

Who is likely to be rementioned? An experimental study of implicit causality bias in Croatian

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ABSTRACT: Implicit causality (IC) verbs influence the pronoun ambiguity resolution by directing the speakers' (readers' or listeners') attention to the referent that is likely to be the cause of the event or state. Although IC bias is considered universal, there are cross-linguistic differences in its direction and strength. Previous studies have attempted to build large datasets of IC verbs, but very few Slavic languages have been investigated. In this experimental study, we examined the direction and strength of IC bias in Croatian, an understudied Slavic language in this regard, and compared it with IC bias observed in English. After selecting 137 verbs and classifying them according to thematic roles (agent-patient, agent-evocator, stimulus-experiencer, experiencer-stimulus), 86 participants were asked to complete sentence fragments containing these verbs. The study was conducted under the semantic structure account. Our results show that most Croatian verbs followed the predicted direction, which is consistent with findings suggesting that the direction of IC bias is relatively generalizable across languages. We also detected cross-linguistic variability in the strength of IC bias, especially in stimulus-experiencer verbs. This is consistent with studies showing that the strength of IC bias can vary across languages. Implications for theoretical and methodological approaches are discussed.

Key words: implicit causality verbs, semantic structure account, verb taxonomy, Croatian

1. Introduction

1.1. *Implicit causality*

Certain interpersonal verbs, such as *impress* or *fear*, influence readers (or listeners) to resolve the pronoun ambiguity in the sentence to the referent associated with the event or state being addressed. For instance, when presented with the following sentence fragment – “Peter *impressed* John because he...”, readers tend to assume that the rest of the sentence refers to the subject, Peter, and they would conclude that Peter did something that impressed John (e.g., he won an Olympic medal). In contrast, substituting the verb *impress* with *fear* can influence the readers to resolve the pronoun ambiguity in the sentence in favour of the object. If we consider the following sentence fragment – “Mary *feared* Ann because she...”, then readers would conclude that Ann did something to induce fear in Mary. This phenomenon of verb bias is known as implicit causality (IC) bias (Garvey & Caramazza 1974).

IC verbs shift the direction of causality in the subsequent clause to one of the referents in the preceding clause, and this referent is likely to be “rementioned” (Hartshorne, O'Donnell & Tenenbaum 2015). Depending on the direction of the bias, some verbs are subject-biased, while others are object-biased. Since it depends on individual preferences, verb bias is not an absolute variable, and its strength and direction can vary across verbs. Studies on verb bias have also reported a range of responses favouring either the subject or the object that are not always consistent (Ferstl, Garnham & Manouilidou 2011).

IC has been of interest to researchers from various fields of psychology (see Brown & Fish 1983; Graham & Folkes 1990; Malle 2002). It has been studied extensively in

psycholinguistics as one of the factors that play an important role in determining one's preferences when resolving pronoun ambiguity (see Ehrlich 1980; Kehler et al. 2008; Koornneef & Sanders 2013; Fedele & Kaiser 2015). So far, attempts have been made to provide normative data on IC verbs in widely spoken languages, such as English (Ferstl, Garnham & Manouilidou 2011; Hartshorne & Snedeker 2013; Hartshorne, O'Donnell & Tenenbaum 2015), Spanish (Goikoetxea, Pascual & Acha 2008), and Vietnamese (Ngo & Kaiser 2020). However, this phenomenon has not been closely examined in Slavic languages such as Croatian. Furthermore, there are no large databases of IC verb biases in Slavic languages (cf. Hartshorne, Sudo & Uruwashi 2013). Such databases could provide new insights on IC and help resolve questions regarding the generalisability of the direction and strength of verb biases. Although previous studies have proposed that IC bias is consistent across languages (Brown & Fish 1983; Hartshorne, Sudo & Uruwashi 2013), whether it is a universal phenomenon or whether it varies cross-linguistically continues to be an open question.

The IC phenomenon was first introduced in 1974 by Catherine Garvey and Alfonso Caramazza, who noticed that certain verbs can influence pronoun resolution by directing the underlying cause to one of the pronoun referents. This semantic information is inherent in the root of these verbs, suggesting that each verb is either subject- or object-biased. Building on the findings of Garvey & Caramazza (1974), researchers have attempted to further understand IC bias through the lens of general cognitive accounts or more specific linguistic accounts, such as the *semantic structure* account (Hartshorne & Snedeker 2013; Hartshorne, Sudo & Uruwashi 2013; Hartshorne 2014).

The general cognitive account stems from psychology research, where IC is considered to be cognitively and universally independent of language and culture (Brown & Fish 1983). This indirectly implies that IC goes beyond language processing *per se* and that it can spread across general causality in interpersonal domains, such as one's perception of reality and interpersonal events. Other approaches have not strongly disputed this account of cross-culture universality (see Hartshorne, Sudo & Uruwashi 2013), but controversies related to invariance and stability of IC remain. The *semantic structure* account postulates that IC bias is often associated with the literal meaning of the verb and is closely related to thematic roles of the verb's arguments. It is relevant to consider factors related to world knowledge since they can lead to the creation of verbs that encode specific causal information (see Hartshorne & Snedeker 2013), which is then reflected in the verb's thematic roles. Most importantly, this account does not predict universality or language specificity with respect to the IC phenomenon. Therefore, given that the structure of an argument often differs across languages (Evans & Levinson 2009), there may be a corresponding variation in IC bias (Hartshorne, Sudo & Uruwashi 2013). Consequently, this poses a challenge while constructing proper thematic role taxonomy that can be generalised across languages.

1.2. *Implicit causality verb taxonomy*

Once the association between IC and thematic roles was established, different taxonomies were proposed within the semantic structure account. The first of such taxonomies

was proposed by Roger Brown and Deborah Fish in 1983, who classified IC verbs into *action* (behavioural) and *state* (mental) verbs. Since this distinction was very broad, Brown & Fish (1983) proposed several sub-categories based on verb thematic roles. For action verbs, they suggested thematic roles of the *agent* (someone or something provoking an action that has specific motivations) and the *patient* (someone or something experiencing a change of state). For state verbs, they proposed thematic roles of the *stimulus* (someone or something giving rise to a certain feeling or mental state) and the *experiencer* (someone or something experiencing a certain feeling or mental state). In total, three types of interpersonal verbs depending on thematic roles were identified: *agent-patient* (AgPat), *stimulus-experiencer* (StimExp), and *experiencer-stimulus* verbs (ExpStim).

