described how language users manipulate reference. The theory is one of the pillars of modern cognitive linguistics, as it studies the ways in which "language provides a patchy and partial trigger for a series of complex cognitive procedures," language being "a recipe for constructing meaning," relying on a lot of independent cognitive activity (Saeed 2003: 362). Mental spaces emerge in our mind as we think and use language – we are able to establish links between mental spaces, and this is how we can make sense of counterfactuals, modality, ambiguity, etc.

2.1. Conceptual blending

In conceptual blending, we use two (or more) input spaces which are blended into what we call the blended space, whereas the process of blending is made possible (or at least aided) by the existence of the generic space, which contains what the inputs have in common at all moments in the development of the integration network (Fauconnier and Turner 2006: 308). All these belong to what Fauconnier and Turner (2002: 47) dubbed the "minimal network" – it normally consists of the generic space, two input spaces, and the blended space. The generic space contains what inputs have in common at any moment in the development of the network, which, in turn, makes it highly schematic – it represents a basis for establishing cross-space mappings between the inputs. The result of conceptual integration is the blended space, with the emergent structure as its essential element – it is important to note that the emergent structure is not present in any of the input spaces. More complex blending occurs in a frame network, i.e. a network of spaces that all share an organizing frame. Processes involved in conceptual blending "project elements and relations from each input so as to form an integrated representational structure that may differ substantially from that in the input spaces" (Coulson 2000: 120–121). According to Fauconnier and Turner, the process of conceptual blending is very conservative because "[i]t always works from stable inputs and under the constitutive and governing principles". At the same time, it is also creative, "delivering new emergent structure that is intelligible because it is tied to stable structures" (Fauconnier and Turner 2002: 396). According to Fauconnier and Turner (1998: 136):

> Conceptual blending is not a compositional algorithmic process and cannot be modeled as such for even the most rudimentary cases. Blends are not predictable solely from the structure of the inputs. Rather, they are highly motivated by such structure, in harmony with independently available background and contextual structure; they comply with competing optimality constraints [...], and with locally relevant functional goals. In this regard, the most suitable analog for conceptual integration is not chemical composition but biological evolution. Like analogy, metaphor, translation, and other high-level processes of meaning construction, integration offers a formidable challenge for explicit computational modeling.

We employ integration networks in nearly all spheres of our life: in understanding kinship terms (e.g. Coulson 2000: 120; Turner 2008: 14–15), in reading fables, stories, poetry, comics or novels (e.g. Turner 1996; Stamenković 2009), in creating and understanding art (e.g. Turner 2006), in solving riddles (e.g. Fauconnier and Turner 1998: 136–141), in music cognition (e.g. Antović and Tasić 2011) or film cognition (e.g. Oakley 2008), in understanding political events and political cartoons (e.g. Bergen 2004; Figar 2013), etc. Whereas the centrality of the mental operation of blending has been robustly confirmed by (mainly corpus-related) empirical data (Turner 2010), the theory needs additional experimental grounding that would involve studies with respondents.

2.2. Visuo-spatial cognition

The present study ought to tie conceptual blending theory to the findings related to the primacy of visual and/or visuo-spatial cognition. Namely, the function of visuo-spatial experience in conceptualization seems to be very important, if not essential (Arnheim 1969: 13–37; Edwards and Goodwin 1985; Mandler 2006: 41–51, 66–78). Some claim that visual cognition itself is crucial (Arnheim 1969; Sweetser 1991; Chilton 2010), whereas others believe that concepts are built via spatial relations (Jackendoff 1987; Mandler 2006, 2008; Landau *et al.* 1984). The visual system is of fundamental importance in our interaction with the world (Marr 1982), and has been best studied among all cognitive capacities (Pinker 1997) – perhaps this is the cause of the presumption that it has an important role in categorization in general. On the other hand, our spatial apparatus is at least moderately dependent on visual stimuli and is connected to bodily balance and orientation. Both constructs are fundamentally related to the general notion of embodiment that cognitive linguistics has used since its very beginnings (nowadays called *the embodied mind theory*, as in Lakoff and Johnson 1999). In spite of their interrelated nature, authors disagree in providing one of them relative primacy over the other two (Stamenković *et al.* 2014). Taking into account both of these stances, and without taking sides in this regard, the current study ought to investigate whether visuo-spatial stimuli can have an impact on how well or how quickly we mentally run the blends, once we encounter them in riddles.

