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Directionality of conditionals in the context of visual priming

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The theory of mental models is used to explain the differences in the effectiveness when deriving different types of conclusions such as modus ponens (MP) and modus tollens (MT). This difference is seen as a result of different number of mental models that are required in order to construct a valid conclusion. The theory explains mental models as a type of mental representations that can have abstract content, but can also contain perceptive and spatial information. These models are content and context sensitive, e.g., directionality of the conditionals affects the effectiveness of conclusions alongside the number of models required. Contemporary studies have shown that many cognitive processes (e.g., the understanding of sentences) have a significant perceptual basis. Research presented here tested the possibility of perceptual grounding of deductive reasoning. Prime stimulus served as a context for mental model construction. The direction of conditionals (either the antecedent preceded the consequent or vice versa) and spatial orientation expressed in the content of the conditional have been used as critical perceptual features. A four-factor experiment was carried out with perceptual priming, conditional direction, and the conclusion type manipulated as independent factors. The participants' task was to decide as quickly as possible whether the presented conditional conclusion was right or wrong. Visual priming, as well as conditional directionality, showed a significant effect on both MP and MT types of conclusions. It is interesting that the effect of perceptual priming for MT was in the opposite direction when compared to the MP one. These findings support the assumption that mental models could be perceptually grounded. It also implies that mental models can be manipulated through the perceptive context.

Key words: reasoning, conditionals, directionality of conditionals, visual priming, mental models

According to the mental models theory (Johnson-Laird, 1983, 1993, 2001; Johnson-Laird & Byrne, 1991), conditional reasoning is based on the construction of mental models of the premises and drawing conclusions from them. The number of models required in a reasoning task is the main predictor of the difficulty of the task. Besides the number of models, another factor that can affect conditional reasoning is the directionality of premises (Evans, 1993). In our previous research we have demonstrated the strong conditional directionality effect on the speed and accuracy of conditional inference verification (Valerjev, Bajšanski, & Gulan, 2010). In the study presented here, we examined the effects of the spatial orientation of antecedent and consequent, as well as the directionality of premises on conditional reasoning.

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Deductive reasoning

The differences between the normative theory of deduction and human performance have been firmly established. The normative theory of deduction has been described by first-order logic, or more precisely, with the predicate calculus and proposition calculus. According to logical rules, conditional inference is described by a logical relation called implication that is always true except when the antecedent is true and the consequent is false.

Human performance is only partially rational and logical, and this has been demonstrated in many examples. There are also typical biases in human conditional reasoning. A good theory of deductive reasoning has to explain most of the observed phenomena. Three main groups of theories emerged, all aiming to explain deductive reasoning: the formal rules theories (Braine & O'Brian, 1991; Braine, Reiser, & Rumain, 1984; Rips, 1983, 1990, 1994), the specific rules theories (Cheng & Holyoak, 1985, 1989), and the mental model theory which is most interesting for research presented here.

According to the mental model theory (Johnson-Laird, 1983, 1993, 1999, 2001), when people reason they construct and manipulate with cognitive representations that are called mental models. Mental models are representations of states of affairs that are described by premises and that contain combinations of affairs that could be descriptions of valid conclusions. When we read or hear a sentence we construct an appropriate model. Some sentences can be represented with more than one model. For example, an exhaustive representation of a conditional premise contains three mental models (Johnson-Laird & Byrne, 1991) which is illustrated in the example below. The conditional *If P, then Q.* (e.g., *If it rains, then streets are wet.*) can be described with three possible mental models (and this is termed exhaustive representation).

[p]	[q]	[it rains]	[streets are wet]
[¬ p]	[q]	[it does not rain]	[streets are wet]
[¬ p]	[¬ q]	[it does not rain]	[streets are not wet]

However, human cognition that deals with these mental models tends to be economical. When one reads the conditional sentence, only the first model is initially constructed. Only if necessary, another two models are fleshed out. This is the main difference between modus ponens (MP) and modus tollens (MT) inferences. Modus ponens inference is a conditional syllogism in the form of:

If P, then Q.
P.
Therefore, Q.

