# The Cognitive Underpinnings of Irony Interpretation by Children

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## ABSTRACT

Verbal irony is when a speaker's communicative intent is not the literal meaning of the statement and is commonly used as banter or to soften criticism. The main aim of this thesis is to investigate the cognitive underpinnings of irony interpretation in children. To date, the main focus of the developmental irony literature was on the role of mentalising, which is often defined as the ability to understand that others may have different beliefs, knowledge or desires. There are some good theoretical reasons that other cognitive skills, such as Executive Functions, might be crucial for irony interpretation too. For instance, it is theoretically plausible that one of the main components of EF, cognitive flexibility, might play an important role as the addressee of the ironic comment must switch between decoding the actual (literal) and the intended (ironic) meaning. Yet, only a handful of research looked at other than mentalising cognitive skills underpinning irony interpretation. To attempt to explore what cognitive factors underpin irony interpretation, $N = 233$ children (6- to 12-year-olds) were tested with newly developed irony measures across two correlational (Experiment 1 and 2) and one experimental study (Experiment 3). Over all the empirical studies, there was evidence for the role of mentalising – particularly in the experimental study – but it was not clear which particular aspect of mentalising was required. Moreover, there was conflicting evidence regarding the role of cognitive flexibility; in the correlational studies cognitive flexibility was found to be an independent predictor or irony whereas in the experimental study the effect of cognitive flexibility was not found. In the final chapter a suggestion is made that using more sensitive online measures, such as eye-tracking, and moving towards experimental as opposed to correlational measures might enable the detection of the role of cognitive flexibility on the irony interpretation.


Keywords: irony, executive functions, theory of mind

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**Declaration**

I declare that this thesis is my own work carried out under the normal terms of supervision.

Maria K. Zajączkowska

**Publications**

Within this thesis, Chapters 2 and 3 (combined) are currently in press and Chapter 4 (Experiment 3) is published:

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## TABLE OF CONTENTS

## LIST OF TABLES

# CHAPTER 1. GENERAL INTRODUCTION

## 1.1. Pragmatics

To become successful conversationalists, children not only need to learn semantic or syntactic rules of language, but they should also master the pragmatic aspect of it. *Semantics* usually refers to the decontextualized lexical meaning of words and the relationship between them at the sentence-level meaning (Grice, 1975). Although providing the universal definition of *pragmatics* can be very challenging, as the literature investigating this phenomenon is vast and numerous theorists offer different views of this domain of language, many approaches broadly define pragmatics as the ability to use language effectively and appropriately in the interaction with other people (e.g., Bates, 1976; Gallagher, 1991; Leech, 1983; Levinson, 1983). *Pragmatics* is also often understood as the use of language in context, which can affect the interpretation of utterances (Blakemore, 1992; Sperber & Wilson, 1995). Norbury (2014) implies that *pragmatics* can be perceived as the person's ability to comprehend the speaker's intention with all the verbal and non-verbal cues that may inform about those intentions; the ability to interpret the physical context, social norms and expectations. The speaker has to integrate all these with the structural aspects of language (syntax, vocabulary, phonology) to achieve successful communication.

Therefore, if the 'core' of pragmatics seems to be the ability to take context into account when interpreting language – *irony* is a prototypical example of exactly this as it is believed that this form of non-literal language relies heavily on context (Katz & Lee, 1993). Imagine that after your child spilled the juice over the clean tablecloth, you say to them:

(1) *'Well done!'*

Probably to understand that the speaker means something other than what they say, the child needs to first notice the incongruity with the context ('I spilled the juice over the clean tablecloth – this is not good'). Therefore, in order to understand the statement (1), the child needs to be able to understand the speaker's intention in the given context. The same statement could be interpreted literally if the child caught the cup with juice and saved the clean tablecloth from staining. It is believed that irony comprehension emerges much later than understanding of other forms of figurative language, such as metaphors (e.g., Winner, 1988) as irony requires higher order mentalizing skills than other non-literal tropes (e.g., Happe, 1993; Norbury, 2005).

