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Processing epistemic modality in a second language: a self-paced reading study

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Abstract: The current study brings together two novel perspectives: one is concerned with second language acquisition of complex modal semantics by learners of a Slavic (Croatian) language, and the other relates to online processing of modal auxiliary verbs in L2 English. The study sought to examine how English L2 learners process modal verbs ***can*** and ***may*** in their epistemic, deontic, and dynamic meaning, referring to epistemic possibility (e. g. *He may come to the party*), to giving or asking permission *(You may/can come in*), or to the expression of ability (*He can speak four languages*). Participants were a group of Croatian university students majoring in English (N = 12) and a group of English L1speakers studying at a UK university (N = 8). They all completed a self-paced reading task which is thought to be tapping into implicit linguistic knowledge. Results suggest that Croatian speakers acquire the dynamic and deontic modal meaning up to the native level, but they differ from English native speakers as far as epistemic modal semantics is concerned. The results are in line with previous studies in L1 and L2 research which demonstrated delayed acquisition of epistemic modality in comparison with non-epistemic modality. However, the findings also contribute to research on cross-linguistic influences and L1 concept transfer, suggesting that features and their related concepts which are not instantiated in one's L1 may not be fully acquired even at more advanced levels.

Keywords: modality, epistemic, deontic, dynamic, processing, self-paced reading

1 Introduction

Researchers generally agree that modality refers to a wide range of meaning, including probability, possibility, prediction, obligation, necessity, permission, willingness, etc., which all diverge from factual information and objectivity. For example, when saying:

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(1) *They **may** be waiting in front of the door* – we do not know whether they are waiting or not; there is only a possibility that they are waiting.

There is much less agreement among researchers when it comes to definitions and classification of modal verbs. Palmer (1979, 1986), who is considered a proponent of a semantically oriented approach to modality, embraced a definition offered by Lyons (1977: 452) which relates modality to 'opinion and attitude' and to subjectivity as a fundamental feature of modality. Lyons attempted to logically explain modality in terms of precise categorisation, even though there are no absolute formal and semantic criteria that could be used as defining criteria. For that reason, Coates (2014) pointed out that formal logical approaches failed to acknowledge the problem of indeterminacy ('fuzziness') in natural languages.

Such indeterminacy has also led to different views on modal auxiliaries from the perspective of language acquisition – namely, those that view the set of modal auxiliary verbs as polysemous (e. g. Leech 1987; Palmer 1986) and those that consider them as semantically unified or monosemous but pragmatically defined (e. g. Papafragou 1998). In the current study, Leech's and Palmer's theoretical position is adopted which seems to be more relevant to second language learning. This characterisation primarily concerns the fact that, from the perspective of L2 acquisition, modal verbs present a difficult mapping and learning problem involving matching a lexeme to complex syntax and semantics. Such an approach posits that each modal verb covers more than one meaning and, in turn, a single meaning can be covered by multiple modals. For example, if we take modal auxiliary *may*, it can be used to indicate a possibility in present or future time, meaning 'it is possible that', as in (1) but it can also be used to ask or give permission, especially in formal settings, as exemplified in:

(2) *You **may** leave earlier*, meaning 'you are allowed to leave', or 'you are permitted to leave earlier'.

On the other hand, the act of asking or giving permission to do something can be accomplished not only by using the modal *may*, but also by the use of *can* (in more informal contexts) and by the above mentioned substitute verbs *be allowed* and *be permitted*.

Thus it is not surprising that second language acquisition of modality presents a challenge for L2 learners. The current study offers an insight into the problems L2 learners might be experiencing while learning and mastering

the semantics of English modal auxiliaries. The next section casts just a glimpse on some theoretical issues related to English modal verbs and their categorisation. This is followed by an account of L2 acquisition of English modality.

2 Background

2.1 Modality and modal verbs

Although a number of semantic, syntactic, and pragmatic theories have been put forward to explain the properties and functions of modal verbs, they still remain "one of the biggest problems for grammatical analysis" (Palmer 2003: 1). Researchers coming from different backgrounds have used different terminology to classify modal verbs, but most often the differentiation has been along the line of epistemic vs. non-epistemic.