2.3. Visual stimuli in analogy

The study of conceptual blending is largely tied to analogy and relational reasoning, as the function of very many conceptual blends is based on cross-domain analogies, relying on comparison of situations. In cases in which a blend does not contain the vital relation of analogy, cross-space mappings at work in blending are still mostly analogical (Fauconnier 2001). Just like blending, analogy, which is frequently in the very core of blends, permeates very many personal, cultural and social aspects (Holyoak and Thagard 1995). Analogy, as a type of relational reasoning involves retrieval of structured knowledge from long-term memory, manipulating bindings in working memory, generating analogical inferences, learning abstract schemas, etc. Different kinds of constraints (similarity, structure, and purpose) interact in order to determine the best set of correspondences between source and target (Holyoak 2012). There have been various attempts to evaluate the role of (mostly non-animated) visuo-spatial stimuli on the process of analogical problem solving and reasoning (e.g. Gick and Holyoak 1980, 1983; Beveridge and Parkins 1987; Gattis and Holyoak 1996; Pedone *et al.* 2001). As an illustration, Pedone *et al.* (2001) performed four experiments dealing with analogical problem solving using as diagrams visual stimuli in a problem solving task. They examined the impact of perceptual properties on the effectiveness of diagrams in analogical problem solving, whereas they used variations of convergence diagrams as source analogues for the radiation problem. Their investigation confirmed that animation enhances analogical transfer in cases where it encourages the interpretation of a diagram as a helpful source analogue. Similarly, we will try to use two variants of animations in an attempt to enhance efficiency in the process of riddle solving.

3. EMPIRICAL PROCEDURE

The empirical procedure was designed to measure the impact which blended or non-blended animated visual stimuli have on the process of riddle solving in terms of overall success of the process and the time needed to complete the task.

3.1. Respondents

The study involved a total of 90 first and second year students enrolled in the English Department, Faculty of Philosophy, University of Niš. Prior to testing, these students had not had any courses related to conceptual blending and cognitive linguistics in general. The experiment was conducted individually in 90 sessions of 4–10 minutes over two weeks. We made sure that none of the respondents was acquainted with the riddle.

3.1. Instrument

All the respondents were read a Serbian translation of *The Riddle of the Buddhist Monk* taken from Turner's *The Literary Mind* (Turner 1996: 72), previously presented in Arthur Koestler's *The Act of Creation* (1964): *A Buddhist monk begins at dawn to walk up a mountain. He stops and starts and varies his pace as he pleases, and reaches the mountain top at sunset. There he meditates overnight. At dawn, he begins to walk back down, again moving as he pleases. He reaches the foot of the mountain at sunset. Prove that there is a place on the path that he occupies at the same hour of the day on the two separate journeys* (The Serbian translation: *Budistički sveštenik počinje da se penje uz planinu u zoru. Na putu do vrha zaustavlja se na nekoliko mesta i menja brzinu kretanja onako kako mu to odgovara, a na vrh planine stiže u sumrak. Tamo na vrhu meditira preko noći. Sledećeg dana u zoru reće da silazi sa planine istom putanjom, takođe se zaustavlja na nekoliko mesta i menja brzinu kretanja, a u podnožje planine stiže u sumrak. Dokaži da postoji jedno mesto na putanji koje on zauzima u isto vreme u toku dva različita putovanja*). In the example, we encounter blending of two input spaces, each of them being "a partial structure corresponding to one of the two journeys" (Fauconnier and Turner 1998: 137). Here, we also find a partial cross-space mapping between the input spaces, which connects counterparts in the input spaces. It includes: "the mountain, moving individual, day of travel, motion in one space to the mountain, moving individual, day, and motion in the other space" (Fauconnier and Turner 1998: 137). The generic space in this case contains the elements that the inputs have in common: "a moving individual and his position, a path linking foot and summit of the mountain, a day of travel" (Fauconnier and Turner 1998: 137). In the end, we arrive at having the blend, which contains "the two counterpart identical mountain slopes are mapped onto a single slope. The two days of travel

[...] are mapped onto a single day [...] and therefore fused" (Fauconnier and Turner 1998: 138). Thus, the blend contains two moving individuals (monks), whose positions have been projected from the inputs "in such a way as to preserve time of day and direction of motion, and therefore the two moving individuals cannot be fused" (Fauconnier and Turner 1998: 138). Instead of this, in the blended space, there is a meeting point of the two monks (Fig. 2).