While the form of MT is:

If P, then Q.
Not Q.
Therefore, not P.

According to mental model theory, reading the first conditional premise leads to initial model construction. For a valid conclusion MP inference requires only the first model. However, MT inference requires all three models (or at least two in the case of biconditionals) for the conclusion to be valid. Therefore, MPs are a faster and more accurate type of inference than MTs. There are also mental models for other logical relations (e.g., conjunction, disjunction) and other forms of deductive reasoning. Mental models can also represent spatial relations, events, processes, and some operations of complex systems (Johnson-Laird, 2001).

If the mental models represent spatial relations it may imply that they also include perceptual features. According to Johnson-Laird (2001), the mental models might originally evolve as the ultimate output of perceptual processes. However, it is important to point out that mental models should not be equalized with visual imagination. It is still questionable how much of the mental model's nature is visual and/or spatial. Some evidence suggests that the visual and spatial features of mental models can vary.

Knauff and Johnson-Laird (2002) studied the effect of the type of relational terms on the three- and four-term series problems (also referred to as the linear syllogisms). In problems such as these, participants are asked to draw valid conclusion from premises which describe relations between three or four terms (for example, If *the dog is cleaner than the cat*, and *the ape is dirtier than the cat* does it follows that *the dog is cleaner than the ape).* Some of the relations in their study were easy to envisage visually and spatially (for example *above-below*), some were easy to envisage visually but hard to envisage spatially (*cleaner-dirtier*), and some relations were hard to envisage both visually and spatially (*better-worse*). When participants were asked to make conclusions they were most successful in the visuo-spatial tasks and least successful in the visual type. The authors concluded that visuo-spatial representations facilitated better conclusions because attention was focused on the relevant aspects of the task. On the other hand, visual-only representations did the opposite. They unnecessary loaded the attention with the irrelevant details and made inference slower.

In another study, Jahn, Knauff, and Johnson-Laird (2007) used relational reasoning tasks. The participants' task was to verify the offered orders of the letters. Relations like *left from*, *right from*, *next to*, *between* were used. Their study has shown that participants of western-cultural background have a tendency to order the models from left to right.

Another interesting effect that affects MP and MT reasoning was found by Girotto, Mazzocco, and Tasso (1997). They found that a different order of premises presentation (first the second premise, and then the conditional premise, e.g., *Not Q. If P, then Q. Therefore, not P.*) made MT inferences more accurate. Such an order of premises activates the ¬ q model in working memory and makes the connection with ¬ p more likely.

Valerjev et al. (2010) manipulated the order of the antecedent and the consequent in the conditional premise. The results obtained showed that MPs were processed faster and more accurately in standard conditional order (antecedent – consequent), and less efficiently in inverse conditional order (consequent – antecedent). The effect was reversed for MT inferences. MTs were processed faster and more accurately in inverse order, and less efficiently in standard order. They concluded that MPs and MTs have an opposite reasoning direction.

This research deals with conditional deductive reasoning and it is based on the following assumptions:

1. According to the mental model theory of reasoning (Johnson-Laird, 2001), the number of models that need to be constructed in the reasoning task is the main predictor of task difficulty. Hence, there are differences in speed and accuracy between MP and MT types of conclusion.
2. The directionality of conditionals (which means concluding from the antecedent to the consequent or vice versa) can affect the speed and accuracy of the conclusion as demonstrated in our prior research.

3. The spatial orientation of an antecedent and a consequent can play an important role during initial model construction and can be affected by visual priming.

The aim of this study was to explore the effects of the conclusion validity (valid/invalid), type of conditional conclusion (MP/MT), the directionality of conditionals (standard/inverse), and visual priming (congruent/incongruent) on the speed and accuracy of conditional inference verification.

