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Paweł Chełminiak
Department of Pragmatics of English, Faculty of English, Adam Mickiewicz University

Recognizing Communicative Intentions Lies at the Heart of Irony Processing; and Bilinguals Might do it Better: A Literature Review

Bilinguals perform better in interpreting intentions, the pillar of irony comprehension. As bilingualism becomes normal, exploring the role of the second language (L2) in irony comprehension seems invaluable. Evidence suggests that L2 proficiency impacts irony processing in the native language (L1). Some studies highlight the positive role of L2 proficiency in L2 irony processing - irony comprehension may proceed comparably in L1 and L2 provided one is highly proficient in both languages. While some evidence shows that irony processing is less efficient in L2, other suggests that the processing difficulty in L1 and L2 is attenuated. I review various studies exploring irony comprehension in the bilingual context. It is suggested that bilinguals may be privileged irony comprehenders due to a better developed mentalizing capacity. Bilingual irony processing evidence is inconclusive and needs further exploration. This paper reviews studies which have addressed the issue.

Key words: irony, irony processing, bilingualism, theory of mind, L2 proficiency

Address for correspondence: Paweł Chełminiak
Department of Pragmatics of English, Faculty of English, Adam Mickiewicz University
E-mail: pawel.chelminiak@amu.edu.pl

Verbal Irony

Interpreting the intended meaning of "The weather is just great" uttered with reference to a cold, gloomy and rainy day (especially when the weather forecast predicted completely different conditions) takes understanding the context in which the comment is uttered, and, most importantly, certain communicative skills. The aforementioned comment is an example of irony, whereby the speaker communicates their failed expectations (nice weather) in the face of adverse weather conditions. Importantly, what an ironic speaker intends to convey is an attitude towards the opinion mentioned (echoed), whereby they dissociate themselves from the literal meaning of their words (Wilson & Sperber, 1992).

In the traditional view, irony was treated as a trope, which was characterized by a substitution of a figurative meaning for a literal one (Wilson & Sperber, 1992). Traditional accounts saw irony as a figure of speech, which conveys the intended meaning in a figurative manner (semantic approach; Sperber & Wilson, 1981) and a two-layer utterance with both, incompatible meanings (literal and figurative) opposing each other (Grice, 1975). Based on the valence of the context an ironic comment is embedded in we distinguish ironic criticism and ironic praise. Ironic criticism is embedded in a negative context but features a positively-worded comment which conveys a negative ironic meaning (e.g., "Such a great dinner!" uttered with reference to a dinner one did not like). Ironic praise is embedded in a positive context but features a negatively-worded comment which conveys a positive ironic meaning (e.g., "Such a horrible dinner!", uttered with reference to a delicious dinner) (Caffarra et al., 2019). These two types of ironic utterances demonstrate two different processing patterns. Ironic criticism, a more prototypical, more frequently used type, is learned, detected and understood faster and more easily than ironic praise, which is harder to interpret, due to its lower frequency of use and non-prototypicality (Caffarra et al., 2019; Caillies et al., 2019; Ellis et al., 2021; Harris & Pexman, 2003). In order to accurately interpret an ironic intention, one needs to be capable of taking perspectives to be able to "see through" an ironic comment and arrive at what the speaker had in mind initially (Sperber & Wilson, 2002). Essentially, they need a set of skills collectively known as Theory of Mind.

Theory of Mind

The ability to communicate our attitudes and attribute attitudes to others is a building block of human cognition (Garfield et al., 2001). What I refer to here as Theory of Mind (Garfield et al., 2001) or mentalizing (Frith & Frith, 2003) has also been referred to as intentional stance (Frith & Frith, 2003), and social cognition (Channon et al., 2005; Shamay-Tsoory et al., 2005). It is noteworthy that all these terms encapsulate the same set of mechanisms. Theory of Mind is defined as "the cognitive achievement that enables us to report our propositional attitudes, to attribute such attitudes to others, and to use such postulated or observed mental states in the prediction and explanation of behavior" (Garfield

et al., 2001). Theory of Mind is not a single skill or function of our cognition but a set of skills and dispositions (Garfield et al., 2001). The mentalizing capacity becomes first visible at the end of infancy, from 18 months of age onwards (Frith & Frith, 2003). Even slightly earlier, from 12 months of age, an infant is capable of representing agents, goals and means of getting to the goal (Frith & Frith, 2003). Research demonstrates that language comprehension and the mentalizing capacity are inextricably linked, in that passing a false belief task is successful after a child has reached a certain level of linguistic development (Jenkins & Astington, 1996). The ability to mentalize can be shaped by such factors as cultural and linguistic background (Tiv et al., 2023) and family size, with a bigger number of siblings contributing to a better performance on Theory of Mind tasks (Jenkins & Astington, 1996), or immersion in a bilingual environment (Rubio-Fernández & Glucksberg, 2012; Schroeder, 2018). Moreover, cultural setting shapes the timing of the mentalizing capacity development as children who come from different countries (therefore different cultures and linguistic environments) develop the mentalizing capacity at different ages (Liu et al., 2008; Wellman et al., 2001).

Irony Comprehension Early Emergence in Children

Irony comprehension is a pragmatic skill. As children enter middle childhood their pragmatic abilities are on the increase (Del Giudice, 2014). The ability to comprehend ironic meaning is considered a great step in children's social cognition development (Aguert et al., 2017). The capacity is modulated by children's neural maturation, social skills and the mentalizing ability (Pexman & Glenwright, 2007). Extant research covering irony comprehension by monolingual children suggests that their capability of understanding ironic meanings may be dependent on age. Early evidence supporting irony comprehension development in children suggested that the ability begins to emerge between the ages of five and six (Dews et al., 1996; Harris & Pexman, 2003). The reason why children younger than 6 years old have trouble understanding ironic remarks, may have its roots in their imperfect inferencing skills, and hence they cannot read speaker's beliefs and intentions when these are communicated implicitly (Winner & Leekam, 1991). There is some evidence, however, which demonstrates that children younger than 5 years old are capable of understanding ironic intent (Angeleri & Airenti, 2014). In a study exploring the development of joke and irony comprehension involving children aged 3 – 6.5 years old Angeleri and Airenti (2014) diversified irony into two types of utterances. The first one implied the negation of something interlocutors were able to directly refer to, and a contextual cue was present (contingent irony). The understanding of the second type of the ironic utterances drew on shared knowledge, and a contextual cue was absent (background irony). When these two irony types were considered, contingent irony comprehension appeared to be easier than background irony comprehension, owing to the access to contextual cues (or references) which are readily accessible in the case of contingent irony.