## 1.2. Verbal Irony

**1.2.1. Theories of verbal irony.** The theorists investigating conversational irony (verbal irony) often define it as a figure of speech in which the literal meaning of the utterance is a semantic inversion of the implied meaning (e.g., Anolli, Infantino, & Ciceri, 2001). This definition is in line with the common understanding of irony. However, some authors claim that such definition is an oversimplification of this complex linguistic phenomenon and note that it is at times not clear what the opposite of an utterance's literal meaning is or what the literal meaning itself actually is (Gibbs, O'Brien, & Doolittle, 1995). The fields of linguistics, philosophy and psychology offer various theories and perspectives on explaining irony and its mechanisms. Interestingly, none of these approaches is dominant among the researchers studying irony. Below, I will briefly discuss some of the key theoretical frameworks of irony that shaped the current thinking about verbal irony.

Grice (1975) has established one of the theories of implicit meaning interpretation. In his theory of conversational implicature, Grice (1975) generates the maxims of conversation and the schema for pragmatic inference that derive from these maxims. Grice suggests that in conversation speakers follow the Cooperative Principle: 'Make your

conversational contribution such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged.' (1975, p. 45). He proposes four maxims that require from speakers to be as informative as the current purpose of the exchange requires (Quantity); to say things that are true (Quality); to be relevant (Relation); and to be perspicuous (Manner). Speakers are able to infer the meanings that are not explicitly stated due to the mutual knowledge of those four maxims as well as the addressee assumption that the speaker follows the cooperative principle. Because of that knowledge, it is possible to flout the Gricean maxims (e.g., by saying something that is not true when joking) without undermining the implicature. By flouting the maxim, the speaker gives the hearer a salient hint for drawing an inference and recover the implicature.

Grice (1975) attributes the definition of irony to Aristotle – 'saying something but meaning the opposite'. In Grice's very brief characterization on irony, this figure of speech is seen as conversational implicature, in which the ironist implicates the opposite of what is literally said. Therefore, the ironic speaker deliberately violates the maxim of quality (truthfulness). According to Grice (1989), the main purpose of irony is to criticise and to express negativity.

Similarly to Grice, Cutler (1974) claims that the implied meaning of ironic utterance is the opposite of its literal meaning. Cutler distinguishes two categories of ironic statements – *spontaneous irony* and *provoked irony*. In the first category fall all ironic utterances that appear out of immediate context, where the speaker communicates what he or she means in the context in which it is produced without any reference to the previous context. The second type of irony (provoked) includes the speaker's reference to the previous event, the knowledge shared with its audience. According to Cutler, the important feature of the *provoked irony* is the specific ironic tone of voice which indicates

that the speaker is being insincere. She argues that the obligatory condition for irony mentioned by Grice (1975) where the contextual situation makes it clear for both the speaker and the hearer that the speaker believes what he says to be false, can be replaced and signalled by means of intonational cues solely.

The alternative approach is proposed by Sperber and Wilson (1981) in their Relevance Theory, who argue that the traditional views on irony have some serious weaknesses. They challenge the main claim of the traditional/standard meaning substitution approach that ironical utterances convey the opposite of what is literally said. Sperber and Wilson propose that there are many instances (such as ironical understatements) where the meaning is not the opposite to what is said. For instance, imagine that you are in the shop and you can see a complaining customer who is furiously shouting at the shop assistant; you say:

(2) *'You can tell he's upset'* (Wilson & Sperber, 1992)

The traditional definition of irony would suggest that the actual meaning (being the opposite the literal statements) would be: (1) *You can't tell he's upset* or (2) *You can tell he is not upset*. According to Sperber and Wilson, neither of these interpretations is correct; therefore, ironical understatements would not fit the traditional definition of irony. Wilson and Sperber (1981) developed a new account of irony – the Echoic Mention Theory, in which the role of the background knowledge shared by the speakers is emphasised with the majority of ironic utterances referring to (*mention)* some previously shared event between the interlocutors. In their understanding of irony, the addressee of ironic utterance is reminded *echoically* by the ironist of a proposition previously experienced or said. In the example of the ironic understatement, the ironist does not say the *opposite* to what he or she means, but *less* than he or she means. The speaker by the ironic utterance *echoes* their

thought, a belief, an intention that is attributed to the intended victim. This dissociative attitude to be interpreted is expressed with an ironic, scornful tone of voice.