In the case of action verbs, the cause is typically assigned to the agents. Since the agent corresponds to the subject in a sentence, AgPat verbs are by default subject-biased (e.g., *David_{Ag} called Paul_{Pat} because he fell off the bike.*). On the other hand, the cause in state verbs is attributed to the stimulus. Thus, in sentences with StimExp verbs, the grammatical subject is assigned the role of the stimulus (e.g., *Peter_{Stim} amazed John_{Exp} because he won the Championship.*), whereas in sentences with ExpStim verbs, the grammatical object is assigned the role of the stimulus (e.g., *Mary_{Exp} adored Lisa_{Stim} because she is an expert in math.*).

However, subsequent research showed that Brown & Fish (1983) made certain incorrect predictions about the direction of causality within the class of action verbs they studied. More precisely, Au (1986) noticed that certain action verbs exhibit a strong bias toward the entity, which is the object of the sentence, leading to the identification of two classes of action verbs: *action-agent* and *action-patient* verbs. According to Au, action-agent verbs fall into the category of subject-biased verbs, as perceived earlier by Brown & Fish (1983). The action-patient category consists of verbs whose patient gives rise to the reaction of the agent. In this case, the patient is by default the object of the sentence, making action-patient verbs object-biased (e.g., *Rita_{Ag} criticized Helen_{Pat} because she caused a car accident.*).

The taxonomy proposed by Brown & Fish (1983) was further reviewed by Rudolph (1997) and Rudolph & Försterling (1997). To account for fine-grained classification of verbs, Rudolph & Försterling (1997) proposed the *revised action-state taxonomy*, where they developed a classification of psychological verbs similar to Brown & Fish (1983), as well as introduced a new category of action verbs similar to those proposed by Au (1986). Here action verbs were classified into *agent-patient* (AgPat) and *agent-evocator* (AgEvo). In AgEvo verbs, the agent performs an action as a reaction to the state or behaviour of the patient. Although this is essentially the same classification as the one proposed by Au (1986), the distinction between AgPat and AgEvo verbs represents a continuum rather than a dichotomy (Rudolph 1997). For example, *to help* can be classified as both an AgPat and an AgEvo verb, depending on the context. In summary, Rudolph & Försterling (1997) distinguished four IC verb categories depending on their thematic roles: AgPat, AgEvo, StimExp, and ExpStim (for other possible classifications see Semin & Fiedler 1988, 1991; Corrigan 1992; Corrigan & Stevenson 1993). Since the revised action-state taxonomy has been widely adopted in previous research (Crinean & Garnham 2006; Goikoetxea,

Pascual & Acha 2008; Ferstl, Garnham & Manouilidou 2011; Ngo & Kaiser 2020), it will form the basis of the IC verb analysis performed in the present study.

1.3. *Implicit causality across languages*

Studies that have used the semantic structure account to understand IC are associated with certain empirical challenges. For example, studies have detected verbs that are biased in the opposite direction from the one expected (Au 1986; Goikoetxea, Pascual & Acha 2008; Ferstl, Garnham & Manouilidou 2011), or found that the effect of IC bias was greater in state verbs than in action verbs (Goikoetxea, Pascual & Acha 2008; Ferstl, Garnham & Manouilidou 2011). From a cross-linguistic perspective, it is particularly interesting to note that different results have been reported across languages with respect to IC bias consistencies. For example, the results obtained in Spanish (Goikoetxea, Pascual & Acha 2008) supported the revised action-state taxonomy proposed by Rudolph & Försterling (1997) in German: most IC verbs showed consistent predictions in a certain direction, with AgPat and StimExp verbs being subject-biased and AgEvo and ExpStim verbs being object-biased. However, this effect was weaker in the subject-biased verbs than in the object-biased verbs. Additionally, state verbs generally exhibited stronger causal biases than action verbs.

Similarly, in English (Ferstl, Garnham & Manouilidou 2011), StimExp, ExpStim, and AgEvo verbs exhibited the predicted bias, but no preferences were found for AgPat verbs. Ngo & Kaiser (2020) reported similar strengths of subject bias in English and Vietnamese, though the overall subject bias was higher in English. Further analysis of individual verbs revealed that English and Vietnamese differed in the direction of IC bias with respect to StimExp verbs. In English, these verbs showed preferences towards the subject, whereas, in Vietnamese, they were split between the subject and the object and exhibited a preference towards the object. However, these findings do not correspond to Hartshorne, Sudo & Uruwashii (2013), who revealed that the direction of causality for state verbs was consistent across languages belonging to different families and diverse cultural backgrounds, including Dutch, English, Finnish, Italian, Japanese, Mandarin Chinese, Spanish, and Russian. It is important to note that Hartshorne, Sudo & Uruwashii (2013) did not examine direct comparisons of these languages. Therefore, further analyses of the observed tendencies of IC verbs are required.

Although most studies show similar IC bias patterns across languages, certain controversies have led researchers (e.g., Ngo & Kaiser 2020) to encourage the development of new normative, comparative, and/or experimental studies that can assess typologically different languages, especially with respect to the direction and strength of IC bias across languages. This was the motivation for the present study, which focuses on IC bias in Croatian, an understudied Slavic language with respect to this phenomenon.

Despite the lack of clear predictions, variations in linguistic structure across languages may influence verb biases. For instance, in languages such as Japanese and Finnish, the ExpStim verbs are expressed explicitly by adding a bound morpheme with a causal meaning (see Hartshorne et al. 2010; Pyykkönen & Järviö 2010). On the other hand,

the IC remains implicit in English, a language which lacks the causal morpheme. Slavic languages are morphologically rich, but causality is not entailed in the morpheme. There is only one previous study that investigated IC in a Slavic language – Russian (Hartshorne, Sudo & Uruwashi 2013). Nevertheless, specificities of Croatian, which belongs to the family of Southern Slavic languages, may provide new insights on verbs associated with IC bias.