METHOD

Participants and design

Thirty-eight psychology students (29 female) from the University of Rijeka and the University of Zadar participated in this study. Their age varied from 19 to 24 years with an average age of 20 years. All participants took part in all experimental situations. Experimental design was 2 × 2 × 2 × 2 repeated measures design with four independent variables, each with two levels. Independent variables were the directionality of conditionals (standard, inverse), the form of conditional inference (MP, MT), visual priming (congruent, incongruent), and the validity of inference (valid, invalid).

Materials and procedure

Experimental trials were presented in random order on a computer monitor. Participants had to evaluate 128 (eight in each experimental condition) conditional syllogisms. There were also 32 additional filler tasks that were randomly mixed with conditional syllogisms. The purpose of these filler tasks was to prevent the participant's possible habituation to characteristic form of valid and invalid conditional tasks.

The participants were instructed to keep their eyes fixed on the fixation cross that appeared in the middle of the screen. After that, the first premise that was presented for 2500 ms was followed by the presentation of a prime for 150 ms, and finally by the second premise and conclusion, the presentation of which lasted until the participant responded (Figure 1). The participants' task was to press the "yes" button if the conclusion was true, or the "no" button if the conclusion was false. The participants were instructed to react as quickly and accurately as possible. The instruction was followed by five practice tasks after which the participants were asked whether they needed more practice. When they said they were ready, the experimental situation trials began.

Notice that response time was measured from the presentation of the last event in trial. Every valid version of the task had its non-valid version. Thirty two additional valid and non-valid tasks were added as fillers to the total and the response time for them was not recorded. They had a different syntax than the experimental tasks and their purpose was to avoid the emergence of association between syntax and answers. After the conclusion was presented, the participants had to verify it by pressing one of two buttons ("true" or "false"). They used their right forefinger for "true" answer and their left forefinger for "false" answer during the experiment. In previous experiments with conditionals (Valerjev et al., 2010) the authors rotated the "true" and "false" side among participants. The results showed no difference in response time between these two types of answering. Also, several participants reported that it felt more natural for them when the "true" answer was on the right side.

All tasks were in abstract form which combined letters and spatial sides (left-right). Eighteen different letters were used. Each task had a different combination of two letters. All letters were consonants, and care was taken that all pairs of letters used in these tasks had a front-behind spatial relation on the QWERTZ keyboard. In other words, not a single pair of letters was taken from the same row, and not a single pair of letter had a clear left-right relation on keyboard. These tasks were presented in Croatian, but they were abstract enough that they could be easily translated into any other language. Examples of the tasks below are in English. Besides validity, three independent variables were manipulated through the tasks. The directionality of the conditional premise (standard or inverse) was manipulated by presenting the antecedent-consequent sequence or vice versa. The visual context was manipulated by the prime stimulus that

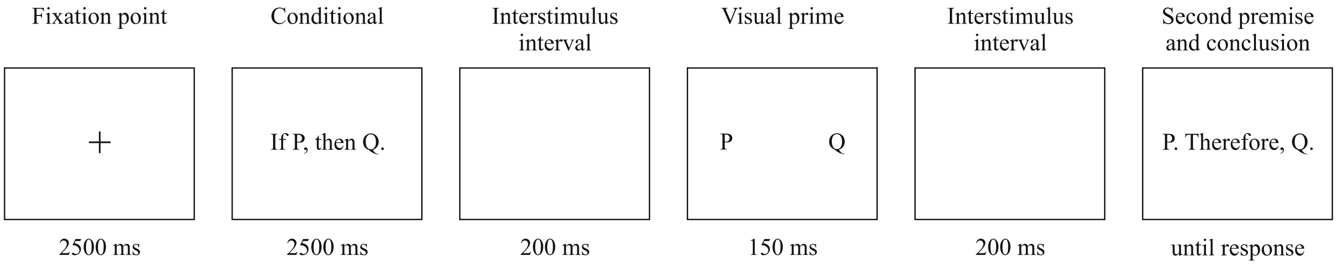

Figure 1. Sequence of events in an experimental trial.

occurred between the conditional and the second premise. The congruent context prime presented two letters in the same spatial left-right relation as it was stated in the conditional and the incongruent context prime presented an opposite spatial relation. The type of conditional syllogism was manipulated by the second premise, the affirmation of the antecedent for MP, and the negation of the consequent for MT. The examples below illustrate the experimental manipulation.