One of the most known variations and critical responses to Sperber and Wilson's account, is the Pretense Theory proposed by Clark and Gerrig (1984), which was further extended by Kumon-Nakamura, Glucksberg, and Brown (1995) in their 'Allusional Pretense' account. In the Pretense theories, the ironic speaker pretends to perform a speech act and expects the hearer to recognize the mocking attitude behind the ironic statement. The speaker exaggerates the tone of voice of someone that they are mocking.

The Allusional Pretense Theory of Discourse Irony (Kumon-Nakamura et al., 1995) offers slightly different notions of pretense and echo and proposes several conditions for ironic statements, which include the elements of both attribution (echo) and pretence. According to Kumon-Nakamura et al., there are two necessary conditions for discourse irony: (1) pragmatic insincerity and (2) occurrence in the instance of a violation of expectations.

Although Wilson (2013) argues that the two theories (the Echoic Mention Theory and the Pretense Theory) explain mechanisms of irony in a very different way (with Echoic Mention Theory being more successful; Wilson, 2017), others claim that the two accounts have very much in common on their theoretical side (e.g., Winner, 1988). As Winner pointed out, both approaches are actually substitution theories (not at the utterance level) with the ironic speaker substituting one voice for another depending on a new role played in Pretense Theory and the hearer substituting the speaker's utterance with the speaker's ostensive belief in the Echoic Mention Theory.

**1.2.2. Irony processing.** Now that several theories of what is considered as verbal irony have been outlined, it might be worth to mention some theoretical and empirical

approaches explaining how the ironic utterances are processed and which cues might be especially important in the processing of the ironic meaning.

Gibbs (1986) was one of the first researchers who offered new developments in pragmatic theory of irony and provided experimental insight into verbal irony processing. Gibbs challenged the traditional, Gricean view on the type of 'particularized' conversational implicatures where speaker implicates something different from what he says, such as in the case of metaphor, metonymy, irony. According to Grice's theory, the listener's task is to derive an appropriate implicature, which in the case of figurative language should require special cognitive processes (Grice, 1989; Searle, 1979b) – rejecting the literal statement first before decoding its actual, non-literal meaning.

Gibbs (1986), in the series of six experiments challenged the theoretical 'literal-first' model and was the first one to experimentally demonstrate that there is no need to construct the literal interpretation of the ironic utterance first. Gibbs in his experiments presented participants with sarcastic statements in written descriptions of conversations and analysed response times for understanding the target sentences (sarcastic or non-sarcastic). In his research, Gibbs emphasised the importance of contextual information that is crucial in the comprehension process (for instance, ironic utterances that echoed previously mentioned beliefs or norms were processed faster). Following Gibbs' direct access account, many studies showed that processing of some types of ironic utterances does not take longer than processing of literal statements (Dews & Winner, 1999; Giora, 2003; Glucksberg, 2001; Schwoebel, Dews, Winner, & Srinivas, 2000).

Slightly different view on irony processing was suggested by Giora and Fein (1999), who presented their participants with lexical decision task and analysed the speed of their responses to literally or ironically related words. Giora and Fein tested whether the familiarity of ironic utterances would affect their saliency (accessibility in the mental

lexicon) and the speed of the processing of ironic meaning. The familiar and non-familiar ironies were classified as such in the pre-test and included statements such as '*Very funny*' (familiar irony) vs '*I think you should eat something*' (less familiar irony). Both statements could be interpreted as either ironic or non-ironic depending on the context. Yet, Giora and Fein's (1999) study findings suggest that it is the salient meanings (more familiar ones) that are always activated first, regardless of contextual information, whose relevance was emphasised by Gibbs (1986).

Pexman, Ferretti, and Katz's (2000) irony comprehension framework supports and synthesises both the Graded Salience (Giora & Fein, 1999) and Direct Access (Gibbs, 1986) hypotheses, and suggests that both factors are operating in verbal irony understanding. Pexman et al. also provided some evidence against those early pragmatic models of irony processing which assume that irony is only detected after the literal meaning has been processed and rejected. The results of their online reading experiment showed that the cues to ironic interpretations, such as familiarity of the statement, occupation of the speaker (being less/more likely to use irony), and counterfactual context have their influence at the earliest stages of comprehension of the ironic statements.