Croatian has a rich morphological system, which includes bound grammatical morphemes that express grammatical categories (number, gender, and case for nouns and adjectives, as well as person, number, tense, and aspect for verbs), stem alternations, and derivational morphemes used to express aspect and actionality. From the syntactic perspective, this language has a specific canonical word order, *subject-verb-object* (SVO), which means that the relevant information usually takes the first place in the sentence. Croatian is also a pro-drop language, where a personal pronoun can be dropped in the preverbal subject position, resulting in two pronominal forms – null and overt pronouns. Consequently, the information that is mentioned first and is referred to by the null pronoun is highly salient, and this information is known to influence pronoun resolution preferences (Kraš 2008).

Previous IC studies have predominantly focused on the English language, but examining the features of languages that are very different from English may provide further cross-linguistic insights regarding the strength and direction of IC bias (see Goikoetxea, Pascual & Acha 2008). Due to the lack of explicit predictions made in the framework of the semantic structure account and inconsistent results of previous studies, we aim to fill this gap by examining IC in Croatian.

1.4. *Present study*

The purpose of the present study was to provide further insights on IC bias by focusing on a language (Croatian) that has not yet been studied from this perspective. We also aimed to contribute additional data to the currently available datasets of IC verb biases.

This study had two specific aims:

- (1) to observe the direction and strength of IC bias for verbs belonging to different thematic role categories in Croatian, as proposed by the semantic structure account;
- (2) to examine IC bias from a cross-linguistic perspective by comparing the direction and strength of IC biases for each thematic role in two typologically different languages, Croatian and English.

Consistent with the semantic structure account, we expected AgPat and StimExp verbs to be more subject-biased, and AgEvo and ExpStim verbs to be more object-biased. Furthermore, we expected to observe stronger IC bias in state verbs (StimExp and ExpStim) than in action (AgPat and AgEvo) verb categories. Based on previous findings, we hypothesised that both languages would have similar directions of IC bias, but their strength may vary.

2. Methods

2.1. Participants

During recruitment, a detailed email containing relevant information about the study was sent to university students via their online student platform. The final sample consisted of 86 bachelor's and master's students who agreed to take part in the study: these students received course credits for their participation. A large proportion of participants (97%) were women, ranging in age from 19 to 30 years ($M = 21.42$, $SD = 1.66$). All participants were monolingual native speakers of Croatian, and none of them had studied Philology or Psychology. All participants reported no previous history of sensory, neurological, or psychiatric disorders.

This study was conducted within the framework of a larger project that was approved by the Ethics Committee of the Faculty of Education and Rehabilitation Sciences, University of Zagreb [Class: 602-04/17-42/7, Reg. No. 251-74/17-01/2]. Written informed consent was obtained from all subjects for their anonymised data to be analysed and published for research purposes.

2.2. Materials and procedure

For the cross-linguistic comparison, we constructed sentences containing 137 verbs selected from a previous study conducted in English (Ferstl, Garnham & Manouilidou 2011). The verbs analysed in the present study were selected based on the following criteria: 1) at least 20 verbs representing each thematic role were chosen; 2) verbs that were close synonyms in the English study were omitted (e.g., *abandon/leave/desert*, or *flabbergast/amaze/astonish*), since such verbs rarely have more than one adequate Croatian translation (e.g., *napustiti* for *abandon/leave/desert*, and *zadiviti* for *flabbergast/amaze/astonish*); 3) verbs were chosen if their corresponding Croatian equivalents were high frequency verbs (e.g., *nazvati* for *telephone* and *pomoći* for *help*); and finally, 4) in order to maintain participant motivation and reduce the risk of drop-out, we restricted the total number of verbs to < 150 .

Of the 137 verbs analysed, 75 were action verbs (54 AgPat and 21 AgEvo) and 62 were state verbs (42 StimExp and 20 ExpStim). The strength of IC bias was relatively evenly distributed amongst the chosen verbs: 81 verbs (59.1%) were reported to have bias scores over ± 70 , while the other 56 (40.9%) were reported to have bias scores below ± 70 (Ferstl, Garnham & Manouilidou 2011). Besides the above-mentioned criteria for verb selection and the classification of semantic class and thematic roles, sentence fragments were additionally controlled for relevant and language-specific features. Referents were controlled for gender (both female referents in 68 sentences, and both male referents in the other 69 sentences), and entire sentence fragments were controlled for length and tense (all sentences were presented in the past tense). Frequency data were obtained from the Croatian web corpus *hrWac* (Ljubešić & Klubička 2016), with over 1.4 billion tokens. The criterion used to classify high vs low-frequency words in such studies is arbitrary at times, but the present study used the criterion described in Morrison & Ellis (1995):

high-frequency words were those that appeared in the corpus at a ratio of 100 or more per million.¹

The study was performed in two steps that were conducted several weeks apart. In the first step, a web-based questionnaire in the form of a completion task was sent to the participants via email. A completion task is a widely used method to investigate IC bias, and this method was used in Ferstl, Garnham & Manouilidou (2011). In this task, participants were asked to complete sentence fragments with selected IC verbs followed by the connective *because*.² The word *because* implies causation and, therefore, ensures a high proportion of continuations with an explicit mention of causation. Thus, a participant provides an explicit cause for an event or state for which the cause is still implicit. In the present study, participants were instructed to complete sentence fragments such as *Ivan je uplašio Petra jer je...* [‘John frightened Peter because...’]. In the second part of the study, an individualised spreadsheet consisting of sets of each respondent’s sentences were sent back to them along with the question: “Who did you refer to in these sentences?” The self-reports about the continuations of each sentence received from the respondents served to prevent major data loss associated with potential uncertainty in the written choices made by the investigators,³ as well as to prevent participants from getting a sense of the main purpose of the study. Nevertheless, two independent investigators went through each respondent’s self-report sheet and coded the answers to increase the usability and reliability of the data.