A more striking observation was that children in the younger groups (3- and 4-year-olds) demonstrated a good performance on contingent irony comprehension and even some performance on background irony comprehension. More recently, it has been suggested that this complex ability may be observed in children as young as 3 and 4 years old (Banasik-Jemielniak & Bokus, 2019; Loukusa & Leinonen, 2008).

The comprehension process is a complex cognitive endeavor and proceeds gradually as the child develops (Dews et al., 1996; Garfinkel et al., 2023). First, the child begins to understand that a speaker is being ironic or that their intended meaning is incongruent with the literal meaning of their words. Only later does the child appreciate the irony, i.e. comprehends what the speaker means by uttering an ironic remark (Garfinkel et al., 2023; Harris & Pexman, 2003). Essentially, the ability to appreciate the intention to criticize by means of irony precedes the ability to appreciate the ironic comment's humorous aspect (Pexman & Glenwright, 2007), which may occur by age nine or ten (Pexman, 2023). Indeed, appreciating irony for its humor poses a great challenge for children (Pexman, 2023) even if they are explicitly taught about ironic speakers' intention to be funny (Lee et al., 2020). Loukusa and Leinonen (2008) showed that some children aged 3 and 4 start to accurately recognize the intent of an ironic remark, even though their performance is limited and deficient. Banasik-Jemielniak and Bokus (2019) found that children comprehended ironic comments differentially depending on the comment's reference. While children aged 6 years old were able to understand ironic remarks regardless of the inclusion or exclusion of the reference to the addressee's behavior, younger children (aged 4 years old) were more accurate at comprehending irony when it was targeted at the addressee's action, compared to when such a reference was absent. In a different study, Banasik (2013) observed significant performance differences between four-, five-, and six-year-olds on the Reflection on Thinking Test (a Theory of Mind test) in the absence of age differences on Irony Comprehension Task (demonstrating that four-year-olds were just as accurate as their five- and six-year-old colleagues). In the Theory of Mind test, the oldest age group (six-year-olds) performed better than the five-year-olds, who, in turn, performed better than the four-year-olds. It was suggested that the observed age differences (poorer performance of the four-year-olds compared to five-year-olds, and five-year-olds compared to six-year-olds) may originate from the test's difficulty and complexity stemming from the task (explicit verbalization of observed relations necessary in making explanations of the incongruities embedded in ironic comments). On the other hand, the comparable results on the irony test may suggest that even the younger children may have drawn on available cues such as intonation, mimicking or context and may have understood that the key to making sense of irony is very often the reversal of meaning. Importantly, Banasik (2013) suggests that the ability to reflect on other people's mental states predicts ironic meaning

detection. In a different study, Garfinkel et al. (2023) asked their 8-year-old participants to reflect upon ironic comments and provide reasons for why the ironist expressed an ironic remark. It was suggested that compared to 5-year-olds (prior data), 8-year-olds were more inclined to talking about interlocutors' emotions and intentions and delving into the pragmatic reasons for speaking ironically. The roots of the inconsistency of the evidence are still difficult to define. Evidence from bilingual children irony comprehension shows that 6-year-olds were highly accurate in irony recognition (Banasik & Podsiadło, 2016). In a study conducted with Polish-American bilingual children living in the USA, Banasik and Podsiadło (2016) presented their participants with stimuli (featuring sarcastic, blame-imbued irony, and non-sarcastic, blameless irony) consisting of pictures displayed on a screen and stories presented auditorily. Participants were highly successful at identifying ironic and literal intentions. Most importantly, they were equally accurate at recognizing both types of ironic utterances (those placing criticism on the addressee, and those without such criticism). Such an early-developed capacity may be nurtured by continuous exposure to two languages and language acquisition in the natural setting. Banasik and Podsiadło (2016) emphasize more research exploring figurative language comprehension by children bilinguals is needed to make claims about bilingual children advantage.

Theory of Mind and Irony Comprehension

Theory of Mind plays a crucial role in irony comprehension, because in order to arrive at the intended interpretation of an ironic utterance, one has to be able to understand not only the actual beliefs of the speaker, but also the speaker's beliefs about the listener's beliefs. This two-order intentionality and the accurate identification thereof ensures a correct interpretation of an ironic remark (Dews & Winner, 1997; Ronderos et al., 2023).

There is evidence from children (Banasik, 2013; Banasik & Podsiadło, 2016) and adult (Ronderos et al., 2023; Tiv et al., 2023) participants which shows that the mentalizing ability (Theory of Mind) has a positive effect on irony comprehension. Specifically, having access to the speaker's beliefs and intentions opens the gate to the interpretation of their intended meaning. In addition, the speaker information about their attitude or communicative style (e.g., being known as a jokester) improves the interpretation (Regel et al., 2010). Moreover, Ronderos et al. (2023) found evidence which supports the relation between mindreading ability and sensitivity to irony. In their study, Ronderos and the team (2023) found that participants who scored higher on a mindreading task ('Reading the Mind in the Eye') performed better at irony comprehension than those participants who scored lower. Specifically, when ironic utterances clearly communicated the speaker's intention participants read them faster than when the context did not provide such a contextual clue about the speaker's communicative intention. This result demonstrates a critical role of Theory of Mind capacity in irony processing.