MP tasks

DIRECTIONALITY OF CONDITIONAL PREMISE

STANDARD: If V is left, then T is right.

INVERSE: T is right, if V is left.

VISUAL PRIMING

CONGRUENT: V T

INCONGRUENT: T V

VALIDITY

VALID: V is left. Then, T is right.

INVALID: V is left. Then, T is not right.

Example: STANDARD/CONGRUENT/VALID

If V is left, then T is right.

V T

V is left. Then, T is right.

MT tasks

DIRECTIONALITY OF CONDITIONAL PREMISE

STANDARD: If F is left, then C is right.

INVERSE: C is right, if F is left.

VISUAL PRIMING

CONGRUENT: F C

INCONGRUENT: C F

VALIDITY

VALID: C is not right. Then, F is not left.

INVALID: C is not right. Then, F is left.

Example: INVERSE/INCONGRUENT/INVALID

C is right, if F is left.

C F

C is not right. Then, F is left.

RESULTS

The five participants who failed to produce at least one correct response in each of the 16 experimental conditions were excluded from the analysis. Thus, data for the remaining 33 participants was analyzed. Mean reaction times and the percentage of the correct responses for each experimental condition are presented in Table 1.

In the analysis of response times, the participant medians of response times were calculated for each experimental condition, and the four-way repeated measures ANOVA was carried out on this data. A summary of ANOVA is presented in Table 2. The significant main effect of the validity of inferences was obtained, $F(1, 32) = 118.59$, $p < .01$: invalid inferences took longer to verify ($M = 2490$ ms, $SE = 269$) than valid inferences ($M = 1976$ ms, $SE = 220$). A significant main effect was also obtained for the type of inference, $F(1, 32) = 69.74$, $p < .01$: MP inferences were verified faster ($M = 1890$ ms, $SE = 205$) than MT inferences ($M = 2576$, $SE = 311$). The interaction between validity and type of inference was also significant, $F(1, 32) = 16.91$, $p < .01$.

Although the main effect of directionality was not significant, its interaction with the type of inference was significant, $F(1, 32) = 36.75$, $p < .01$. A post-hoc analysis (Duncan test) supported our hypothesis about the different effect of directionality on MP and MT inferences: MP inferences were verified faster in standard form ($M = 1763$ ms, $SE = 167$) than in inverse form ($M = 2017$ ms, $SE = 139$), whereas MT inferences were verified faster in inverse ($M = 2467$ ms, $SE = 230$) than in standard form ($M = 2686$ ms, $SE = 221$).

Our results failed to support the hypothesis about the effect of visual priming on verification times. The main effect of priming was not significant, and its interaction effects were also non-significant. However, the interaction

Table 1

Percentages of correct responses and their mean response times (RT; in milliseconds) in verifying conclusions as a function of validity of inferences, inference type (modus ponens-modus tollens), directionality (standard-inverse), and visual priming (congruent-incongruent)

	Standard congruent		Standard incongruent		Inverse congruent		Inverse incongruent	
	%	RT	%	RT	%	RT	%	RT
Valid MP	99	1408	98	1494	95	1632	97	1688
Valid MT	82	2590	84	2433	89	2334	89	2227
Invalid MP	84	1999	71	2149	77	2400	85	2346
Invalid MT	56	2873	61	2849	61	2678	56	2629

Note. MP = modus ponens; MT = modus tollens.