2.3. Coding and data analyses

Two independent investigators coded the IC verb biases based on their own judgement and the participants’ answers. Subject continuations were coded as 1 and object continuations were coded as 0, and all codes were double-checked for consistency. Bias scores were calculated using the formula reported in Ferstl, Garnham & Manouilidou (2011). According to this formula, IC bias is defined as the difference between the number of subject (NP1) and object (NP2) responses, weighted by the total number of responses:

$$\text{Bias score} = 100 * (N \text{ of NP1} - N \text{ of NP2}) / (N \text{ of NP1} + N \text{ of NP2}),$$

where N of NP1 represents the number of subject continuations and N of NP2 represents the number of object continuations. Using this formula, the bias score ultimately

¹ Taking this criterion into account, all verbs analysed in the present study had a mean relative frequency > 0.001%.

² Changing a connective may suggest different coherence relations, which can, in turn, influence one’s preferences (Kehler et al. 2008). For example, this can occur in the case of the connective *so*, which implies a result and/or consequence of an event or state (see Stevenson et al. 2000; Crinean & Garnham 2006; Garnham, Vorthmann & Kaplanova 2021). This so-called *implicit consequentiality* phenomenon can reverse referential biases associated with IC verbs.

³ A high level of ambiguity is commonly observed in responses when performing these types of tasks (Goikoetxea, Pascual & Acha 2008).

varies between 100 (NP1 continuations) and -100 (NP2 continuations). Null, incomplete, and ambiguous responses were treated as missing data and excluded from the analysis.

In line with the two aims of the study, several analyses were performed. First, IC bias scores were calculated for each verb depending on their thematic roles (AgPat, AgEvo, StimExp, ExpStim). Conclusions about IC direction were derived based on these scores. A one-way analysis of variance (ANOVA) was performed to determine the strength of IC bias between verb categories that were assumed to have the same IC bias direction. In addition, we compared the percentages of verbs in Croatian and English that elicited additional explanations about the subject in each verb category. Finally, independent sample *t*-tests and Mann-Whitney *U*-tests were performed to examine whether the IC bias scores obtained in Croatian corresponded to those reported in English.

Data were analysed using SPSS 25.0 (IBM 2017). In the first step, the normality of data distribution was assessed using the Kolmogorov-Smirnov (K-S) test, as well as using measures of skewness and kurtosis (skewness values between -2 and +2 and kurtosis values between -1 and +1 were considered to indicate a normal univariate distribution; see George and Mallery 2010). Given these criteria, the overall bias scores obtained for variables associated with AgP and AgEvo verbs had values within the required range and were normally distributed in both Croatian and English. On the other hand, variables associated with StimExp and ExpStim verbs deviated significantly from the normal distribution (for Croatian: StimExp (K-S = 0.235, $p < 0.001$), ExpStim (K-S = 0.322, $p < 0.001$); for English: StimExp (K-S = 0.285, $p < 0.001$), ExpStim (K-S = 0.301, $p < 0.001$)). Based on the results of the normality tests, corresponding (parametric or nonparametric) analyses were performed.

3. Results

3.1. Direction and strength of IC biases in Croatian

The first aim of the study was to observe the direction and strength of IC bias of verbs belonging to different thematic role categories in Croatian. IC bias direction was determined based on the calculated IC bias scores; positive scores on individual verbs indicated a subject bias, while negative scores indicated an object bias. IC bias direction was observed as a categorical variable (two types of continuations in each verb category), while bias strength was observed as a continuous variable (ranging from -100 to +100). This procedure allowed us to determine whether verbs with the same IC bias directions differed in their strengths, as indicated by Hartshorne, Sudo & Uruwashii (2013).

Table 1 presents descriptive statistics based on IC bias scores for verbs in each thematic role category in Croatian. Further details on individual verbs are provided in the Appendix.

Our results show that, in Croatian, StimExp verbs were subject-biased, while AgEvo and ExpStim verbs were object-biased (Table 1). In addition, AgPat verbs were equally biased to subjects (52%) and objects (48%). The negative mean overall bias score

indicates that, regardless of the direction, the strength of certain verbs within this category may induce a stronger bias towards the object in the sentence.

Another aspect that we examined was whether there was a difference in the overall strength of IC bias in Croatian IC verbs. Since the IC bias scores produce both negative and positive values, we focused only on categories that should exhibit the same IC bias direction, according to the semantic structure account (AgPat vs StimExp; AgEvo vs ExpStim). We performed a one-way ANOVA using thematic roles as the independent variable and overall IC bias scores as the dependent variable. Our analysis revealed significant differences in IC bias scores between the four categories ($F(3,133) = 41.56, p < 0.001$). Post-hoc analyses showed that there was a significant difference between the categories that exhibited a subject bias, AgPat and StimExp, ($p < 0.001$), with verbs in the StimExp category exhibiting a significantly stronger subject bias than those in the AgPat category (see Table 1). No significant differences were observed between the object-biased categories, AgEvo and ExpStim ($p = 0.524$), indicating that verbs belonging to these categories produced similarly strong object biases.

Table 1: Percentages of elicited subject responses for Croatian verbs belonging to four thematic role categories, and their corresponding IC bias scores

Measure	Thematic role (n)	Percentage of elicited subject responses (%)	Mean (SD)	SE	Range (Min; Max)
Overall bias score	AgPat (54)	52	-1.80 (51.66)	7.03	185.91 (-97.67; 88.24)
	AgEvo (21)	29	-35.66 (60.69)	13.24	195.35 (-100; 95.35)
	StimExp (42)	93	73.09 (37.17)	5.73	152.38 (-52.38; 100)
	ExpStim (20)	15	-59.17 (57.34)	12.82	175.98 (-97.67; 78.31)

Note: AgEvo, agent-evocator; AgPat, agent-patient; ExpStim, experiencer-stimulus; StimExp, stimulus-experiencer; SE, standard error

3.2. Direction and strength of IC biases in Croatian and English

In order to address the second aim, i.e., to compare the direction and strength of IC bias scores of Croatian and English verbs, we identified the direction of IC bias for verbs in each thematic role category in both languages. Similar to the above-mentioned analysis (section 3.1), the direction of IC bias was presented as the percentage of elicited explanations about the subject for each thematic role category that a particular verb belongs to in both Croatian and English (Ferstl, Garnham & Manouilidou 2011). These percentages are depicted in Figure 1.