Pexman (2008) discussed this constraint-satisfaction approach for processing of ironic utterances, in which all ironic cues (e.g., statement familiarity, counterfactuality of the discourse context, social identity of the person making the comment) are activated by ironic statement and in parallel. According to this model, the activated cues are supported by inferences about others' mental states and emotions, executive functions or experience with ironic language and when these cues support ironic interpretation, this interpretation is activated prior other interpretative possibilities (e.g., literal compliment or a white lie). Pexman (2008) believes that neither of these cues are considered by children as necessary

conditions for irony; rather, children integrate these multiple cues when trying to interpret the actual meaning of the ironic statement.

**1.2.3. Social functions of irony.** Although there are quite a few theories on what irony is and how it is processed, slightly less consideration is given to *why* irony is used, which is what will be briefly discussed in this section. As Kreuz, Long, and Church (1991) pointed out, the use of irony needs to have tangible benefits for the speaker if they decided to use this nonliteral and ambiguous language form to communicate their intentions given the high risk of being misunderstood.

The speaker might decide to use irony instead of literal statement in order to add humour to the conversational exchange. The research shows that irony is perceived by adults as funnier than literal language (Kreuz et al., 1991; Kreuz & Roberts, 1995; Leggitt & Gibbs, 2000) and that ironic speaker is also seen as having good sense of humour (Pexman & Olineck, 2002). Irony might be also used when the speakers want to indirectly express their attitude towards the addressee or the situation (Giora, 1995; Sperber & Wilson, 1986). When irony is used to criticise it is perceived as less critical by the addressee than the literal criticism; similarly, ironic compliment is viewed as less praising than literal compliment which is known as the muting function of irony (Dews & Winner, 1995; Dews, Kaplan, & Winner, 1995)

## 1.3. Ironical utterances in the experimental literature

As we could see in the brief overview of the theories of irony, there is no agreement among theorists as to what kind of utterances should be considered as ironic. Therefore, as we can imagine, the utterances commonly treated as ironic in the experimental literature also vary a lot.

### 1.3.1. **Types of irony.**

Very often in the experimental studies the terms ‘irony’ and ‘sarcasm’ are used interchangeably. Sarcasm is a sub-type and a prototypical form of irony with clearer cues and a clear victim (the target of the remark) (e.g., Kreuz & Glucksberg, 1989). Therefore, the counterfactual critical statements widely used in the literature (and often referred to as sarcasm) are one of the forms of verbal irony.

Other ironic statements used in the adult literature range from irony (‘The speaker’s observation of a contradictory state of affairs, but not directly critical of the addressee.’; Leggitt & Gibbs, 2000, p. 5-6), through sarcastic comments (‘A statement that clearly contradicts the knowable state of affairs, and is harshly critical toward the addressee.’; Leggitt & Gibbs, 2000, p. 5), hyperbole/overstatements, understatements, satire and rhetorical questions. Consider the following example (Leggit & Gibbs, 2000):

*You are going with a group of friends to a movie. All of them want to see the same movie except for you. You say you will leave them if you don’t get your way. Jennifer thinks you won’t change your mind, and says*:

(3) Irony: *We always get along so well.*

(4) Sarcasm: *You are being so mature.*

(5) Overstatement: *This is the end of the world.*

(6) Understatement: *You are being a little silly.*

(7) Satire/Parody: *You will want to see a cartoon.*

(8) Rhetorical question: *Do you know how to compromise?*

Jokes and teasing are also considered as forms of irony by some researchers. Gibbs (2000/2007) introduced the notion of 'ironic jocularity' and made a connection between verbal irony, jocularity and laughter where 'speakers tease one another in humorous ways' (p. 350).

Although in the adult literature the type of ironic utterances used in the experiments vary a lot, the most commonly used ironic utterances in the developmental literature on irony comprehension follow the traditional definition of irony, where the ironic speaker says one thing and means the exact opposite, such as:

(9) '*It's a perfect day for a picnic'* when it is raining cats and dogs (Hancock et al., 2000).