The classification of modal verbs followed the tradition in logic, where the modes of *truth, knowing, obligation*, and *existence* can be distinguished. Since two of these, *knowing* and *obligation* (*epistemic* and *deontic*) can be expressed by means of modal verbs in natural languages, these two broad modal meanings were adopted for the purpose of classification. In this framework epistemic refers to the speaker's knowledge, beliefs, or opinion, whereas deontic modality concerns the situations where the source of modality is the (acting) subject who *can, may, should, must*, or *will* do something. The following two examples with *may* illustrate the difference between its epistemic and deontic meaning:

(3) *She **may** have already left* [= it is possible that she has already left] – epistemic meaning

(4) *If you wish to talk to the manager you **may** do so* [= you are allowed to talk to the manager] – deontic meaning

However, the difficulty of fitting the root meaning of *can* (meaning *ability* and *sensation*) into this system has motivated Palmer (1979) to add the third category, defined as *dynamic*. For example:

(5) *He **can** speak four languages* [= he has the ability to speak four languages]

2.2 L2 acquisition of English modal verbs

As far as the acquisition of modal verbs is concerned, literature on first language acquisition suggests that non-epistemic (root, or deontic) meaning is acquired earlier than the epistemic meaning (Wells 1981). Experiments were conducted (e. g. Noveck 2001; Ozturk and Papafragou 2015; Papafragou and Ozturk 2006) which showed that older children (7 and 9-year olds) performed similarly to adults, i. e. better than 4 and 5-year olds on tasks that entailed epistemic possibility and epistemic necessity. Noveck (2001) study, for instance, compared children's and adults' comprehension so that the participants were presented with two open and one closed box, and were told that the closed box had the same contents as one of the open boxes. Having heard eight modal statements (e. g. *There might be a parrot in the box*, *There has to be a parrot in the box*, etc) they had to choose the appropriate one. In a more recent study, Ozturk and Papafragou (2015) used a simple task where, after viewing a short animated story, children were told they would play a game in which they had to decide in which box an animal was hidden. There were four scenarios with two boxes on the stage, while test statements and questions targeted the unopened box. It was confirmed that the scenarios with uncertain outcomes (epistemic possibility) presented a particular difficulty for younger children.

In explaining such results Papafragou (1998) makes links to the Theory of Mind (Gopnik and Wellman 1994) which is based on the young children's incapability to see that beliefs may have different sources. This Theory postulates that only after the age of 3 – 4 children develop the ability to relate mental states (beliefs, desires, knowledge, etc.) to others. Initially, they are prone to identify their own belief contents with reality. Another hypothesis would imply that children's acquisition of modal auxiliaries may be closely related to the input children receive at that age, i. e. they are normally exposed to conversational situations where expressions of permission, ability, intention, or obligation are considerably more frequent than those where epistemic modals are used.

When it comes to foreign or second language acquisition, a most persistent problem for language learners seems to be the opacity and lack of transparency characteristic of modal form-meaning mapping. Although the relatively simple form of English modals can generally be learnt easily, there is evidence that mastering the complexity of modal semantics and pragmatic inferences will necessitate an investment of considerably more effort and time on the part of the learner (Dittmar and Terborg 1991; Giacalone Ramat 1992). In the Pavia Project Giacalone Ramat and her colleagues longitudinally studied the acquisition of L2 Italian by learners coming from different L1 backgrounds

(Chinese, Tigrinya, Persian, German and English). It was observed that at early stages of acquisition only deontic modality was used in grammaticalised, inflected verb forms, whereas a limited range of epistemic meaning was achieved by the use of epistemic adverbs (in Italian *forse* and *magari*, meaning 'perhaps' or 'maybe') and some basic formulaic expressions with modal verbs, such as *non (lo) so*, meaning 'I don't know'. Furthermore, the use of epistemic adverbs was more frequent and more target–like in learners with L1 German and English. Finally, only more advanced learners, for example a German L1 speaker, developed epistemic modality through the use of modal verbs which were correctly inflected for person and tense. This was observed only after more than two years of learning

This study reflects a general tendency in the development of tense, aspect and modality in second language, by showing that lexical means precede verbs as inflected grammatical categories. In modality in particular, this process first involves the use of adverbs and pragmatic means as those external to the grammatical system, while the development of inflected linguistic constructions takes place only after an extended period of time. It appears that the same acquisitional process – from external to internal – can be observed in the developmental path from deontic to epistemic meaning in modality. Among the accounts provided, Talmy's (1988) cognitive explanation of change from deontic to epistemic is based on his notion of *force dynamics*, such that root (deontic and dynamic) modals encode force-dynamic actions in the external world, and then extend into the internal domain where epistemic meanings are encoded. Bybee and Pagliuca (1985), on the other hand, explain the change as metaphorical extension of obligation onto necessity, and then to possibility and probability. It is interesting that a similar process of semantic change, from deontic to epistemic, is also observable in historical development of modality. As Giacalone Ramat (1992: 298) underscored, there are 'striking similarities' between the two processes – the one in L2 acquisition and the diachronic development in history.