Our results show that the direction of IC bias does not differ considerably in Croatian and English verbs (Figure 1). In all four categories, the percentages of subject responses were quite similar for Croatian and English verbs: AgPat (52 vs 54%), AgEvo (29 vs 33%), StimExp (93 vs 93%), and ExpStim (15 vs 20%). However, the Croatian and English

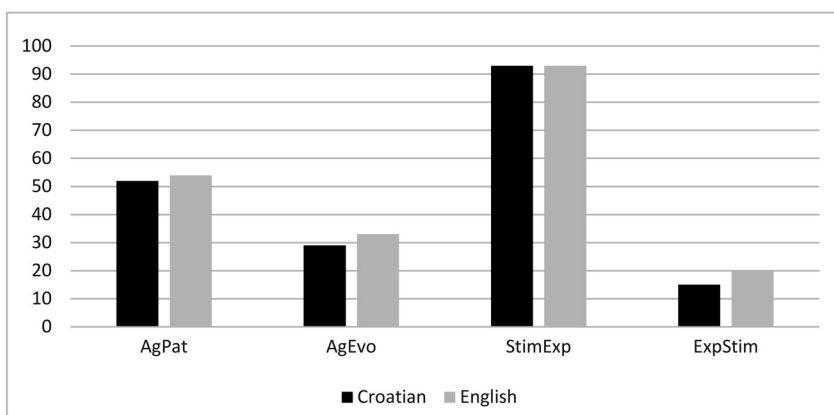


Figure 1: Percentages of elicited subject responses for Croatian verbs belonging to four thematic role categories (AgEvo, AgPat, ExpStim, StimExp). Note: The English verbs were taken from Ferstl, Garnham & Manouilidou (2011).

verbs analysed in the present study may vary in the strength of their IC bias. In order to test this assumption, we compared the overall IC bias scores in each thematic role category for both languages. Table 2 presents descriptive statistics on IC bias scores calculated for Croatian and English verbs.

Table 2: IC bias scores for Croatian and English verbs belonging to four different thematic role categories

Thematic role (n)	Croatian			English		
	Mean (SD)	SE	Range (Min; Max)	Mean (SD)	SE	Range (Min; Max)
AgPat (54)	-1.80 (51.66)	7.03	185.91 (-97.67; 88.24)	3.33 (49.21)	6.69	178 (-96; 82)
AgEvo (21)	-35.66 (60.69)	13.24	195.35 (-100; 95.35)	-32.95 (48.75)	10.63	187 (-94; 93)
StimExp (42)	73.09 (37.17)	5.73	152.38 (-52.38; 100)	61.11 (32.99)	32.99	164 (-77; 87)
ExpStim (20)	-59.17 (57.34)	12.82	175.98 (-97.67; 78.31)	-57.80 (51.67)	11.55	186 (-94; 92)

Of the four thematic role categories, two (StimExp and ExpStim) did not meet the normality criterion. Therefore, we performed independent samples *t*-tests and Mann-Whitney *U*-tests to determine whether the IC bias scores obtained in Croatian corresponded to those reported in English. Our results indicate that there was no significant difference between Croatian and English in the strength of IC bias for the AgPat ($t(106) = -0.529$, $p = 0.598$) and AgEvo verbs ($t(40) = -0.160$, $p = 0.874$). Furthermore, the strength of IC bias differed significantly for the StimExp verbs ($U = 537$, $z = -3.088$, $p = 0.002$), but not for the ExpStim verbs ($U = 177$, $z = -0.623$, $p = 0.547$).

4. Discussion

The main purpose of the present study was to broaden our understanding of the IC phenomenon by expanding on existing findings with comprehensive (normative) data from another language. Several studies have explicitly mentioned the importance of deepening the empirical basis of psycholinguistic research on reference resolution to a broader set of languages (see Hartshorne, Sudo & Uruwashi 2013; Ngo & Kaiser 2020). The Croatian language is understudied in this aspect and there is a lack of available data on IC verb biases. Therefore, another motivation for this study was to initiate and encourage the accumulation of psycholinguistic data for this language.

The present study uses an experimental approach and it is based on a publicly available database of English verbs and their IC bias scores (Ferstl, Garnham & Manouilidou 2011) to ensure reliable and comparable conclusions. Detailed results (subject and object continuations, as well as IC bias scores for individual Croatian verbs) are provided in the Appendix. Data collected was analysed from two perspectives, corresponding to the aims of this study: (1) a within-language investigation of IC bias across four thematic role categories, and (2) a cross-linguistic comparison of the IC phenomenon.

4.1. *Implicit causality in Croatian*

Our expectations regarding the direction and strength of IC bias for Croatian verbs belonging to four different thematic role categories were based on the predictions presented under the semantic structure account (Hartshorne and Snedeker 2013). Our findings regarding IC bias direction in Croatian verbs indicated that StimExp verbs were more subject-biased, while AgEvo and ExpStim verbs were more object-biased. On the other hand, AgPat verbs showed a fairly even distribution between subject and object bias, making them equally biased. Our results are similar to those obtained in English (Ferstl, Garnham & Manouilidou 2011) and Vietnamese (Ngo & Kaiser 2020). Although the verb categories followed the predicted direction, one may still expect to observe differences with respect to the strength of IC bias (Hartshorne, Sudo & Uruwashi 2013), highlighting the importance of conducting a detailed investigation of the strength of IC bias within each category.