However, in studies on child irony production, researchers have also proposed that sarcasm, ironic hyperbole, understatements, and rhetorical questions should be considered as instances of ironic language (e.g., Recchia, Howe, Ross, & Alexander, 2010).

This broader view on types of utterances that constitute irony is criticised by some theorists. Wilson (2017) argues that those definitions of irony, which include jokes, hyperboles, understatements and rhetoric questions might be too broad to explain the differences between ironic and non-ironic instances of these figures of speech. For instance, hyperbole does not have to be ironical at all and is actually perceived by linguists as more linked to metaphor than to irony (Claridge, 2011). Therefore, according to Wilson, it might be very difficult to investigate and understand the mechanisms of the developmental trajectories of irony understanding when such gross irony definitions are used in the experimental research.

**1.3.2. Ironic tone of voice.** Other than obvious linguistic information, when making judgements about speaker intent the hearer can rely on ironic tone of voice, which is characterised by a flat/deadpan intonation, slower tempo, lower pitch level and greater

intensity (e.g., Ackerman, 1983; Chevallier, Noveck, Happé, & Wilson, 2011). Therefore, not only the types of ironic utterances vary a lot in the experimental literature but also the tone of voice with which the target ironic statements are uttered and presented to the participants.

Although many researchers propose that intonation is in fact crucial to the identification of some aspects of irony (Capelli et al., 1990; de Groot, Kaplan, Tosenblatt, Dews, & Winner, 1995; Demorest, Meyer, Phelps, Gardner, & Winner, 1984; Dews et al., 1996; Zajaczkowska, 2016) others believe that intonational cues do not help children to decide between ironic and non-ironic statements (Winner & Leekam, 1991). For instance, Filippova and Astington (2008) found that when semantic cues are available in the irony task, children are less likely to use intonational cues to identify ironic speaker's emotions. Intonation could be a "give away" marker that an utterance should not be interpreted literally. However, as we have seen in the overview of the theories of irony, irony is much more than simply "the opposite of the literal meaning" and its full complexity is likely to require a consideration of other factors that might contribute to its understanding.

As it was demonstrated, there is no agreement among researchers with regards to what statements should be used and considered as ironic in the experimental literature (see Wilson, 2017). Therefore, the selection of the most influential developmental studies on irony production and comprehension presented below will consist of both traditional and broader notions of irony where ironist's tone of voice is or is not emphasised.

## 1.4. The development of irony production and comprehension

**1.4.1. Irony production in typical children.** There is very limited literature on the irony production in children with main reason being that it is extremely difficult to create conditions in which children would be most likely to produce irony. Only three studies presented below have looked at the irony production by children.

Two of the studies investigated the children's production of different forms of irony in family interactions (Pexman, Zdrazilova, Mcconnachie, Deater-Deckard, & Petrill, 2009; Recchia et al., 2010). In both studies the researchers followed a broader view on what is considered as irony and grouped the utterances into one of the following categories: sarcasm, rhetoric question, hyperbole, and understatement, and jocularity (only in Pexman et al., 2009). Pexman et al. (2009) observed children and their parents in the family setting, during 8-minute Domino task, and then coded any instances of both verbal and gestural irony. They found that children as young as four and five were able to produce ironic gestures and ironic remarks. The most frequent instances for verbal irony were hyperbolic expressions, such as:

(10) *'Just put one down ... today!'* to someone who is taking a long time to place a domino (Pexman et al., 2009).

The authors suggest that it might be easier for children to exaggerate an attitude with hyperbole than to negate it as it is in case of sarcasm.

Recchia et al. (2010) not only explored the production but also comprehension of irony in naturalistic settings. Thirty-nine families were recorded during 90-min observations. Similarly to what was found in the study by Pexman et al. (2009), children were most likely to use hyperbolic ironic statements, followed by rhetorical questions; the latter were most frequently used by their parents. The analyses of children's responses to ironic comments revealed that six-year-old older siblings were more likely to respond with full understanding of ironic remarks than their four-year-old sibling. It was for sarcasm and rhetorical questions that children most frequently showed understanding of the discrepancy between the literal and intended meaning as well as the function of the statement. Children rarely demonstrated understanding of ironic hyperboles or understatements.