Moreover, the interface of irony comprehension and Theory of Mind is further substantiated by evidence from irony processing studies in autistic participants (Happé, 1993; Panzeri et al., 2022). Autism spectrum disorder (ASD) is a neurodevelopmental condition which is described by social communication and interaction impairments (Panzeri et al., 2022). There is evidence which points to the autistic participants' reduced ability to understand ironic intent (Happé, 1993). It is noteworthy, however, that the impairment is not an absolute category, but rather, a matter of degree. Autistic participants are placed on a spectrum with varying degrees of the impairment. While some autistic participants develop language, exhibit regular linguistic abilities, and perform similarly to typically developing (TD) peers, other autistic individuals demonstrate various linguistic impairments affecting expressive and/or receptive skills (Panzeri et al., 2022). Similarly, autistic individuals differ in their capacity to appreciate ironic intent. There has been some speculation that this reduced sensitivity to irony in autistic individuals may be rooted in autistic individuals' deficient mentalizing abilities (Happé, 1993). Happé (1993) found that only those participants who passed second-order tasks (recognizing the speaker's informative intention and their communicative intention; recognizing the speaker's intentions about others' mental states), and not just first-order Theory of Mind tasks (recognizing the speaker's informative intention) were able to comprehend irony. In a different study, Panzeri et al. (2022) tested irony comprehension and mentalizing abilities by autistic children and found that autistic children performed worse than their TD controls on both irony and mentalizing tasks. It was suggested that both skills may be impaired in autistic populations. However, other evidence suggests the difficulty in irony comprehension by autistic individuals may not concern the ironic intent detection but may originate elsewhere. Pexman et al. (2011) compared children with high-functioning Autism Spectrum Disorder (HFASD), TD children matched for verbal ability and TD children matched to the HFASD group for chronological age. The study showed that children with HFASD and both groups of TD peers were equally accurate in making judgments of speaker intent and speaker belief for ironic criticism. However, there were group differences in the accuracy of humor detection. Unlike TD peers, individuals with HFASD failed to correctly identify humorous aspect of ironic remarks. This result shows that HFASD individuals were unable to interpret the ironic remarks as simultaneously critical and humorous (Pexman et al., 2011). Moreover, data from judgment latencies and eye gaze demonstrate that HFASD individuals used different decision-making processing strategies for making sense of the nonliteral ironic remarks relative to the TD peers. In a different study, HFASD children participants, asked to interpret ironic statements, resorted to rephrasing or explanatory strategy instead or interpreted the ironic remarks literally (MacKay & Shaw, 2004). It appears that even though some children with ASD are able to comprehend irony, they are at a disadvantage appreciating all its social functions or use alternative ways of arriving at the proper interpretation.

Bilingualism

Bilingualism provides one with the opportunity to communicate with people and discover various cultures. These foreign experiences enable a broader perspective on the world, lead to a personal enrichment, stronger generation ties and intercultural relationships and greater flexibility on the job market (Grosjean, 2021). Research shows that the mentalizing capacity can be enhanced in bilinguals due to their increased exposure to two linguistic and communicative systems (Rubio-Fernández & Glucksberg, 2012; Schroeder, 2018). Nowadays, interlocutors engage in bilingual communication more than ever before. More than a half of the present-day world's population regularly uses two or more languages (or dialects) daily (Grosjean, 2021). Even though, the position of bilingualism seems well-founded, the definition of a bilingual is not so straightforward. A rather carefully weighed definition sees a bilingual as "someone who can function in both languages in conversational interaction" (Wei, 2007). Due to essential variables, such as age and manner of acquisition, proficiency level, domains of language use and attitudes towards the language, the concept of bilingualism is better understood as a continuum, rather than as a categorical unit.

The Influence of Bilingualism on Theory of Mind

Bilingual experience has a positive influence on mentalizing as it promotes the development of communicative ability, and it enhances the Theory of Mind competences (Rubio-Fernández & Glucksberg, 2012; Schroeder, 2018). Moreover, bilingual individuals develop the mentalizing capacity earlier than monolinguals (Bromberek-Dyzman, 2024). Consequently, Schroeder (2018) suggests that Theory of Mind, the ability to attribute mental states and recognize communicative intentions, can be nurtured by exposure to the second language, and there is evidence which supports the beneficial role of bilingualism in the development of Theory of Mind (Diaz & Farrar, 2018; Goetz, 2003; Schroeder, 2018; Tiv et al., 2021). The bilingual advantage in mentalizing can be observed as early as at the age of 2. In a study with young children (2- and 3-year-olds), Kovács (2009) compared monolinguals' and bilinguals' performance on two Theory of Mind tasks: a standard false-belief task and a modified false-belief task involving a language-switch situation with a monolingual and a bilingual character. Results indicated that bilingual children outperformed monolingual children on tasks involving the Theory of Mind capacity. Kovács (2009) suggests that the better completion of the tasks bilingual participants owed to precocious control functions which developed during monitoring and selecting languages. Schroeder (2018) claims there are three main accounts (explanations) behind the advantageous performance of bilinguals over monolinguals on the Theory of Mind tasks: executive functioning, metalinguistic awareness, and socio-pragmatic awareness. The executive functioning account draws on the bilingualism/executive functioning interface and suggests that the degree to which executive functioning

is developed is an indicator of the Theory of Mind capacity (Devine & Hughes, 2014). Specifically, Schroeder (2018) suggests the mechanism responsible for executive functioning should suppress the bilingual's mental state (their own beliefs and knowledge) and highlight someone else's (e.g., interlocutor's) mental state. Specifically, even though adults' attention may be distracted from reasoning about other people's mental states by their own perspective, bilinguals are less likely to be affected by the egocentric bias of their own perspective, owing to the enhanced executive control (Rubio-Fernández & Glucksberg, 2012). On the metalinguistic awareness account bilingualism promotes metalinguistic awareness (Bialystok, 1988; Goetz, 2003), which is linked to the development of Theory of Mind (Doherty, 2000). Bilinguals' metalinguistic knowledge about a linguistic form and the fact that there are two labels for the same concept (one label per language) may be the reason why it may be easier to accept that two people can have different mental states and attitudes in response to the same stimulus or event. More importantly, this mechanism may function to ensure the understanding in case the mental state is different from one's own (Schroeder, 2018). Lastly, the socio-pragmatic account explains how bilinguals make sense of the fact that while certain speakers only speak one of their languages, others speak both. The realization that people's linguistic repertoires and knowledge differ may be conducive to understanding that their mental states may differ as well (Schroeder, 2018). The three accounts (executive, metalinguistic and socio-pragmatic) help explain why bilinguals exhibit an advantageous performance on tasks involving the Theory of Mind competences. The executive functioning mechanism constitutes complex mechanisms which are discussed in the next section.

Bilingualism and Executive Control

Executive control is considered to be a set of interrelated processes and components, and it is disputed to what extent these processes and components develop and operate independently of each other (Bialystok & Viswanathan, 2009). Specific processes which can be distinguished are mental set shifting (Shifting), inhibition of prepotent responses (Inhibition) and information updating and monitoring (Updating) (Miyake et al., 2000). Shifting, or switching, (also referred to as cognitive flexibility) encompasses the ability to shift between tasks. Inhibition refers to the capability of suppressing information which is irrelevant at a particular moment, and it has been shown to be better developed in bilinguals, who have an advantage at inhibiting their knowledge when responding to a question involving mentalizing and adopting another person's perspective in Theory of Mind tasks (Javor, 2017). Lastly, monitoring underlies information updating in working memory, and, most importantly, is responsible for retaining information relevant at a particular moment in an online manner. Research shows that working memory facilitates irony comprehension in adults (Antoniou & Milaki, 2021) and pragmatic meaning comprehension in children (Antoniou et al., 2020). In sum, these three processes comprise the general cognitive capacity governing

our communication.