2.3 Modality in Croatian

Although the process of semantic change, following a unidirectional path from deontic/root to epistemic modal meaning, is well documented in languages around the world (Bybee et al. 1994), there are still language–specific differences that characterise each individual language. For example, in some Slavic languages modality has not been recognised as a verb category on its own right (Hansen 2009, cited in Karabalić 2011). Croatian is one of such Slavic languages. Modal verbs do exist in Croatian but they differ from English on a number of both

formal and functional properties. For example, modal verbs in Croatian, such as *morati* 'must', *moći* 'can/may', *htjeti* 'will, shall' are the verbs with all regular properties, which means they have full infinitive form, can be tensed, can be conjugated for number and gender, and can also be used in combination with another modal verb. Furthermore, while dynamic and deontic meaning of modal verbs in Croatian share some common characteristics with other languages, not all modals have their epistemic meaning. Rather, epistemicity related to possibility would be expressed using lexical means. For example, an English sentence containing *may* that expresses epistemic possibility in future time (e. g. *She may come tomorrow*) will be rendered in Croatian by means of an adverb, *možda* ('perhaps' or 'possibly') and either the future or the present tense of the main verb:

(6) *Ona će možda sutra doći*
She will perhaps tomorrow to come
'She may come tomorrow.'
or
Ona možda dolazi/dođe sutra
She perhaps is coming/comes tomorrow
'She may come tomorrow.'

Among the dissimilarities between the two languages it is important to notice that the Croatian verb *moći* stands for both *can* and *may* in English. In other words, *may* does not have its equivalent in Croatian. However, the deontic meaning of *may* indicating permission can be easily covered by the use of *moći*. (It is to be noted that in English too, *may* is frequently replaced by *can* when referring to permission, especially in more informal contexts). For example, a sentence such as, *You may/can borrow my book*. (= I give you permission to borrow my book) will be translated as *Možeš posuditi moju knjigu*. Similarly, the dynamic meaning of *can* indicating ability is also relatively easily expressed by the use of the verb *moći*, as the following example shows:

(7) *On može trčati vrlo brzo*
He can (3 p.sing) to run very fast
'He can run very fast.'

2.4 Cross-linguistic influences

Taking into consideration the above mentioned differences and similarities between the two languages, a hypothesis can be put forward that for native

speakers of Croatian the acquisition of deontic and dynamic modal auxiliaries in English will not present a challenge, whereas epistemic meaning might impose considerably more difficulty. Since the learners' L1 does not recognise the concept of epistemic possibility when expressed by a modal verb, it is unknown whether they can acquire the full semantics of modal *may*. Cross-linguistic influences have been shown to have impact on the competence to use a target language (e. g. Collins 2002; von Stutterheim 2003), specifically in the areas of space, temporality, and affect which is closely related to epistemic modality (Odlin 2005). Cross-linguistic influence or conceptual transfer also intertwines with the issue of ultimate attainment, a long-standing topic in research on L2 acquisition. To date, research is mixed as to whether linguistic features that are not instantiated in a learner's L1 can be fully acquired in their L2 (Hawkins and Liszka 2003; Hopp 2010; Liszka 2004).

Many of the studies targeting grammatical development and ultimate attainment have employed grammaticality or acceptability judgement tasks – which are thought to be solid indicators of the learner's explicit and metalinguistic knowledge (Ellis 2005), but may be less informative about the learner's implicit knowledge. On the other hand, studies on conceptual transfer have been predominantly concerned with productive use of language, and likewise, studies in L2 acquisition of modality have so far mostly been interested in the production of modal verbs. Important longitudinal studies that investigated the development from deontic/dynamic to epistemic use of modal auxiliaries in both L1 and L2 production (e. g. Dittmar and Terborg 1991; Giacalone Ramat 1992; Stephany 1986) were not matched by research concerned with comprehension issues. Therefore, studies focusing on L2 comprehension of epistemic modality are clearly needed. Moreover, the acquisition of modality has not been approached yet via the investigation of online processing.

3 The current study

The current study set out to examine L2 learners' online comprehension of modal auxiliaries. The following question was asked: To what extent do Croatian learners of English at an upper-intermediate level acquire modal verbs *can* and *may* with their full semantics?