The respondents were divided into three groups: (1) Group A was read the riddle having no visual stimulus at all; (2) Group B was read the riddle accompanied by Animation 1 (Fig. 1) serving as the visual stimulus – in the animation, one Buddhist monk travels up the mountain, meditates overnight, and walks down the mountain the following day (the passage of time was marked by the sun/moon appearance, there was no visual blending in this animation); (3) Group C was read the riddle coupled with Animation 2 (Fig. 2), in which the two journeys happened simultaneously – there was one monk travelling up the mountain and one monk going down the same path. This, in turn, meant that there was a meeting for the "two" monks, i.e. the intended blend was run visually. The animations used were adapted versions of the animations found in *Blending Box Experiments*, *Build 1.0* (Turner 2010: 2–5), created by Mark Turner. The animations were adapted using Adobe Flash Professional CS5 – the main change was removing the red arrow which marked the meeting point of the two monks. Neither the riddle nor the demand question mentioned the act of "meeting" or the "duality of monks". The animations were thus not an illustration of the text – they served as prompts for the blend itself.

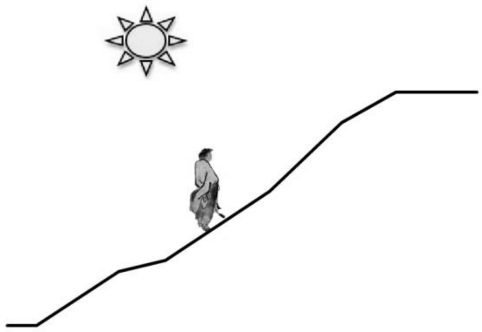

Fig. 1 Animation 1 – One monk travelling up and down the mountain.

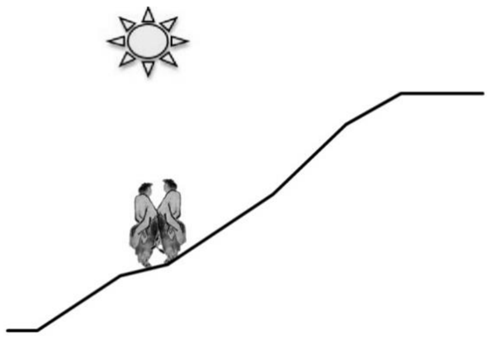

Fig. 2 Animation 2 – "Two" monks meeting on their paths.

3.3. Procedure

After the riddle was read to a respondent, i.e. after he or she was given the task of proving that there was a place on the path that the monk occupied at the same hour of the day on the two separate journeys, we measured time that elapsed from the last word of the riddle to providing the final answer, be it correct or incorrect. Besides this, the responses were coded as either "Correct" or "Incorrect" (the latter includes those that explicitly gave up giving a definite solution to the riddle, the solution being the fact that the "two monks" have to "meet each other" at some point).

3.4. Results

A bivariate correlation test showed that there were statistically significant correlations between the animation group "membership" and both response correctness and the time required to provide the solution to the riddle. In both cases, the correlation was significant at p = .01 level. As we move from "No Animation", across "Animation 1" to "Animation 2", the percentage of correct answers increases, whereas the time required to provide a response decreases:

Table 1 Responses per Animation Group

Animation Group		Response	
		Incorrect	Correct
No Animation	Count	28	2
	%	93.30%	6.70%
Animation 1	Count	22	8
	%	73.30%	26.70%
Animation 2	Count	17	13
	%	56.70%	43.30%
Total	Count	67	23
	%	74.40%	25.60%

Table 2 Time Required per Animation Group

Animation Group	N	Mean[1]	Std. Dev.	Std. Err.	Min.	Max.
No Animation	30	71.85	39.11	7.14	13.49	137.8
Animation 1	30	42.84	23.62	4.31	8.1	113.26
Animation 2	30	34.09	19.14	3.49	10.82	81.56
Total	90	49.59	32.60	3.44	8.1	137.8

[1] The mean time required to give a response (in seconds)

In order to test the significance of the responses related to the number of correct and incorrect answers (a categorical variable), we ran Chi-Square tests (Pearson Chi-Square, Likelihood Ratio, Linear-by-Linear Association), which confirmed that there were significant relations between the number of correct and incorrect answers within each stimulus type/respondent group (No Animation, Animation 1, Animation 2). When viewed against the whole population, Chi-Square tests also confirmed that the relation between the correct and incorrect answers was statistically significant.