Table 2
The effects of conclusion validity, type of inference, directionality, and visual priming on response times to verifying conclusions

Source	*df*	*F*
Validity (V)	1, 32	118.59**
Type of inference (TI)	1, 32	69.74**
Directionality (D)	1, 32	0.30
Visual priming (VP)	1, 32	0.17
V × TI	1, 32	16.91**
V × D	1, 32	0.77
V × VP	1, 32	0.25
TI × D	1, 32	36.75**
TI × VP	1, 32	4.07[a]
D × VP	1, 32	0.53
V × TI × D	1, 32	0.19
V × TI × VP	1, 32	1.11
V × D × VP	1, 32	0.63
TI × D × VP	1, 32	0.92
V × TI × D × VP	1, 32	0.13

[a]*p* = .052. ***p* < .001

Table 3
The effects of conclusion validity, type of inference, directionality, and visual priming on percentage of correct responses to verifying conclusions

Source	*df*	*F*
Validity (V)	1, 32	157.00**
Type of inference (TI)	1, 32	96.29**
Directionality (D)	1, 32	1.93
Visual priming (VP)	1, 32	0.36
V × TI	1, 32	9.57*
V × D	1, 32	0.03
V × VP	1, 32	1.58
TI × D	1, 32	1.51
TI × VP	1, 32	0.84
D × VP	1, 32	2.44
V × TI × D	1, 32	10.83*
V × TI × VP	1, 32	0.33
V × D × VP	1, 32	2.93
TI × D × VP	1, 32	28.00**
V × TI × D × VP	1, 32	27.74**

**p* < .01. ***p* < .001

between priming and the type of inference was marginally significant, $F(1, 32) = 4.07$, $p = .052$. We expected that MP inferences would be verified faster in a congruent condition and MT inferences in an incongruent condition. Although response times for congruent MPs were lower ($M = 1860$ ms) than for incongruent MPs ($M = 1919$ ms), and they were lower for incongruent MTs ($M = 2534$ ms) than for congruent MTs ($M = 2619$ ms), these differences were not statistically significant.

Four-way repeated measures ANOVA was carried out for the proportions of the correct responses for each participant in each experimental condition. A summary of ANOVA is presented in Table 3. A significant main effect of validity of inferences was obtained, $F(1, 32) = 157.0$, $p < .01$: there were more correct responses for valid inferences ($M = 0.92$, $SE = 0.04$) than for invalid inferences ($M = 0.69$, $SE = 0.04$). A significant main effect was obtained for the type of inferences, $F(1, 32) = 96.29$, $p < .01$, whereas MPs were verified more correctly ($M = 0.88$, $SE = 0.02$) than MTs ($M = 0.72$, $SE = 0.05$). The interaction between validity and type of inference was also significant, $F(1, 32) = 9.57$, $p < .01$, and a three-way interaction between validity, inference type, and directionality was significant, $F(1, 32) = 10.83$, $p < .01$. A post-hoc analysis revealed that there were more correct responses for valid MT inferences in inverse ($M = 0.89$, $SE = 0.03$) than in standard form ($M = 0.83$, $SE = 0.04$). However, the analysis for the number of correct responses didn't reveal differences for MP inferences regarding the directionality, as it was obtained in the analysis of reaction times.

The three-way interaction between visual priming, inference type, and directionality was significant, $F(1, 32) = 28.00$, $p < .01$. A post hoc analysis revealed several effects. For standard MPs, there were more correct responses in congruent ($M = 0.92$, $SE = 0.02$) than in the incongruent priming condition ($M = 0.84$, $SE = 0.02$). The opposite pattern was revealed for inverse MPs: there were more correct responses in the incongruent condition ($M = 0.91$, $SE = 0.02$) than in the congruent condition ($M = 0.86$, $SE = 0.02$). For MT inferences, there were more correct responses in the congruent inverse condition ($M = 0.75$, $SE = 0.03$) than in the congruent standard condition ($M = 0.69$, $SE = 0.02$). Although these results are far from decisive, they point to the possible effect of visual priming on the processing of MP and MT inferences: congruent priming facilitates MP inferences in standard directionality form, and it facilitates MT inferences in inverse directionality form. Finally, a four-way interaction between all factors was also significant, $F(1, 32) = 23.74$, $p < .01$.