A self-paced reading task was used with the aim to investigate how L2 learners process sentences involving the three categories of modality. Such tasks have been used in both first and second language research as an experimental method that can tap into real-time (online) processes while readers attempt to comprehend sentences that are presented either word by word or as phrase by

phrase (e. g. Hopp 2006, 2010; Pliatskias and Marinis 2013; Roberts and Liszka 2013; Stewart et al. 2009). Research in monolingual sentence processing has provided evidence that native speakers vary their reading time on a word–by–word basis and adjust their reading depending on the properties of each word (Just et al. 1982). In psycholinguistic experiments it has been observed that native speakers always show an increase in reading time either on words, or following the words that cause some kind of ambiguity or violate either the grammatical or logical/semantic meaning of the sentence. Such reaction to ambiguities or ungrammaticality in sentences suggests that native readers 'feel' when violations of syntax or sentence semantics occur. Therefore, when L2 learners are presented with similar ambiguities or ungrammatical sentences, it is possible to test their behaviour as being similar or different from native speakers' reactions. During a self–paced reading task, each participant reads the input at his or her own speed, and presses a button or the space bar on the computer, which brings up the next word. The procedure is repeated until the whole text of the input is processed.

In the current study it was first necessary to investigate whether English native speakers would show an increment in reading time when encountering violation of modal semantics in a context where the use of a certain modal verb is unacceptable, and secondly, to investigate whether Croatian native speakers as relatively advanced learners of English would show the same patterns in reading times as the English native speakers. Only modal verbs *may* and *can* were tested, in their epistemic and non-epistemic meaning. Such a decision was made with the aim to obtain more fine–grained information, bearing in mind that to closely examine the acquisition of all three modal categories, the participants should be presented with at least several sentences/contexts in which the use of a modal is either acceptable or unacceptable. Moreover, these two auxiliaries are probably the most ambiguous ones in the English modal semantics: because they can even be used interchangeably when asking or giving permission. On the other hand, they significantly differ with regard to their epistemic meaning. While epistemic possibility of *may* has been already discussed [see examples (1) and (3)], most scholars would agree that *can* is used with its epistemic meaning only in negative but not in affirmative statements, as exemplified in:

(8) *He is a bachelor so he* ***can't*** *be married.*

(9) *They* ****can*** *be waiting in front of the door.*

Equally, the dynamic meaning of modal *can* cannot be extended to the use of *may*. For example:

(10) *I **can** smell something burning.*

(11) *I ***may** smell something burning.*

3.1 Method

3.1.1 Participants

Twenty participants volunteered in this study: twelve were Croatian learners of English at an upper-intermediate level (the CEFR level B2–C1, based on the test administered by the university language tutors) and eight English native speakers. Mean age was 21, and 20 respectively. All participants were university students, Croatian learners majoring in English at a university in Croatia, and English native speakers majoring in Education at a UK university. The learners of English (9 females and 3 males) had on average 10 years of English instruction at school and university, and none of them had spent more than two weeks in an English speaking country. At the time of data collection they were all in their second year of undergraduate university study. The English native speakers were either in year one or year two of their university study.

3.1.2 Materials

Similar to the self–paced reading studies concerning grammatical features or constructions (such as present perfect vs past simple in Roberts and Liszka 2013; or regular and irregular past simple forms as in Pliatskias and Marinis 2013) this study used 24 experimental items with the modals *can* and *may* manipulated so that each of the two modal verbs was used either appropriately in a given matching context or inappropriately in a mismatching context (where the counterpart modal should have been used). The experimental items were presented to the participants in a pseudorandomised manner, and there were 16 filler items, so that altogether each participant had to read 40 items. The 24 experimental items included in the task were divided according to their meaning into: *epistemic*, *deontic* and *dynamic*. Each of these three semantic meanings was represented by eight items out of which four were used in a matching and four in a mismatching context.

Each item consisted of three sentences where the first sentence was an introduction to the context, the second sentence contained the modal verb,

and the third sentence aimed at wrapping up the whole little 'story' or event. The following table presents the items in the administered self–paced reading task where the use of *may* and *can* is either acceptable or unacceptable (Table 1):

Table 1: Examples of items in the self-paced reading task.

Acceptable (context–matching)	Unacceptable (context–mismatching)
*Angela has recently spent a lot of time travelling and photographing. She **may** be looking for a new career. Angela is a talented photographer.*	*Angela has recently spent a lot of time travelling and photographing. She ***can** be looking for a new career. Angela is a talented photographer.*
*Molly has recently enrolled on a computer course and is learning how to use the keyboard. She **can** already type very fast although she is quite a beginner. Molly is a good learner.*	*Molly has recently enrolled on a computer course and is learning how to use the keyboard. She ***may** already type very fast although she is quite a beginner. Molly is a good learner.*

3.1.3 Tasks and procedures

The experimental items were counterbalanced in order to account for possible differences in the task items although all effort was made to make the items as comparable as possible. Thus, half of the participants read one version and the other half read the other version of the test, i. e. half of the participants read 12 experimental sentences containing the acceptable modal auxiliary use and 12 sentences containing unacceptable modal auxiliary use, while the other half of the participants read the counterpart items, such that those that were acceptable in the first version of the task were now unacceptable, and vice versa.