One-Way Between-Groups ANOVA with Post-Hoc Tests was used to explore the differences related to the time required to provide a response (a continuous variable) between the three experimental groups. The tests showed a statistically significant difference between the group of students that had no visual stimuli on the one hand and the two groups of students that had visual stimuli on the other, at the $p < .001$ level in both cases: $F(2, 87) = 14.33$, $p < .001$. Additionally, the effect size, calculated using eta squared, was .25, which can be considered a large effect size (Cohen 1988, cited in Pallant 2010: 254). Post-hoc comparisons using the Tukey HSD test indicated that the mean score for the group with no animation ($M = 71.85$, $SD = 39.11$) and the group with the first animation ($M = 42.84$, $SD = 23.62$) showed a statistically significant difference in the mean time required to solve the riddle, at the $p < .001$ level. In addition, the same test also indicated a statistically significant difference between the group with no animation ($M = 71.85$, $SD = 39.11$) and the group with the second animation ($M = 34.1$, $SD = 19.14$), again at the $p < .001$ level. Furthermore, the two groups with animations ($M = 42.84$, $SD = 23.62$, and $M = 34.1$, $SD = 19.14$, respectively) did not show any statistically significant differences ($p = .47$) in the mean time required to solve the riddle.

3.5. Discussion

Given the results, we can say that animated visual stimuli indeed seem to speed up the course of riddle solving, as the respondents who had visual stimuli were roughly 1.85 times quicker when providing the answer. On the other hand, the presence of an animation accompanying the riddle, particularly one which involved the meeting point (the animations not being illustrations of the text, but prompts for the blend), seemed to facilitate the process of riddle solving – the respondents who were aided by this animation had the highest score in giving correct answers. Thus, if we go back to our initial study question: *Can animated visual stimuli aid the process of riddle solving in those cases where the riddle is closely based on conceptual blending?*, we may say that the answer is yes, although we are talking about one example – we need to employ similar procedures to a whole set of similar riddles in order to provide a definite answer to this question.

4. Conclusions

Although the results of the presented study do indicate that animated visual stimuli speed up the course of riddle solving, and that the presence of an animation accompanying the riddle, particularly one which involved animated blending, facilitates the correct outcome in the process, we still need additional procedures in order to make a more general claim that animated visual stimuli affect and/or facilitate the mental process of conceptual blending. First of all, we need to employ the same method in order to analyze other riddles related to blending. Second, if we perform a similar procedure involving riddles not based on blending, we would be able to compare the results and see whether appropriate animated stimuli can affect them in a similar manner. Third, animated visual stimuli and their effects should also be tested with other processes linked to conceptual blending, such as problem solving, comics and cartoon comprehension, text comprehension, creative tasks, etc. Therefore, we have made one small step towards investigating the effects of animated visual stimuli on the process of conceptual blending, and we sincerely hope that this will lead to similar studies in the near future.

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UTICAJ ANIMIRANIH VIZUELNIH STIMULUSA NA PROCES POJMOVNOG SAŽIMANJA U REŠAVANJU ZAGONETAKA

Ovaj rad predstavlja pokušaj da se proceni važnost vizuelno-prostornih elemenata u procesu pojmovne integracije uz pomoć istraživanja uticaja animiranih vizuelnih stimulusa na rešavanje zagonetaka. Naši ispitanici (90 studenata prve i druge godine Departmana za anglistiku Filozofskog fakulteta u Nišu) imali su zadatak da reše „Zagonetku sa budističkim sveštenikom", koja je čuvena ilustracija konceptualne integracije. Rezultati ukazuju na to da animirani vizuelni stimulusi ubrzavaju rešavanje pomenute zagonetke, jer su studenti kojima su prikazivane animacije, kada je reč o davanju odgovora, bili 1,85 puta brži od onih koji su zagonetku rešavali bez animacije. Pored toga, prikazivanje animacije, a posebno one u kojoj dolazi do susreta „dva" sveštenika, mnogo je češće dovodilo do tačnog odgovora ispitanika. Zbog svega ovoga, možemo da zaključimo da vizueno-prostorni stimulusi mogu da imaju uticaj na brzinu konceptualne integracije u umu, makar onda kada govorimo o rešavanju ove konkretne zagonetke.

Ključne reči: *konceptualizacija, pojmovno sažimanje, vid, animacija, rešavanje zagonetaka*