There is evidence which demonstrates a beneficial role of bilingualism in language functions. Bilingual children exhibit the onset of executive functions development at an earlier age than monolingual counterparts (Bialystok, 2001; Kovács, 2009). Peal and Lambert (1962) found that bilingual children performed better than monolingual children on a battery of tests spanning language and non-verbal tasks. Bilingual children outperformed the monolingual counterparts on tasks which involved symbol manipulation and reorganization, which was taken to reflect the bilingual children's advantage over monolingual children in metalinguistic awareness and the ability to ignore misleading information. What is more, bilinguals possess better executive control than monolinguals when all background factors are controlled for (Bialystok et al., 2012). This, however, is a contentious issue, and there is no evidence for the general bilingual effect in all executive functions (Giovannoli et al., 2020). The bilingual effect is observed in inhibitory control (Ansaldo et al., 2015; Bialystok et al., 2004; Degirmenci et al., 2022; Giovannoli et al., 2020; Massa et al., 2020) and cognitive flexibility (Giovannoli et al., 2020). The bilingual effect emerged when assessing these functions with tools such as the Sky Search task, the Flanker task, the Dimensional Change Card Sort task, and the Trail Making Test, to name a few (Giovannoli et al., 2020). The bilingual effect did not emerge in tasks measuring the working memory capacity (Giovannoli et al., 2020). Giovannoli et al. (2020) suggest the incoherence may be caused by experimental design nuances, for example, individual participants' language profiles and methodological choices made such as sample size or type of task or even different versions of the same task. Specifically, Bialystok (2015) proposes a refocusing of perspective and that where bilinguals may exhibit an advantage is not in inhibition but in failure to inhibit attention to the non-target language. This, in turn, leads to the involvement of executive functions and their development.

Bilingual Experience and Pragmatic Meaning Comprehension

Irony comprehension takes language but also pragmatic skills (e.g., making sense of other speakers' words) (Banasik-Jemielniak & Kałowski, 2022), which are honed by social interactions (Bromberek-Dyzman, 2024). Consequently, bilinguals, who are more capable of inferring other people's mental states and the subtle, veiled meanings (Rubio-Fernández & Glucksberg, 2012; Schroeder, 2018), should demonstrate an advantage when processing pragmatic functions. Bilinguals demonstrate an advantageous performance in nonliteral language processing such as conventional metaphors (Sundaray et al., 2018), utterances which contain the violation of conversational maxims (Siegal et al., 2009), or irony (Tiv et al., 2023). In addition, bilingual speakers demonstrate a better performance when they are asked to read sentences containing pragmatic information on the speaker identity, in that, compared to their L1 counterparts, L2 readers are more likely to rely on speaker information in making sense of the meaning (Foucart et al., 2015). This may suggest intensified sensitivity to

veiled, social, pragmatic and contextual layers of meaning (Foucart et al., 2015). Other evidence shows that bilinguals understand implicatures comparably to native speakers, provided their L2 proficiency is sufficiently high (Antoniou, 2019). Indeed, bilinguals may enjoy heightened sensitivity to pragmatic meanings compared to monolinguals.

Irony Processing in the Native Language

A great deal of extant irony processing research has been concerned with irony processing by monolingual speakers (Colston, 2002; Colston & O'Brien, 2000; Gerrig & Goldvarg, 2000; Gibbs, 1986, 1994; Giora et al., 1998; Ivanko & Pexman, 2003), while the comprehension of irony in bilinguals started to be explored only recently (Bromberek-Dyzman, 2015; Bromberek-Dyzman et al., 2010, 2021; Bromberek-Dyzman & Rataj, 2016; Caffarra et al., 2018; Cheang & Pell, 2011; Ellis et al., 2021; Peters et al., 2016; Puhacheuskaya & Järvikivi, 2022; Tiv et al., 2023). A detailed review of studies on irony processing in the native language is beyond the scope of this article. For a detailed review see Bromberek-Dyzman (2012). For the sake of presenting the full picture of irony research a brief summary of what was found about irony comprehension in monolinguals is presented here.

Previous behavioral studies have predominantly focused on whether irony comprehension takes longer than literal meaning comprehension, and these studies provide inconclusive results. While some studies demonstrate that irony is processed faster (Gibbs, 1986) others show that irony comprehension is slower (Giora et al., 1998) than literal meaning. According to the one-stage account (the direct access model; Gibbs, 1986), which assumes the priority of context in which an ironic utterance is embedded, the degree of figurativity of utterances is not essential and both literal and non-literal meanings are processed in a similar way due to the facilitating function of context. Importantly, the one-stage account does not predict a privileged status of the literal or the non-literal meaning. Meaning comprehension may be faster or slower depending on the context that may either facilitate or impede meaning comprehension. Experimental evidence shows that irony does not take longer to understand than literal meaning as long as the context supports the interpretation (Colston, 2002; Colston & O'Brien, 2000; Gerrig & Goldvarg, 2000; Gibbs, 1986, 1994; Ivanko & Pexman, 2003). Conversely, according to the two-stage account (standard pragmatic model; Grice, 1975; the graded salience hypothesis; Giora, 1997), irony processing always entails longer processing time, during which both types of meaning (literal and ironic) need to be accessed and considered (Giora et al., 1998; Grice, 1975). Research shows that irony processing, indeed, takes longer than its literal controls (Dews & Winner, 1999; Giora et al., 1998; Giora & Fein, 1999; Schwoebel et al., 2000). Evidence from eye-tracking studies on irony processing corroborates this finding (Filik et al., 2017; Kaakinen et al., 2014). The speed of irony processing can be a resultant of various factors which partake

in communication, i.e., the type of irony (ironic criticism or ironic praise; Dews & Winner, 1995; Gibbs, 1986), the task (true/false, lexical decision task, evaluative decision task; Dews & Winner, 1995; Gibbs, 1986), input presentation mode (self-paced, limited response window; Gibbs, 1986; Giora et al., 1998, 2007), or the amount and salience of cues that create an expectation of irony (Gibbs, 1994; Giora, 1997). The evidence is inconsistent and provides support in favor of faster and facilitated irony processing (Colston, 2002; Colston & O'Brien, 2000; Gerrig & Goldvarg, 2000; Gibbs, 1986, 1994; Ivanko & Pexman, 2003) or slower irony processing (Dews & Winner, 1999; Giora et al., 1998; Giora & Fein, 1999; Schwoebel et al., 2000) compared to literal meaning. This disparity may be caused by methodological factors (specified above) which lead to various conclusions regarding how the brain makes sense of ironic meaning, therefore, it remains an open question, and an important avenue for future research.