Before starting to read the sentences, the participants read three items for practice – these items had a similar structure to the experimental items but were unrelated to the use of modal auxiliaries and were designed only to help the participants familiarise themselves with the self–paced reading task.

The experiment used the Psychopy software (Peirce 2007, 2009) which is freely available on the internet and has so far been widely used in eye–tracking and self–paced reading tasks. This study used the 'stationary window' where the text of each experimental item (and of each filler) appeared on the screen word by word until the end of the entire task. The words of the sentences were white on the dark grey screen, and were positioned in the middle of the screen. The participants received the instructions both orally and in written form before the

commencement of the task. They were instructed to press the space bar to proceed, and as they pressed the space bar the word on the screen would disappear and the next word would appear. After each set of sentences there was the instruction on the screen reminding the participants what they were required to do. The instruction read: *Please read each sentence carefully. Press the space bar to proceed*. At the end of the whole task there was a sentence saying that the task was finished and the participants were thanked for their contribution to the experiment.

The task was administered individually so that each participant was tested separately, in a quiet classroom. Among the 40 sets of sentences containing the experimental items and the fillers, ten (25%) random comprehension yes/no questions were inserted in order to make sure that the participants were paying attention to the meaning of the sentences they were reading. The questions were unrelated to the use of modals in order not to interfere with the processing of the sentences in which modals were used. Since one participant in the English native speaker group provided two erroneous answers to these questions, the data from this participant were removed from the analysis.

3.1.4 Data analysis

The data collected in the experiment were analysed using SPSS statistical software. A mixed design factorial ANOVA was employed, with the two groups (L1 speakers vs. L2 learners) as between–participants independent variable and the factor 'condition' as within–participant independent variable with two levels: acceptable vs. unacceptable (or context-matching vs. context mismatching). To further examine the significant results obtained by ANOVA, a paired samples t-test was used to confirm the significant differences between the two conditions (acceptable vs. unacceptable) in each group.

4 Results

Before the analysis, the data were screened for outliers. Following the procedure in Roberts and Liszka (2013), and Pliatskias and Marinis (2013), any outlying response time that fell two standard deviations away from an individual's mean was removed and replaced by the participant's mean for that segment. This affected 0.78% of the English native speakers' data and 0.87% of the learners' data.

In all experimental sentences, six segments were examined such that the first segment was the modal, followed by five other words. The following three examples illustrate which segments (words) were analysed in sentences containing modal auxiliaries. The three examples illustrate the use of (a) epistemic, (b) deontic, and (c) dynamic modals.

(a) ...(They) may/be/waiting/in/the/car/...
1 2 3 4 5 6
(b) ... (Visitors) may /not/enter/this/way/. James (is confused)...
1 2 3 4 5 6
(c) ...Can /you /pass/me/the /water (please)...
1 2 3 4 5 6

Six segments starting from the modal verb were investigated because of a possibility that the effect of processing slowdown at critical point could spill over to the following segments/words (Just et al. 1982). Due to the fact that a modal meaning can be grasped only in the context and interpreted at the sentence level, this study has extended the number of analysed segments following the critical segment, since there seemed to be little chance that both native and non-native speakers would interpret the modal immediately after it has been encountered. Five segments following the modal belonged to various categories and had different functions: in declarative sentences the modal was followed by a base verb form, followed by a NP (e. g. *He can play the piano*.) ; in some sentences the modal was followed by an auxiliary and the inflected (aspectual) verb form, followed by a NP or PP (e. g. *She may be looking for a new career*.); in interrogative sentences the modal was followed by a NP + VP + NP (e. g. *Can you open the door for me?*). Interrogative constructions, specifically with dynamic *can* in speech acts of request were used to reflect their frequency in communicative contexts, but were not submitted to any separate analysis.

Descriptive statistics for mean reading times (RTs) of six segments in sentences read by both groups of participants are presented in Table 2 (epistemic modal category), Table 3 (deontic), and Table 4 (dynamic).