A slightly different aspect of irony production in conversation was explored by Whalen and Pexman (2010) who investigated when children (seven-, nine-, and 11-year-old) begin to respond to ironic remarks with irony in context-appropriate ways. The researchers presented children with ironic criticisms (positive statement that is meant to convey a negative meaning) such as (11) and ironic compliments (negative statement that is meant to convey a positive meaning, such as (12):

(11) '*That was a great play!*' when someone misses the goal (Whalen & Pexman, 2010)

(12) '*You sure are a terrible tennis player*,' to a friend who is playing like a pro (Whalen & Pexman, 2010)

The findings revealed that for ironic criticism older children were more likely to respond to irony with irony than younger children. However, there was no significant increase in mode adoption with age with regards to ironic compliments. Interestingly, some children adopted the ironic mode and responded to irony with irony prior its comprehension.

The appropriate use of irony is quite a difficult skill to master but the handful of research presented above shows that even children as young as four can use some forms of irony in the naturalistic setting (Pexman et al., 2009). Yet, it is surprising that although hyperbolic ironic statements were the types of statements to be most likely used by children, they demonstrated clear difficulties with understanding this form of irony, with sarcasm and rhetoric questions being the least challenging to comprehend (Recchia et al., 2010). Also Whalen and Pexman's (2010) study showed that in some cases, irony production preceded its comprehension and that the ability to appropriately respond to ironic criticism with irony develops with age. Yet, it is difficult to know from production exactly how children interpret and represent irony, which is why comprehension studies are perhaps more revealing.

**1.4.2. Irony comprehension in typically developing children.** Before reviewing the most prominent studies on irony comprehension in children, it is worth discussing which social-cognitive components of understanding of the ironist's mind are investigated in the field. The tests on irony comprehension differ but they usually measure the child's understanding of one (or more) of the following: 1) speaker's actual meaning, 2) speaker's belief, 3) speaker's communicative intention, 4) speaker's motivation/attitude. As can be seen in Table 1., the comprehension questions measuring the same component vary a lot across studies.

Given the discrepancies in irony components measured in the studies, it is quite challenging to establish a clear irony acquisition sequence. Nonetheless, the following section offers a brief overview of the most influential studies in the field, which looked at the ability to understand different components of understanding of the ironic speaker's mind, the social functions of irony, and different forms of irony.

Table 1

*Components of Understanding of the Ironist's Mind Usually Measured in the Developmental Literature*

| **Component** | **Examples of the questions asked in the irony tests** |
|---|---|
| Speaker's actual meaning | *Does Oliver mean that? What does he mean?* (from Filippova & Astington, 2008)<br>*Did B really think that A was a good basketball player?* (Hancock, Dunham, & Purdy, 2010) |
| Speaker's belief | *Does Oliver think that Robert is a great scorer?* (from Filippova & Astington, 2008)<br>*When Sam said ''That was a great play!'', did he think John made a good play or a bad play?* (from Pexman & Glenwright, 2007) |

| | |
|---|---|
| Speaker's communicative intent | *Does Oliver want Robert to believe that he thinks that [ironic utterance]?* (from Filippova & Astington, 2008)<br>*What do you think the teacher meant?* (from Bosco & Bucciarelli, 2008)<br>*In your opinion, why did the boy answer to the girl: 'I don't have the slightest idea'?* (from Bosco, Angeleri, Colle, Sacco, & Bara, 2013) |
| Speaker's attitude | *Why did he say that?* (from Filippova & Astington, 2008)<br>*In one of these stories, the big brother is being (mean) (nice) to his little brother. Was that in this story (experimenter points to one of the two final pictures) or in this story (experimenter points to other final picture)?* (from Winner & Leekam, 1991)<br>*Point to one of the faces to show me how nice or mean Sam was trying to be when he said, 'That was a great play!'* (from Pexman & Glenwright, 2007) |

***Age of acquisition.*** Many studies on irony comprehension show that children become able to recognize the incongruity between the actual and intended meaning behind simple counterfactual ironic statements at around the age of five or six (Ackerman, 1983; Whalen & Pexman, 2010; Hancock et al., 2000; Harris & Pexman, 2003; Sullivan, Winner, & Hopfield, 1985; Winner & Leekam, 1991). The age of acquiring of the prototypical form of irony is similar to the age of the emergence of children's counterfactual reasoning (retrieving and manipulating a mental representation of reality), more specifically to understanding of counterfactual emotions, such as regret and relief (e.g., McCormack, O'Connor, Beck, & Feeney, 2016).