Irony Processing in the Non-Native Language

Bilingual irony processing studies to date have tested irony in reading (Bromberek-Dyzman, 2015; Bromberek-Dyzman et al., 2010, 2021; Bromberek-Dyzman & Rataj, 2016; Ellis et al., 2021; Li & Jung, 2023; Tiv et al., 2023), listening (Bromberek-Dyzman et al., 2021; Caffarra et al., 2018; Cheang & Pell, 2011; Peters et al., 2016; Puhacheuskaya & Järvikivi, 2022) and audio-visual (Bromberek-Dyzman et al., 2021) settings. Moreover, some studies compared bilinguals' with monolinguals' irony comprehension (Ellis et al., 2021; Peters et al., 2016), some studies focused on bilinguals' L1 and L2 irony comprehension (Bromberek-Dyzman et al., 2010, 2021; Bromberek-Dyzman & Rataj, 2016), bilinguals' L2 irony comprehension with differing L2 proficiency levels (Li & Jung, 2023), bidialectals' irony comprehension in the more frequently used dialect (Antoniou & Milaki, 2021), bilingual children's comprehension in one of their languages (Banasik & Podsiadło, 2016), while other studies explored how accent perception (Caffarra et al., 2018; Puhacheuskaya & Järvikivi, 2022) and unfamiliar language perception (Cheang & Pell, 2011) impacts irony comprehension.

Bromberek-Dyzman et al. (2010) tested literal (literal praise) and ironic (ironic criticism) language comprehension in the native and non-native languages of their participants. In the self-paced study (participants were given unlimited time for decision-making), where participants were asked to make a judgment whether the target sentence in each story was favorable or unfavorable, participants made significantly faster responses to literal stimuli, compared to ironic ones, in both tested languages. Researchers proposed that when not under time pressure, participants respond faster to literal meaning. No differences, however, were found between ironic/literal language processing in the native and non-native languages. The fact that no language effect was obtained in this study was taken to reflect participants' high L2 proficiency (literal language) and the mentalizing (Theory of Mind) ability (ironic language). Equipped with the ability to mentalize, comprehenders are capable of attributing intentions and mental states to others,

and, consequently, interpreting ironic meanings. If the mentalizing capacity develops with the exposure to bilingualism, participants in this study may have enjoyed better performance in L2 irony comprehension, than they would have without such a competence. Though without a statistically significant language effect, it was observed that responding in the non-native language (to both literal and ironic trials) produced longer latencies than responding in the native language. The authors suggest that the ability to appreciate ironic meaning is universal across all languages one speaks.

In a different study, Bromberek-Dyzman and Rataj (2016) aimed at elucidating the process of irony comprehension in the native and non-native language, using a response window paradigm. When under time constraint, participants, whose task was to read stories and judge them in terms of praise or criticism conveyed, tended to take longer to respond to stimuli in the non-native language (although without a statistically significant language effect), regardless of the meaning (literal or ironic), but ironic utterances resulted in longer response times than the literal ones in both native and non-native languages. The researchers suggested that these results point to the great cognitive demand that irony processing entails irrespective of the language of processing. Interestingly, irony processing in one's non-native language may proceed as fast as in one's native language, as long as L2 proficiency is sufficiently high.

In another study, Ellis et al. (2021) investigated participants' ability to recognize irony and compared the performance of Chinese learners of English to English native speakers. Participants were asked to read positive and negative literally and ironically intended stories and evaluate them as either positive or negative. They found that learners' scores were visibly lower and response times slower than native speakers' results. This study provides additional evidence that irony processing comes with a cognitive cost, which is even greater in the non-native language, and that even proficient L2 learners attend to explicit processing strategies when comprehending irony.

There is some evidence demonstrating the role of prosodic features in irony comprehension in the non-native language (Caffarra et al., 2018; Cheang & Pell, 2011; Peters et al., 2016; Puhacheuskaya & Järvikivi, 2022). Interestingly, non-native speakers use prosodic cues in a different manner than native speakers do (Peters et al., 2016). It appears, that non-native speakers have a tendency to rely on contextual semantic cues more than on prosodic cues when processing irony in the spoken discourse. In their study, Peters et al. (2016) had their participants listen to short discourses in four conditions and answer comprehension questions about the discourses. The four conditions mixed positively and negatively valenced contexts with sincere and sarcastic prosody. The items resulted in four categories (Congruent: Positive Context/Sincere Prosody, Negative Context/Sarcastic Prosody, Incongruent: Negative Context/Sincere Prosody, Positive Context/Sarcastic Prosody), where the positive and negative contexts differed by just one word, which biased the meaning toward either an ironic or a literal interpretation

and the sincere and sarcastic prosodies were uttered accordingly. Native speakers relied on both contextual and prosodic cues for sarcasm interpretation but preferred contextually derived information when context and prosody did not match. In contrast, the non-native speakers depended on contextual cues entirely. The prevalent reliance on contextual semantic information and the simultaneous ignorance of prosodic cues may have its roots in the non-native participants native language (Arabic) habits, such as very little or no use of prosody in the interpretation of intentions. Moreover, the authors claim that non-native speakers need to expend greater processing resources to override an initial phonological pattern interpretation and to apply the right phonological rules of the language of processing, which may be even more difficult to activate in ironic speech.

Interestingly, the difficulty connected with processing ironic intentions may, indeed, be, at least partially, rooted in the prosody of ironic statements. Peters et al. (2016) showed that native and non-native participants relied on different irony features for comprehension when these were uttered in English by an English native speaker. In a different study, Caffarra et al. (2018) demonstrated that participants rated ironic statements differently depending on whether they were uttered in their native language by native speakers with a native accent or foreign speakers with a non-native accent. This effect, however, applied only to the less frequent type of ironic utterances, namely, ironic praise. While critical ironic utterances were rated for their level of irony similarly in both accents, ironic praise was considered less ironic when uttered by non-native speakers with a foreign accent, relative to items uttered by native speakers with a native accent. When participants were asked to rate ironic statements uttered by non-native speakers, they tended to understand them in the literal way. It has been suggested that the speaker's characteristics included in their accent (native or foreign) are actively incorporated into the online interpretation process and bias the outcome understanding of an utterance.