As can be seen in Tables 2–4, the reading times of English L1 speakers were shorter than those of English L2 learners in acceptable condition through all three modal categories, with the exception of dynamic modals, where L2 learners were faster only at the first segment. Where modal verbs were used in a mismatched condition, i. e. unacceptably, L1 speakers were slower in sentences with epistemic modal meaning. However, the reading times of L2 learners did not differ from native speakers when reading unacceptable sentences with

Table 2: Epistemic modal verbs: mean RTs in milliseconds (SD in parentheses).

		Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6
English L1	**Acceptable**	418 (69)	418 (85)	420 (91)	456(71)	482(94)	492(61)
speakers	**Unacceptable**	486(98)	544(175)	535(159)	**718(233)**	563(200)	576(176)
English L2	**Acceptable**	458(178)	454(149)	490(200)	522(194)	477(189)	556(221)
learners	**Unacceptable**	464(204)	490(188)	517(180)	**501(189)**	526(206)	557(236)

Table 3: Deontic modal verbs: mean RTs in milliseconds (SD in parentheses).

		Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6
English L1	**Acceptable**	458(203)	438(81)	503(140)	498(201)	454(109)	469(194)
speakers	**Unacceptable**	378(74)	446(50)	549(181)	**563(142)**	455(142)	502(149)
English L2	**Acceptable**	521(270)	588(269)	509(201)	533(206)	543(257)	470(196)
learners	**Unacceptable**	392(176)	537(250)	579(231)	**563(223)**	489(236)	532(219)

Table 4: Dynamic modal verbs: mean RTs in milliseconds (SD in parentheses).

		Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6
English L1	**Acceptable**	538(133)	490(105)	550(103)	543(141)	552(126)	627(261)
speakers	**Unacceptable**	561(237)	544(220)	452(76)	**680(102)**	649(363)	635(284)
English L2	**Acceptable**	493(215)	518(236)	543(215)	585(260)	580(243)	646(223)
learners	**Unacceptable**	570(338)	644(374)	519(211)	**714(206)**	642(254)	717(319)

deontic, and were even somewhat longer in mismatching sentences with dynamic meaning.

The following three figures (Figures 1, 2, and 3) show the differences between reaction times (RTs) in context–matching and context–mismatching use of modal auxiliaries with epistemic, deontic and dynamic meaning, calculated so that the RTs in context–mismatching condition were subtracted from RTs in context–matching conditions.

A mixed factorial ANOVA was performed on each of the six segments in experimental sentences, separately for each modal category (epistemic, dynamic, deontic). The results showed the following: In sentences with epistemic modal meaning there was an interaction of group and condition only at segment 4: $F(1, 18) = 11.153$, $p = 0.004$, $\eta = 0.38$, while at all other segments there was no interaction between the group and condition. This means that the reading time at segment 4 was significantly different in two different conditions (acceptable vs. unacceptable) in two groups (L1 and L2 speakers). The main effect of condition at

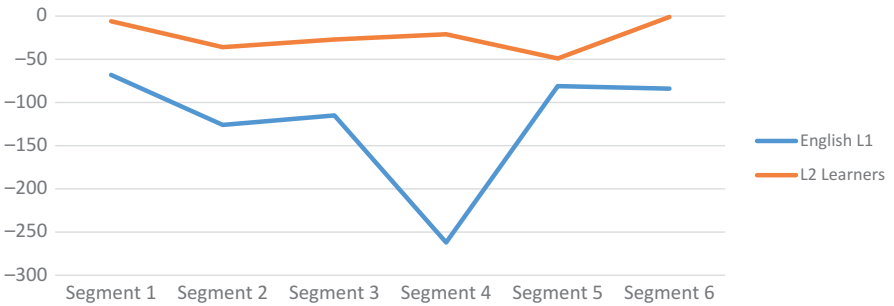

Figure 1: Reaction times (RTs) in context–matching minus context–mismatching use of epistemic modals.

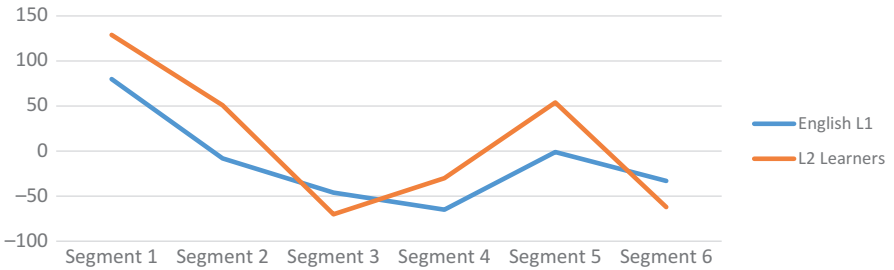

Figure 2: Reaction times (RTs) in context–matching minus context–mismatching use of deontic modals.