DISCUSSION

The effect of the type of inference (MP vs. MT) was not a surprise. In numerous studies MPs were verified more accurately than MTs (Johnson-Laird & Byrne, 1991), and in more recent studies with mental chronometry MPs were proved to be faster, too (e.g., Barrouillet, Grosset, & Lecas, 2000; Valerjev, 2006; Valerjev et al., 2010). This effect is usually explained by the predictions of the mental model theory (Johnson-Laird, 2001). There is only one mental model needed for a valid MP conclusion. This mental model is constructed relatively early, while reading the first (conditional) premise. The second premise only confirms the first part of the model, and then the second part of the model emerges as a conclusion. This kind of conclusion is very natural and quite easy, and more than 96% of the answers were correct. On the other hand, MT is not as easy as MP. The second premise denies the consequent and the initial mental model is eliminated. The reasoner has to construct another valid model which contains the negation of the consequent. This means that MP requires only one model, and MT requires three (or at least two) mental models. Hence, MT conclusions are harder, slower, and less accurate (76% in this study). The difference in the number of mental models was also a good explanation for differences in accuracy for many other types of conclusions (e.g., regular syllogisms or disjunctions; Johnson-Laird & Byrne, 1991). However, conditionals are complex and since directionality effects were significant in this research, there will be more discussion on whether the MP vs. MT differences are explicable by a different number of necessary mental models alone.

The effect of the validity of conclusion was also expected. It is common that valid conclusions are verified faster and more accurately than invalid conclusions. The same effect was obtained in our previous study (Valerjev et al., 2010). Johnson-Laird (2001) explained that when reasoners construct models they focus on what is true and neglect what is false. It is easier for reasoners to evaluate the conclusion when their own derived conclusion is confirmed by the one offered. Otherwise, the reasoners have to search for alternative models (or combinations of the models) in the evaluation phase of the reasoning process, and this search makes the response time longer.

The effect of directionality demonstrated that form matters: it is not the same if the conditionals are presented in the standard or in the inverse form. MPs are easier and faster to verify when the conditional premise is presented in the standard form. On the contrary, MTs are easier and faster to verify when the conditional premise is presented in the inverse form: consequent, if antecedent. This effect strongly suggests that processes of MP and MT reasoning have a direction. When making an MP conclusion, reasoners make a mental move forward from antecedent to consequent, and when making MT conclusion they do the opposite, that is, they go backward. This effect has been demonstrated in several studies with different experimental procedures. The first hints that the directed nature of the conditional reasoning is possible was suggested by Barrouillet and his colleagues (2000). They used four types of inference – MP, MT, NA (negation of the antecedent), and AC (affirmation of the consequent) – and standard direction in conditional premise. Note that NA and AC are logically invalid conclusions, but human reasoners often derive conclusions from them. What is important here is that reasoning with MP and NA has a "normal" direction, from the antecedent to the consequent, and AC and MT reasoning have the "opposite" direction. The results obtained were in line with this assumption. MP and NA conclusions were faster than AC and MT conclusions. Similar results were obtained in Valerjev's (2006) research on the same four types of conditional inference. In another study, Valerjev et al. (2010) used the inverse conditionals, as well as the standard. The inverse conditionals proved to facilitate faster MT conclusions and slowed the MP conclusions, when compared to the reaction times obtained on standard conditionals. The very same effect was obtained in the present study using the same paradigm. According to classic mental model theory, the mental model(s) for the conditional should be the same every time, if the content of the conditional is identical. However, this research showed that this is not the case. The representation of the conditional premise was affected by the order of occurrence of antecedent and consequent. It seems that not only the content of the mental model, but also the form of the mental model can be manipulated. We assume that the mental models that represent the conditionals have more attributes than content alone, and some of these attributes, such as the directionality, can be manipulated by the form of conditional, and possibly by the context and the premise presentation order. This assumption is still not studied enough and it requires a more detailed empirical verification. Our position is similar to Evans and Over's (2004). They explained that their approach could be classified as a theory of mental models. However, they consider that classic mental model theory needs a revision. According to them, the classic mental model approach interpreted the conditional too tensely – as a functional conditional which was based on extensive logic. Such conditional unambiguously defines mental models. In other words, the classic theory suggests that mental models are constructed in the uniform way. Evans and Over disagree and claim that more features like the directionality of conditionals, the degrees of certainty, confidence, and probability that people associate to conditionals should be taken into account when dealing with mental models.