Similarly, Puhacheuskaya and Järvikivi (2022) found that foreign-accented ironic utterances were rated for their level of irony differently than ironic utterances uttered by native speakers. Specifically, ironic utterances spoken by foreign speakers of English (Mandarin Chinese speakers) were rated as significantly less ironic than those spoken by native speakers of English (Canadian English speakers). While Caffarra et al. (2018) reported an identical trend for foreign- vs. native-accented ironic praise utterances, this study provides evidence for this trend observed in both praising and critical irony. However, the asymmetry of affect was observed, with participants, overall, rating ironic praise utterances as less

ironic and less appropriate than ironic criticism. It was suggested that the foreign-accented less prototypical type of ironic utterances may have made participants doubtful about the speaker's intent.

The asymmetric nature of ironic utterances is a commonly reported phenomenon (Caffarra et al., 2018, 2019; Caillies et al., 2019; Puhacheuskaya & Järvikivi, 2022; Tiv et al., 2023). Specifically, there is a body of evidence which shows that ironic praise (the less frequent type of ironic utterances, featuring negative literal meaning and positive intended, ironic meaning, e.g., "What a mean guy!" uttered about a person who is selfless and kind) is rated as less appropriate (Puhacheuskaya & Järvikivi, 2022; Tiv et al., 2023), lower in perceived irony (Tiv et al., 2023), less ironic when uttered by foreigners (Caffarra et al., 2018), and more difficult to process as evidenced by greater N400-like effects in electrophysiological studies (Caffarra et al., 2019; Caillies et al., 2019) compared to ironic criticism (featuring positive literal meaning and negative ironic meaning, e.g., "What a nice guy!" uttered about a person who is selfish and rude). In a study conducted with bilingual speakers, coming from a culturally and linguistically rich context (Montréal, Canada), Tiv et al. (2023) explored the role of individual differences underlying bilingualism, i.e., the mentalizing capacity and being immersed in a bilingual setting in irony comprehension. Participants were asked to read short stories in English and make a judgment on the stories' naturalness, appropriateness and irony. Those participants who exhibited better mentalizing skills and who lived in a linguistically diverse setting considered ironic utterances (both critical and praising) more appropriate than those with lower mentalizing scores and who lived in a less linguistically diverse neighborhood. Greater mentalizing capacity and experience with linguistic diversity may have made participants more sensitive to the pragmatic and social aspects of irony (Tiv et al., 2023). Moreover, participants who scored higher on the mentalizing task and who lived in high language diversity neighborhoods considered ironic compliments (the less frequent type of irony) more ironic than those who scored lower on the mentalizing task and who lived in low language diversity neighborhoods. These results emphasize the paramount role that bilingual experience plays in irony comprehension (Tiv et al., 2023).

The foregoing studies in the prosodic features of irony and their contribution to the comprehension process show that the native language plays an essential role in the shaping of the influence of prosody on irony processing in the non-native language (Peters et al., 2016). Moreover, some evidence points to the invaluable role of the speaker's characteristics (such as their accent) in shaping the final interpretation of an ironic utterance in the foreign language (Caffarra et al., 2018). While listeners considered utterances less ironic when uttered in a foreign accent (Caffarra et al., 2018; Puhacheuskaya & Järvikivi, 2022), one might wonder how the comprehension would proceed in the case of irony delivered in a non-native language which the listeners are unfamiliar with. Cheang and Pell (2011) asked their English and Cantonese listeners to identify the communicative intent (such

as sarcastic irony, sincerity, neutrality, and humorous irony) conveyed by means of utterances spoken in a foreign language which they did not speak. Specifically, participants were asked to listen to the utterances and judge the speaker's attitude. It was observed that sarcastic irony was processed in a different manner than the other three intentions. Specifically, while they were pretty successful at identifying sincerity, neutrality and humorous irony in the foreign (unfamiliar) language, they only identified sarcastic irony at near-chance levels in that language. Importantly, on average, participants were more successful at identifying all four intentions (including sarcasm) in their native languages. The results of the study place emphasis on the significance of extra-linguistic nuances the proper recognition of which may be invaluable when communicating with individuals representing different cultural, and, specifically, linguistic backgrounds.

The evidence discussed so far points to a greater difficulty when dealing with ironic utterances in the non-native language. In a set of studies conducted with highly proficient L2 users of English and L1 native Polish speakers, Bromberek-Dyzman et al. (2021) explored the nuances embedded in the modality of irony presentation in context. Participants in this study were reading, listening or watching ironically- and literally- intended materials adapted from a popular TV show (House, M.D.). Their task was to decide if the presented comments were mocking or not, while their response times and accuracy were measured. Results show that when they were reading and watching ironic and non-ironic interactions their performance (response times) was comparable in the native and non-native language. When participants were listening to ironic and non-ironic interactions, they responded faster in the non-native language, relative to the native language. It is noteworthy that in both languages participants' performance was both faster and more accurate in response to ironic, relative to non-ironic stimuli. It was argued that such results may be rooted in the high level of L2 proficiency. At the same time, Bromberek-Dyzman et al. (2021) suggested that slower response time rates for non-native trials may be a consequence of the way audio material was presented in the native language (Polish). It is customary in Poland to broadcast TV series with a voice-over translation method, which features both voice tracks (the original one and the translated one) which may result in a reception interference. Participants who could hear two voice streams imposed on one another may have found it confusing and harder to process than just one stream, even if delivered in the L2. Nevertheless, this study shows that the role of L2 proficiency is invaluable and that it leads to an enhanced performance in irony comprehension.

In a different study, Antoniou and Milaki (2021) investigated the impact of L2 proficiency and use on irony comprehension. Interestingly, in their study, participants were bidialectals who spoke two dialects of Greek (Cypriot Greek and Standard Modern Greek), highly proficient in SMG, considered a non-native language. Participants were tested on an act-out irony comprehension task, where they were supposed to indicate an object they thought the character in the story wanted, while their response times were measured. The stories were modelled

in such a way to bias a literal-positive, literal-negative and ironic meaning of the comments. Results showed that response times for ironic and literal interpretations were comparable. However, greater L2 use and better working memory score along with higher general intelligence corresponded with faster irony interpretation in bidialectals. Such results add to the body of work which demonstrates that the boundary between ironic and literal meaning may be less rigidly demarcated, especially as L2 use and working memory capacity increases.