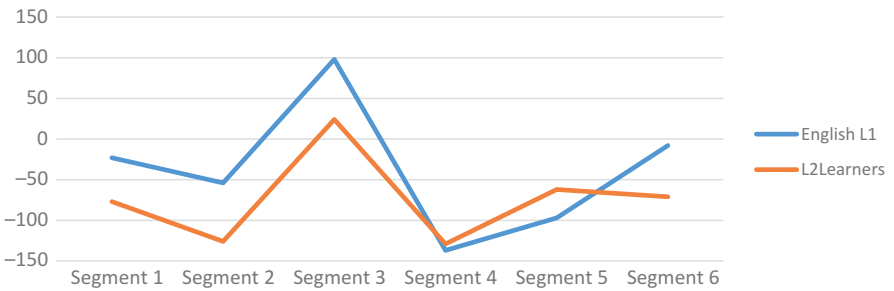

Figure 3: Reaction times (RTs) in context–matching minus context–mismatching use of dynamic modals.

segment 4 was also significant: F (1, 18) = 8.1, $p = 0.011$. The follow-up Paired samples *t*-tests confirmed that it was the group of L1 speakers who showed a significant reading time increment at segment 4 in context–mismatching, unacceptable condition (compared to the context–matching, acceptable condition): t (7) = 3.89, $p = 0.006$, while in L2 learners' group no such difference between the two conditions was observed at any of the six segments.

In sentences with deontic modal meaning there was no significant interaction between the group and condition at any of the six segments, and no main effect for condition, which suggests that the two groups did not differ in either acceptable or unacceptable condition at any of the six examined segments.

In sentences that used dynamic modal meaning there was no significant interaction between the group and condition, which suggests that the two groups performed similarly in both acceptable and unacceptable condition. However, there was an effect for condition at segment 4: F (1, 18) = 7.1, $p = 0.016$. This indicates that the reading times in two conditions (acceptable vs. unacceptable) were significantly different at segment 4. This increment of time in unacceptable condition was observed in both groups. A Paired-samples *t*-test confirmed such results in both groups: for L1 speakers group: t (7) = 2.9, $p = 0.023$ and for the L2 group: t (11) = 2.26, $p = 0.045$.

In summary, the following table presents the results of an independent samples *t*-test between the two groups at segment 4 in each condition (acceptable vs. unacceptable):

From Table 5 it is evident that the two groups, L1 speakers and L2 upper-intermediate learners, demonstrated a significant difference in reading times only in sentences with epistemic modal meaning, and only in unacceptable (context-mismatching) condition. Such a result confirmed the hypothesis based on cross–linguistic influence and L1 transfer: that L2 learners whose native language does not instantiate a certain feature (in this case a modal verb bearing an epistemic meaning) will experience difficulties with its acquisition in L2.

Table 5: Independent samples *t*-test between the two groups in two conditions (run on segment 4).

Category	Unacceptable	Acceptable
Epistemic	t (18) = 2.29*, p = 0.034	t (18) = 1.08, p = 0.30
Dynamic	t (18) = 0.002, p = 0.999	t (18) = 0.47 p = 0.65
Deontic	t (18) = 1.34, p = 0.196	t (18) = 0.37, p = 0.71

5 Discussion and conclusions

The present study sought to answer the question whether L2 learners whose L1 modal system considerably differs from English as their second language, can acquire epistemic, deontic, and dynamic meaning of two modal auxiliary verbs, *can* and *may*. Since the findings from both first and second language research suggest that epistemic modality is acquired later than deontic/root (or agent-oriented and speaker-oriented) modality, it was important to focus on advanced or upper-intermediate learners who have already had extensive experience with English language learning. The results of the self-paced reading task confirmed the hypothesis that these learners experience problems with the epistemic meaning whereas deontic and dynamic meanings could be acquired to the native level. However, a word of caution is needed here: since the sample size in the current study was very small, any firm conclusion in this regard would be too hasty and not entirely appropriate. On the other hand, due to the fact that the sample size was such small, it is interesting that the results were almost clear-cut; thus it is possible to further hypothesise that with larger numbers the statistical analysis would show even stronger relationships and more convincing significant differences or similarities between the groups. Another limitation of this study is that the findings from the self–paced reading task are not compared with the results of an acceptability judgment task, which would provide information on the learners' explicit knowledge and thus portray a fuller and clearer picture of L2 learners' linguistic competence. In the following paragraphs the results are first discussed separately for the group of English native speakers and the group of L2 learners. The performance of the two groups is then compared, and some tentative conclusions are drawn.