In subsequent analyses, we found that verbs from the two categories that show a subject bias differ significantly in their strength, with StimExp verbs inducing a stronger bias than AgPat verbs. However, no differences were observed between the verbs belonging to the categories that show object bias (AgEvo and ExpStim verbs). Our results are partially consistent with studies that have reported stronger IC bias in state verbs (Goikoetxea, Pascual & Acha 2008; Ferstl, Garnham & Manouilidou 2011). The observed differences in the strength of IC bias may be explained by the fact that a greater causal weight is attributed to verbs expressing abstract concepts such as mental or emotional states, rather than verbs expressing concrete physical actions (see Semin & Fiedler 1988, 1991). The lack of differences in the strength of IC bias between AgEvo and ExpStim verbs may be due to the fact that AgEvo verbs share some properties of ExpStim. Although

AgEvo verbs are classified as action verbs, they have the psychological component of ExpStim verbs in that the agent performs an activity, which is a reaction to the state or behaviour of the evocator (see Rudolph & Försterling 1997). In summary, our predictions about the direction of IC bias were confirmed for all four thematic role categories, and we were able to demonstrate that the strength of these biases shows considerable variation.

4.2. *Cross-linguistic perspective*

Although it has been shown that IC biases follow similar patterns across languages (Hartshorne, Sudo & Uruwashi 2013), there are a few exceptions to this assumption (Ngo & Kaiser 2020). In the present study, we compared the direction and strength of IC biases in two typologically different languages: Croatian and English. We found no significant differences between the two languages with respect to direction of IC bias based on verbs associated with all four thematic role categories. Our results are broadly consistent with other studies examining the IC phenomenon through a cross-linguistic perspective. For example, Goikoetxea, Pascual & Acha (2008) replicated the IC taxonomy proposed by Rudolph & Försterling (1997) for German and found that most IC verbs had the same direction in Spanish and German. Hartshorne, Sudo & Uruwashi (2013) revealed similar patterns of IC bias for StimExp and ExpStim verbs across languages, irrespective of the typological differences between the languages they compared (Dutch, English, Finnish, Italian, Japanese, Mandarin Chinese, Spanish, and Russian). Our findings regarding the generalizability of direction of IC bias across languages are consistent with Hartshorne, Sudo & Uruwashi (2013). However, this does not appear to be the case with respect to the strength of IC biases. Our results show that the strength of AgPat, AgEvo, and ExpStim verbs follow similar patterns in Croatian and English, but the strength of StimExp verbs differ significantly between the two languages. In Croatian, StimExp verbs induce a stronger subject bias than StimExp verbs in English. These results are consistent with Ngo & Kaiser (2020), who found differences in the strength of StimExp verbs between English (data were also taken from Ferstl, Garnham & Manouilidou 2011) and Vietnamese, but, in their case, the subject bias was stronger in English. These findings are interesting and suggest that, despite the similarity in IC bias direction across languages, certain verb categories may differ in their strength.

Differences in the strength of IC bias may be related to the properties of individual verb categories, as well as other factors. One such factor is the type of pronominal form (Kaiser and Fedele 2019) that was used as a part of the stimuli in Ferstl, Garnham & Manouilidou (2011) and in the present study. Contrary to English, Croatian is a pro-drop language that allows for the personal pronoun to be omitted in the subject position. Therefore, in Ferstl, Garnham & Manouilidou (2011), the stimuli included the personal pronoun *he/she*, while in the present study, the stimuli were constructed using the null pronoun (similar to Goikoetxea, Pascual & Acha 2008). It is well known that personal pronouns themselves are subject-biased and they refer to the subject as the most salient

referent (see Gundel, Hedberg & Zacharski 1993; Gordon, Grosz & Gilliom 1993; Ariel 1990; Kehler & Rohde 2013). In pro-drop languages, the null pronoun is subject-biased, while the overt pronoun is object-biased (Carminati 2002). Since Croatian has two pronominal forms, the null pronoun in this language may be more subject-biased than the corresponding personal pronoun used in the English language. This could account for the differences observed in the strength of IC bias between Croatian and English, as well as provide an explanation for the difference in the strength of IC bias within the StimExp verb category, which is typically subject-biased. Although Ngo & Kaiser (2020) did not examine the same IC verbs that we analysed in our study, we speculate that StimExp verbs in Vietnamese, another pro-drop language (Ngo & Kaiser 2020) display a weaker bias because their stimuli consisted of overt pronouns.

Finally, it is important to bear in mind that the differences between Croatian and English may be due to the different methodologies that were used in the two studies. Following Ferstl, Garnham & Manouilidou (2011), we used the production sentence completion task, but in our sentence fragments, referents were controlled for gender. This allowed the personal pronouns to be ambiguous, which was not the case in English, and this ambiguity can make the subject bias even stronger. The strategy to refer to the subject in highly ambiguous contexts was largely confirmed in previous studies (Hemforth, Mertins & Fabricius-Hansen 2014). On the other hand, Ngo & Kaiser (2020) used full sentences with nonce verbs (following Hartshorne & Snedeker 2013). Although the pronouns were ambiguous, Ngo & Kaiser (2020) tested only the comprehension of IC verbs. The sentence completion task used in the present study offers the possibility to test both comprehension and production. Most importantly, although an analysis of production and comprehension can lead to similar results, IC bias may be different in the two modalities (Cheng & Almor 2019).

4.3. Implications, limitations, and future directions

Our study is the first psycholinguistic examination of the implicit causality bias verbs in Croatian. This study was conducted within the semantic structure account and the revised action-state verb taxonomy (Rudolph & Försterling 1997). The semantic structure account has proven to be suitable for predicting IC bias direction in Croatian, but subtle differences can be found within individual thematic role categories. On the other hand, evidence suggests cross-linguistic differences in the strength of IC biases, especially for StimExp verbs. Therefore, we recognise the potential for broadening the thematic role classification, and explaining the IC phenomenon within other theoretical frameworks (Semin & Fiedler 1988, 1991; Hartshorne & Snedeker 2013; Hartshorne, O'Donnell & Tenenbaum 2015). Future work should focus on investigating the exact factors that should be considered as a basis for a broader classification of thematic roles.

Following Ferstl, Garnham & Manouilidou (2011), we encourage the use of IC bias scores as a variable in similar studies, since it encompasses two types of information, both equally important in the context of IC biases. First, bias scores provide information

about the direction of IC bias, with a positive score indicating a subject bias and a negative score indicating an object bias. Second, bias scores reveal the strength of the IC bias, with high overall positive or negative values and narrow score ranges indicating stronger biases and stable trends within a particular verb category. Obtaining data on bias scores could be a valid method for the development of large, comparable datasets of IC verbs across different languages, as well as for further detailed analyses of the IC phenomenon within a particular language.