The significant role of L2 use and proficiency in L2 irony comprehension has been observed in another recent study (Li & Jung, 2023). L1 Cantonese speakers were asked to read literal and ironic stories in their L2 (English) and answer comprehension questions while their response times and accuracy were recorded. Participants were divided into two L2 proficiency groups, intermediate and advanced. Overall, irony was processed slower and less accurately than literal meaning. However, when ironic criticism was compared with literal criticism participants response times to ironic criticism were shorter than to literal criticism. The other, less frequent irony type, ironic praise, proved more difficult to process (when compared to literal praise) and resulted in much slower response times. Li and Jung (2023) suggest that the ironic criticism processing advantage over its literal counterpart may be caused by their participants high L2 proficiency honed by their exposure to an ESL context on a daily basis. Specifically, participants with advanced L2 proficiency processed ironic meaning faster than participants with intermediate L2 proficiency, this effect was not observed for accuracy scores, however. In turn, it was proposed that differences in language use may have been the factor for the dissimilarities observed in accuracy rates. Crucially, those participants who spent more time using their L2 in speech daily were more accurate at irony comprehension than those who spent less time speaking in their L2. These data provide additional evidence for the beneficial role of L2 proficiency and use in irony processing in the non-native language.

In sum, the evidence does not provide unanimous results. Some evidence points to a greater difficulty in irony processing in the non-native language compared to the native language (Caffarra et al., 2018; Cheang & Pell, 2011; Ellis et al., 2021; Peters et al., 2016; Puhacheuskaya & Järvikivi, 2022). Other evidence suggests that irony comprehension in L2 may proceed comparably to L1 irony processing when participants are highly proficient in the L2 (Bromberek-Dyzman, 2015; Bromberek-Dyzman et al., 2010; Bromberek-Dyzman et al., 2021; Bromberek-Dyzman & Rataj, 2016). Moreover, participants appear to experience less difficulty comprehending ironic meanings as their mentalizing capacity increases (Bromberek-Dyzman et al., 2010; Ronderos et al., 2023; Tiv et al., 2020; 2023). Bromberek-Dyzman (2024) suggests the discrepancy in the results may be the outcome of irony comprehender-related individual factors such as cognitive maturity (Banasik & Podsiadło, 2016; Banasik-Jemielniak & Bokus, 2019), linguistic proficiency (Bromberek-Dyzman et al., 2021; Ellis et al., 2021; Shively et al., 2008) and the amount as well as the diversity of communicative experience (Tiv et al., 2020; 2023).

The Theory of Mind module and the mentalizing capacity enable the attribution of intentions and mental states to others, and, consequently, the comprehension of ironic meanings (Ronderos et al., 2023). The mentalizing advantage in irony processing studies with bilinguals has not been given adequate attention. In some studies the beneficial role of the mentalizing capacity has been acknowledged (Bromberek-Dyzman et al., 2010; Tiv et al., 2020; 2023), while others did not mention this factor (Bromberek-Dyzman et al., 2021; Bromberek-Dyzman & Rataj, 2016; Caffarra et al., 2018; Cheang & Pell, 2011; Ellis et al., 2021; Peters et al., 2016; Puhacheuskaya & Järvikivi, 2022). It seems that when participants' abilities concerning recognizing and interpreting communicative intentions were measured, these skills had a positive impact on irony computation (Tiv et al., 2023). Research shows that greater language diversity enables higher mentalizing judgments of mental state inferences (Tiv et al., 2021). Moreover, L2 speakers attribute greater resources to mentalize in order to make logical inferences than L1 speakers (Tiv et al., 2021). When exposed to a more linguistically diverse environment, participants enjoy enhanced mentalizing skills and are more prone to accept ironic messages as appropriate, compared to those in less linguistically diverse areas (Tiv et al., 2023). With an exposure to bilingualism, and the development of the mentalizing component, bilinguals may demonstrate a more efficient performance (faster processing, more accurate responses, more appropriate irony judgments) in L2 irony comprehension than they would have with no such a privilege (Bromberek-Dyzman et al., 2010). Though the evidence is scant for the moment, the evidence from bilingual irony processing studies shows that the ability to interpret veiled ironic meanings in the L2 improves with the mentalizing capacity (Bromberek-Dyzman et al., 2010; Tiv et al., 2023). The interface between irony processing by bilinguals and the mentalizing capacity seems an important avenue for future research and a possible explanation of irony processing differences in the L1 and L2 and I propose that future research take account of the role of mentalizing in irony processing by bilinguals in study designs.

Irony comprehension involves a confluence of language processing and social impact (Katz, 2017). Experience which language users have in the second language can have an impact on such social and cognitive capacities as mental state reasoning, executive control, and metalinguistic awareness, which lie at the heart of irony comprehension (Tiv et al., 2020). On top of that, proficiency in the second language and the ability to compute ironic remarks in the first language and the awareness of L1 irony use and functions are closely connected (Kim & Lantolf, 2016; Tiv et al., 2019). L2 proficiency and irony comprehension ability interface suggests that whether one is capable of making sense of ironic language may be promoted by L2 use and proficiency (Tiv et al., 2020). In a study with bilingual participants, Tiv et al. (2020) showed that greater L2 proficiency patterned with enhanced sensibility to ironic intent (irrespective of the valence of ironic comments) in the native language. Moreover, the more proficient participants

were in the foreign language, the faster they responded to ironic praise (the less frequent and more difficult to process irony type) in their L1. These data suggest L2 proficiency plays a pivotal role in L1 irony comprehension and the awareness of the use and functions of irony.

Proficiency in the L2 also plays a pivotal role in irony processing in the non-native language (Antoniou & Milaki, 2021; Bromberek-Dyzman et al., 2021; Bromberek-Dyzman & Rataj, 2016; Li & Jung, 2023; Shively et al., 2008). Bromberek-Dyzman and Rataj (2016) found that irony processing in the non-native language may be as fast as in the native language as long as L1 and L2 proficiency levels are high. Bromberek-Dyzman et al. (2021) emphasize the profound role of L2 proficiency in irony processing in the non-native language in their multimodal irony processing study. High L2 proficiency was conducive to faster L2 irony (and non-irony) comprehension when reading and watching the stimuli and a comparable performance (response times) in the L1 and the L2 when listening to the stimuli. However, Ellis et al. (2021) suggested that language proficiency did not play a major role in their study involving Chinese learners of English. More research is needed to explore the interplay of L2 proficiency and irony comprehension in a more consistent manner to disambiguate the relation, as research shows that L2 proficiency may improve irony proficiency in the L2 (Antoniou & Milaki, 2021; Bromberek-Dyzman et al., 2021; Bromberek-Dyzman & Rataj, 2016; Shively et al., 2008).