The findings of the experiment using a self–paced reading task suggest that English native speakers manifest a noticeable slowdown in processing time when encountering a semantic violation in a context that would require the use of the epistemic modal *may* (e. g. *She **may**/***can** have already left*). The same is observed in contexts that would require the use of the dynamic modal *can* (e. g. *I **can**/***may** smell something burning*). The analyses of six segments starting with the modal auxiliary verb and including the following five words indicate that the increment in milliseconds is most clearly observable at segment 4, i. e. on the fourth word starting from the modal. Such an increment is observed in the native speaker group only when there is semantic violation in sentences using epistemic *may* and dynamic *can*. A similar change in reading time is not observable in sentences using *may* with its deontic meaning. Such sentences are usually present in more formal settings where a specific modal (*may)* has a

pragmatic function. Thus, we may conclude that the 'unacceptable' use of a modal in such situations (e. g. *can* vs. *may*) indicates that an infelicitous use of a modal has taken place, rather than that there is a violation of the modal semantic meaning. This is probably the reason why English native speakers did not show any significant slowdown when presented with sentences that used a more informal manner of expressing or asking for permission. In short, these sentences seem to be entirely acceptable for native speakers. Leech's (2003) study may be indicative in that regard. Having examined several written and two spoken corpora of British and American English, Leech found that for some of the English modal verbs (e. g. *may*, *must*) the use was reduced over the period of 30 years, from 1961 to 1991, whereas the use of *can* increased in the same period.

Similar to the native speaker group, the L2 learner group also did not show increment in reading time when presented with the sentences that exemplified infelicitous modal use in contexts that would pragmatically require a more formal choice. So, with regard to the use of deontic *may*, the two groups did not differ. They also showed similar patterns of behaviour when presented with the sentences using dynamic *can*. However, this behaviour was affected by semantic violations and the two groups both showed a significant increase in reading reaction times when presented with sentences in which the use of the modal verb did not match the context (e. g. *He* ***can/*may*** *play the violin better than his older brother*). It would seem that for Croatian native speakers, who identify *can* primarily with ability, the context mismatching use of *may* was a clear indication of a semantic violation.

The most striking difference between the two groups, however, is observed in sentences where the context would require the use of epistemic *may*, but the context-mismatching *can* was used – which was clearly felt as ambiguity and interpreted by native speakers as a semantic violation (e. g. *They* ***may/*can*** *be waiting in the car*). English L1 speakers showed a significant increase in processing time at segment 4 (718 ms compared to 456 ms recorded for the same segment in context-appropriate modal use). Such an increase is not present in the L2 group, who read segment 4 in unacceptable (context-mismatching) condition as fast as the same segment in the acceptable, context-matching condition (501 ms vs. 522 ms). Such a result is not surprising when considering that: (a) studies in English L1 acquisition find children acquiring the epistemic use of modals later than non–epistemic (Noveck 2001; Ozturk and Papafragou 2015; Papafragou 1998), (b) studies in L2 acquisition also show that epistemic meaning of modal verbs is acquired later than non–epistemic (Dittmar and Terborg 1991; Giacalone Ramat 1992; Klein 1986), and (c) the Croatian language uses lexical means rather than syntactic means to express epistemic possibility and

therefore this missing feature in L1 may significantly reduce L2 learners' sensitivity to semantic violations of this type.

It seems that several interrelated processes are at play here. The slower acquisition path characteristic of epistemic modality, as observed in English L1 children, suggests that the acquisition of modality can be viewed as a more universal process. Strong support for such an explanation can be found in both synchronous cross–linguistic evidence and historical processes of grammaticalisation. There is sufficient evidence suggesting that modal auxiliaries follow the route from deontic towards epistemic meaning (Bybee et al. 1994; Traugott 1989). However, such an explanation, although helpful, may not be sufficient to explicate the findings obtained in the present study, in which cross–linguistic influences and L1 concept transfer can also be observed. The study demonstrates that L2 learners who have had about ten or even more years of L2 instruction and who are otherwise fluent in English, do not show sensitivity to violations of epistemic meaning in the way they exhibit such sensitivity to violations in dynamic modality. Likewise, they do not show sensitivity in the way native speakers exhibit changes in online processing, having encountered a mismatch between the information contained in the context congruous with epistemicity and the modal auxiliary used. More studies with a larger sample size, and including an acceptability judgment test, with participants of typologically different L1s would certainly shed more light on these processes.

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