The limitations and challenges of the present study include a relatively restricted range of tested verbs and the potential bias associated with the sentence continuation task. Despite its widespread usage, the continuation task method has its challenges, such as compromising over the most appropriate and the least ambiguous sentence fragments, especially in languages with a pro-drop feature. One could also question the equivalence of verbs in Croatian and English. Since our intention was to maximise the validity of cross-linguistic comparisons, we were able to include only a restricted set of verbs with the most appropriate translations. In addition, although the sample was quite large, it consisted mainly of female participants. Future studies should control for gender during participant recruitment, since this factor may contribute to differences in judgments of IC (see Ferstl, Garnham & Manouilidou 2011).

Our findings can serve as the first step for future large-scale normative studies that could allow for more in-depth cross-linguistic comparisons. The results represent a good starting point for any psycholinguistic research based on an experimental design that would require careful control of IC bias features in Croatian.

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APPENDIX

Verb		Relative frequency (hrWac 2016)	Semantic category	Number of continuations			
Croatian	English			Subject	Object	Lost	Bias score
bojati se	fear	4.623	ExpStim	5	81	0	-88
boriti se	fight	14.423	AgP	43	38	5	6
brinuti	worry	12.276	ExpStim	5	80	1	-88
brinuti o	worry about	2.577	StimExp	80	4	2	90
cijeniti	appreciate	6.382	ExpStim	4	82	0	-91
čestitati	congratulate	4.786	AgEvo	0	86	0	-100
čeznuti za	yearn	0.260	ExpStim	33	51	2	-21
diviti se	admire	0.535	ExpStim	1	85	0	-98
dočekati	welcome	8.862	AgEvo	34	48	4	-17
dosadivati	annoy	0.349	StimExp	81	5	0	88
dozvati	call	0.272	AgP	59	23	4	44
fascinirati	fascinate	1.375	StimExp	86	0	0	100
ganuti	move	0.294	StimExp	85	0	1	100
gnjaviti	bore	0.905	StimExp	72	14	0	67
hraniti	feed	4.414	AgP	3	81	2	-93
inspirirati	inspire	1.813	StimExp	81	5	0	88
iritirati	irritate	0.931	StimExp	83	3	0	93
ismijati	ridicule	0.360	AgEvo	20	66	0	-53
ispitivati	question	2.405	AgP	52	33	1	22
ispraviti	correct	3.281	AgP	6	79	1	-86
ispričati se	apologize	0.341	AgEvo	84	2	0	95
izazivati	provoke	5.580	AgP	71	15	0	65
izbjegavati	avoid	5.878	AgP	26	60	0	-40
izdati	betray	8.271	AgP	69	15	2	64
iznenaditi	surprise	8.518	StimExp	73	12	1	72
kazniti	punish	5.010	AgEvo	5	80	1	-88
kritizirati	criticize	3.542	AgEvo	10	76	0	-77
lagati	lie	6.396	AgP	65	17	4	59
maziti	cuddle	1.197	AgP	14	72	0	-67
milovati	caress	0.526	AgP	15	71	0	-65
mrziti	hate	5.926	ExpStim	4	82	0	-91
mučiti	tantalize	6.941	StimExp	61	25	0	42
nadahnuti	inspire	0.825	StimExp	83	2	0	95
naljutiti	anger	1.187	StimExp	85	0	1	100
namamiti	attract	5.376	StimExp	69	17	0	60
napustiti	abandon	11.357	AgP	55	29	2	31
nazvati	telephone	18.840	AgP	80	5	1	88
ne voljeti	dislike	7.508	ExpStim	1	85	0	-98
nedostajati	miss	8.737	ExpStim	68	14	4	66
nositi	carry	31.091	AgP	3	83	0	-93
obeshrabiliti	discourage	0.506	StimExp	80	6	0	86
obožavati	adore	4.820	ExpStim	4	82	0	-91
obradowati	gladden	0.899	StimExp	82	4	0	91

očarati	enthrall	0.431	StimExp	84	2	0	95
odbiti	repulse	10.435	StimExp	71	15	0	65
oduševiti	delight	6.553	StimExp	85	0	1	100
odvesti	take away	7.691	AgP	28	54	4	-32
ogovarati	slander	0.321	AgEvo	72	14	0	67
ogrepsti	graze	0.026	AgP	70	15	1	65
ohrabriti	encourage	0.299	StimExp	26	60	0	-40
oklevetati	denigrate	0.111	AgEvo	62	24	0	44
okriviti	blame	0.725	AgEvo	33	52	1	-22
omalovažavati	vilify	0.747	AgEvo	48	37	1	13
omesti	distract	0.692	StimExp	82	4	0	91
opčiniti	entrance	0.286	StimExp	83	2	1	95
opomenuti	admonish	7.908	AgP	2	84	0	-95
oprostiti	forgive	6.827	AgEvo	50	31	5	23
optužiti	accuse	6.123	AgEvo	18	68	0	-58
ostaviti	leave	23.933	AgP	62	23	1	46
pljeskati	applaud	5.376	AgEvo	7	79	0	-84
podmititi	corrupt	0.183	AgP	64	19	3	54
podučavati	instruct	0.723	AgP	51	35	0	19
pohvaliti	praise	5.409	AgEvo	0	85	1	-100
poljubiti	kiss	15.199	AgP	33	48	5	-19
pomoći	help	43.241	AgP	48	38	0	12
posjetiti	visit	12.952	AgP	25	61	0	-42
posramiti	shame	0.552	AgP	65	21	0	51
poštivati	respect	1.994	ExpStim	11	75	0	-74
povjeriti	confess	0.053	AgP	34	52	0	-21
povrijediti	hurt	2.458	StimExp	82	5	0	89
pozdraviti	greet	5.281	AgP	44	41	1	4
požuriti prema	rush at	0.012	AgP	67	19	0	56
pratiti	follow	26.743	AgP	44	39	3	6
preneraziti	startle	0.090	StimExp	85	1	0	98
prepasti	frighten	0.419	StimExp	73	10	3	76
prestíći	pass	0.684	AgP	71	15	0	65
prestrašiti	scare	0.708	StimExp	80	3	3	93
prevariti	deceive	3.511	AgP	59	26	1	39
prezirati	detest	0.814	ExpStim	3	83	0	-93
približiti	approach	4.338	AgP	56	24	6	40
prigovoriti	reprimand	0.951	AgEvo	6	80	0	-86
privući	attract	5.376	StimExp	68	16	2	62
prkositi	defy	0.396	AgP	60	25	1	41
progoniti	prosecute	0.027	AgEvo	42	44	0	-2
proturječiti	antagonize	0.163	StimExp	46	39	1	8
raniti	wound	3.421	StimExp	68	15	3	64
razbjesniti	enrage	0.207	StimExp	85	0	1	100
razočarati	disappoint	3.075	StimExp	84	2	0	95
razveseliti	exhilarate	1.838	StimExp	74	12	0	72
rugati	mock	0.166	AgEvo	12	74	0	-72