Conclusion

Making sense of ironically-intended comments appears to be a demanding task and can result in a successful interpretation or a misunderstanding. Whether one accurately computes the veiled subtleties behind an ironic remark is a confluence of the strength of the context (Gibbs, 1986, 1994), the salience of meanings (Giora, 1997) and certain individual characteristics which make communicators more or less successful at the task. A great body of evidence demonstrates that in order for irony comprehension to proceed undisturbed, an interpreter needs to possess such communicative skills which enable the perception of intentions, beliefs and emotions (Ronderos et al., 2023; Shamay-Tsoory et al., 2005; Tiv et al., 2023). Specifically, irony processing seems to be inseparably linked to a cognitive mechanism, which makes reporting and attributing attitudes to others possible, and which enables communicators to draw conclusions and make inferences related to the explanation and interpretation of behaviors on the basis of these observations (Garfield et al., 2001). This powerful ability, known as Theory of Mind (Garfield et al., 2001), mentalizing, intentional stance (Frith & Frith, 2003) or social cognition (Shamay-Tsoory et al., 2005), is a uniquely human feat (Frith & Frith, 2003) and first manifests at the age of 18 months (Frith & Frith, 2003) but irony comprehension ability does not become operational until the age of 6 (Dews et al., 1996). The role of the mentalizing capacity is further substantiated by evidence demonstrating that it is

nourished by immersion in bilingualism (Rubio-Fernández & Glucksberg, 2012; Schroeder, 2018). The role of bilingual experience cannot be deprecated and, especially in the modern world, it needs to be acknowledged as a significant factor which can shape the course of communication. Specifically, the advantage that bilingualism brings to the table is visible in control mechanisms (executive functioning, metalinguistic awareness, socio-pragmatic awareness) which help in suppressing one's own mental state, while highlighting others' mental states, promoting the metalinguistic awareness, i.e., the knowledge about a linguistic form (or two different linguistic forms in two languages), and the awareness of a different mental state, and making sense of interactions with speakers who do not share any languages, share some or all languages (Schroeder, 2018). It is thanks to these mechanisms that communicators succeed at Theory of Mind tasks, such as irony comprehension. In addition, an essential mechanism, or rather a set of mechanisms which are indispensable in a successful communication are executive functions (Bialystok, 2015), and their components: working memory, inhibition and shifting (Miyake et al., 2000). Executive functions develop in bilingual children at an earlier age compared to monolinguals (Bialystok, 2001; Kovács, 2009). All these components are important in comprehending ironic utterances in the non-native, but also in the native language. However, there is no evidence for a general bilingual advantage in executive functions (Giovannoli et al., 2020). Specifically, bilinguals demonstrate an advantageous performance on tasks involving inhibition (Ansaldo et al., 2015; Bialystok & Viswanathan, 2009; Degirmenci et al., 2022; Giovannoli et al., 2020; Massa et al., 2020) and cognitive flexibility (Giovannoli et al., 2020), but not working memory (Giovannoli et al., 2020). Irony processing ability (irrespective of the language) is interfaced with the proficiency in the non-native language, in that L2 proficiency enormously contributes to irony comprehension in the native (Tiv et al., 2020) and non-native (Bromberek-Dyzman et al., 2021; Bromberek-Dyzman & Rataj, 2016) language. Evidence from irony processing studies in the bilingual context is inconclusive. Some studies report an advantageous performance in the native language with faster processing times in the L1 (Ellis et al., 2021), higher irony ratings in the L1 (Ellis et al., 2021), more accurate identification of sarcastic irony in the L1 (Peters et al., 2016), and more appropriately-sounding praising (Caffarra et al., 2018; Puhacheuskaya & Järvikivi, 2022) and critical (Puhacheuskaya & Järvikivi, 2022) irony in the native (L1) accent. Other evidence suggests a better performance in the non-native language with faster response times to ironic items in auditory modality (Bromberek-Dyzman et al., 2021) and a beneficial role of mentalizing capacity coupled with immersion in a linguistically diverse environment leading to a better comprehension of irony (Tiv et al., 2023). Some evidence points to a comparable performance in the native and non-native language

(Bromberek-Dyzman et al., 2010, 2021; Bromberek-Dyzman & Rataj, 2016) or differential use of available cues such as contextual and prosodic combined or just contextual ones (Peters et al., 2016). These results make it difficult to arrive at a unanimous conclusion about the role of the L2 in irony comprehension. More evidence is needed to make stronger claims about the differences in irony processing in the native and non-native language.

Implications for Further Research

The evidence is still scant and inconclusive. Future research should address the issue of the time course of irony processing in bilingualism with the use of a more time-sensitive methodology, for example, electrophysiological methods. Further research is invaluable in exploring the role of mentalizing and bilingual experience (with all its consequences) in irony processing by bilinguals in their L2. As studies demonstrate, bilinguals, who enjoy the Theory of Mind module and its mentalizing capacity developed to a greater extent, deal with interpreting ironic meanings more efficiently (Bromberek-Dyzman et al., 2010; Tiv et al., 2023). What is more, future research should investigate how bilinguals benefit from their L2 proficiency when making sense of ironic meaning in their L2. In addition, the area of individual factors such as mentalizing, and L2 proficiency should be further expanded by bringing other individual differences such as psychological well-being, personality traits, humor-related traits or cultural factors to the fore and exploring how they interface with irony comprehension and irony use, alike. As has been already suggested individual differences may be pivotal for the better understanding of irony use and the efficiency of its comprehension (cf. Kałowski et al., 2023). Given how the mentalizing capacity, L2 proficiency or cognitive functions shape the ability to detect and appreciate ironic meaning, other individual differences may play a role in irony comprehension, as well. In essence, more evidence is indispensable to verify whether the differences we have observed in irony processing in the L1 and L2 result from the degree to which one is able to recognize and interpret communicative intentions – to mentalize – which, in turn, is fostered by exposure to bilingualism.

Conflict of Interest Disclosure

The Author reports no conflicts of interest.

Data Availability Statement

Data associated with the current study will be made available upon reasonable request to the corresponding author.

Research Ethics Statement

Institutional ethical approval was neither sought nor necessary as this study involved no human participants.

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