In this research visual priming served as a context that should emphasize the possible visual or visuo-spatial nature of the mental models. If the visuo-spatial part of the model exists, the reasoning should be facilitated with the congruent prime stimulus, or slowed down by the incongruent prime stimulus for both MP and MT types of inference. Remember that the visual prime was made by two letters positioned on left and right side of the computer monitor. It was assumed that such visual prime would interfere with the visuo-spatial aspect of the mental model that is based on the content of the model. For example, the conditional premise "If T is left, then G is right" can, according to the mental model theory, activate the visuo-spatial mental model of the form:

T G

When the congruent prime stimulus (T G) or the incongruent prime stimulus (G T) appears on the screen it should have the same effect on both MP and MT conclusion. However, the main effect of the visual priming was not significant.

The interaction between the priming (congruent-incongruent) and the inference type (MP-MT) was marginally significant (p = .052). If the interaction effect was proven significant, the congruent visual priming would facilitate the verification of the MPs and slowed down the verification of the MTs. The incongruent visual priming would slow down the MPs and facilitated the MTs.

The analysis of the number of correct responses revealed that the congruent priming facilitated MP inferences in standard directionality form, and it facilitated MT inferences in inverse directionality form. These results points to the possibility that the effect of congruence of visual priming is more complex than we expected.

One methodological problem of this study is that we expected for spatial properties of conditionals to be activated by a left-right relation. However, it might be that this relation is not salient enough (Franklin & Tversky, 1990). The left-right relation is a relativistic relation (when two people are faced to each other what is left to one is right to the other), and it can often be confusing, especially in the context of logical conclusions. Perhaps another spatial relation should be used. For example, up-down, or in front-behind relations could be more salient.

To conclude, the MP inferences were verified faster and more accurately than the MT inferences in all conditions. The reason for this lies in the fact that the MT inferences need more mental models than the MP inferences. Still, this study has shown that the number of mental models was not the only factor that determined the differences in reasoning with the conditionals. The MP inferences were processed faster in the standard form than in the inverse form of the conditional premise. The opposite pattern was obtained for MT inferences, which were processed faster in the inverse than in the standard form of conditional premise. The directionality of the conditional interfered with different directions of reasoning for MPs and MTs, from the antecedent to the consequent or vice-versa. The directionality seems to be an important property of the mental model and it can significantly affect the speed of reasoning. Finally, although we failed to demonstrate the clear effect of congruence of visual priming on conditional reasoning, the obtained results call for further investigation of visual and spatial properties of mental models.

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ERRATUM

The Editorial board of Review of Psychology is paying special attention to the legal and legitimate use of psychological tests, and the precise citing of the instruments used in studies to be published. In the preceding journal issue, however, we overlooked information published in the article by Koso et al. (Rev. Psychol. 19 (2) (2012) 131-139.) who used *Wechsler Adult Intelligence Scale – Third Edition* (WAIS- III; Wechsler, 1997) as cited in the first submitted version of the manuscript. Since in the reviewing procedures it was asked from authors to refer to a translated form of the test, the published version of the article includes different reference – Berger, J., Marković, M., & Mitić, M. M. (1995). Vekslerov individualni test inteligencije – priručnik (Wechsler Individual Test of Intelligence – Manual) which was in the Reference section translated as Wechsler Adult Intelligence Scale – Manual. As the cited instrument is not originally used by the authors nor approved by Psychological Corporation, that is, Pearson Assessment as the present owner of the WAIS, we wish to apologize to anyone who might consider insulted by this fact.

Editor