sanjati koga	dream	0.521	ExpStim	68	18	0	58
savjetovati	advise	5.423	AgP	41	44	1	-4
smijati se	laught at	0.383	AgP	1	85	0	-98
snimiti	film	12.998	AgP	39	45	2	-7
spaziti	notice	0.294	ExpStim	15	71	0	-65
srušiti	floor	5.856	AgP	64	20	2	52
suprotstaviti se	antagonize	0.134	StimExp	36	50	0	-16
susresti	meet	3.777	AgP	43	41	2	2
susresti se s	meet	0.345	AgP	67	16	3	61
ščepati	grab	0.060	AgP	27	59	0	-37
tući	fight	3.368	AgP	51	33	2	21
tužiti	sue	3.126	AgEvo	11	75	0	-74
ubiti	kill	17.577	AgP	55	29	2	31
udaljiti	alienate	4.562	AgP	29	57	0	-33
udariti	hit	5.053	AgP	42	44	0	-2
ukoriti	scold	0.147	AgEvo	0	86	0	-100
uloviti	catch	2.283	AgP	38	47	1	-11
umiriti	calm down	0.707	AgP	29	56	1	-32
upozoriti	warn	7.908	AgP	45	39	2	7
utjecati	affect	10.634	StimExp	70	16	0	63
utješiti	comfort	0.642	StimExp	20	64	1	-52
uznemiriti	agitate	0.386	StimExp	85	0	1	100
uzrujati	agitate	0.386	StimExp	85	1	0	98
varati	cheat	4.436	AgP	69	17	0	60
veličati	exalt	0.818	AgP	8	78	0	-81
vikati	yell	0.303	AgP	21	65	0	-51
vjerovati	believe	47.942	ExpStim	16	69	1	-62
voditi	lead	46.490	AgP	30	54	2	-29
voljeti	love	56.624	ExpStim	7	78	1	-84
zabavljati	amuse	3.779	StimExp	53	31	2	26
zaboraviti	forget	19.942	ExpStim	74	9	3	78
zabrinuti	concern	2.241	StimExp	85	0	1	100
zadiviti	amaze	0.677	StimExp	82	4	0	91
zagrliti	hug	1.464	AgP	20	65	1	-53
zahvaliti	thank	6.427	AgEvo	6	80	0	-86
zamijetiti	notice	0.985	ExpStim	9	77	0	-79
zapaziti	notice	2.175	ExpStim	11	75	0	-74
zaposliti	hire	6.966	AgP	4	82	0	-91
zastašiti	intimidate	0.219	StimExp	68	15	3	64
zaštititi	protect	5.268	AgP	33	51	2	-21
zavesti	entice	1.041	StimExp	72	13	1	69
zavidjeti	envy	0.636	ExpStim	3	83	0	-93
zbuniti	confuse	3.099	StimExp	84	0	2	100
zgrabiti	grab	0.769	AgP	38	45	3	-8
žaliti	pity	6.903	ExpStim	2	84	0	-95
živcirati	unnerve	1.288	StimExp	81	4	1	91
žrtvovati	victimize	1.862	AgEvo	52	29	5	28

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SAŽETAK

Koga će se vjerojatno spomenuti? Eksperimentalno istraživanje implicitnouzročne pristranosti u hrvatskom jeziku

Implicitnouzročni glagoli utječu na razdvosmislenje upućivanja zamjenicom usmjeravajući govornikovu (čitateljevu ili slušateljevu) pozornost na referent koji je vjerojatniji uzrok događaja ili stanja. Iako se implicitnouzročna pristranost smatra univerzalnom, pronađene su međujezične razlike u smjeru i jačini glagolske pristranosti. U prijašnjim se istraživanjima težilo stvaranju velikih baza implicitnouzročnih glagola, no ta je jezična pojava nedovoljno istražena u slavenskim jezicima.

Cilj ovoga eksperimentalnoga istraživanja bio je ispitati smjer i jačinu pristranosti implicitnouzročnih glagola u hrvatskome, koji je slavenski jezik i u kojem je ta pojava slabo istražena, te dobivene podatke usporediti s podacima u engleskom jeziku. Izabrano je 137 glagola koji su razvrstani prema semantičkim ulogama (agens – pacijens, agens – pobuđivač, poticajnik – doživljavač, doživljavač – poticajnik). Ukupno je 86 sudionika dovršavalo rečenice s tim glagolima. Istraživanje je provedeno u okviru pristupa značenjske strukture.

Rezultati pokazuju da većina hrvatskih glagola pokazuje predviđeni smjer pristranosti, što je u skladu s istraživanjima koja upućuju na to da je smjer implicitnouzročne pristranosti sličan u različitim jezicima. S druge strane, pronađene su međujezične razlike u snazi glagolske pristranosti, ponajprije u kategoriji poticajnik – doživljavač. Taj je rezultat u skladu s istraživanjima koja pokazuju da se jačina implicitnouzročne pristranosti može razlikovati među jezicima. U radu se raspravlja o teorijskim i metodološkim implikacijama.

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