Yet, although children as young as five or six can detect the non-literal nature of irony, they might not succeed in recognizing speaker's pragmatic intention behind using

ironic statements. Ackerman (1983) in his landmark research showed that early interpretation of ironic criticism by children requires a two-stage process: (1) detection of the literal versus nonliteral property of the ironic comment; (2) inferencing the ironic speaker's intended social purpose. The existence of these two separable components of irony comprehension was documented by Hancock et al. (2000), who demonstrated that detection of the non-literal form does not guarantee the accurate inference about the speaker's pragmatic intent. Hancock et al.'s study findings indicated that children between the age of 5 and 6 were able to detect that the ironic speaker's statement should not be interpreted literally more frequently than being able to accurately infer the speaker's intent.

In fact, some studies demonstrated that more sophisticated understanding of irony continues to develop throughout middle childhood (e.g., Demorest et al., 1983; Pexman & Glenwright, 2007). For instance, Demorest et al. (1983) presented children with twelve short stories, out of which two ended with an ironic and two with a sarcastic remark (other language forms included literal statement, understatement, hyperbole, metaphor); the stories were presented by the experimenter and accompanied by one picture. Following each story, children were asked to explain what the speaker meant by the final remark and further to answer a question '*Why did [the character's name] say that?*'. The children's responses were classified into four categories: (1) failure to note discrepancy and purpose, (2) discrepancy noted but purpose ignored, (3) discrepancy noted but purpose inaccurately identified, (4) discrepancy noted and purpose accurately identified. Demorest et al. (1983) found that even nine-year-old children inaccurately interpret sarcasm as deceptive and only after late primary school, at around age 11, they are able to understand the purpose and intention behind the ironic language.

However, using very different methodologies, Climie and Pexman (2008) showed that much younger children than 13-year-old should be credited with the ability to interpret irony. Climie and Pexman (2008) presented children with puppet show scenarios which ended with either ironic or literal remarks. Following the puppet show, children were asked to choose whether the ironic speaker was trying to be mean or nice (which was assumed to reflect how children interpreted the intention behind the ironic remark). The researchers recorded children's eye movements to the response objects as they were making their judgements. The results demonstrated that children as young as five were inclined to always look at the object reflecting ironic interpretation of the statement first, which suggests, according to the authors, that children are able to consider ironic intent when they are as young as five-year-old.

Perhaps such discrepancy with regards to the age of acquisition of ironic statements is related not only to the fact that different tasks are used across studies to assess irony comprehension in children (ranging from yes/no questions to open-ended questions) but also different components of irony are usually measured, such as detection of meaning, intentions, attitudes, beliefs of ironic speaker. Nonetheless, it is currently believed that children begin to understand some aspects of verbal irony around the age of 5 and 6 and that this ability develops with age (e.g., Filippova & Astington, 2010; Pexman & Glenwright, 2007). Yet, the exact progression of children's understanding of those various components of ironic remarks is still not clear.

***Understanding of social functions of irony.*** Beyond consideration of the age of acquisition of ironic utterances per se, some developmental investigators have focused more on understanding of the social and pragmatic functions of verbal irony. It seems that children become sensitive to some of the social functions of irony, such as muting function, where ironic criticism is perceived as less mean and less aggressive than literal

criticisms around the age of five or six (Dews et al., 1996). Dews and colleagues (1996) showed that although five- to six- and eight- to nine-year-olds recognised the muting function of ironic remarks, they were less able to perceive their humorous function. Similarly, Creusere (2000) found that children at the age of eight were not able to appreciate the humour behind the ironic statements and to notice that ironic utterances can be at the same time funny and mean. Creusere suggests that probably the sensitivity to the humour function increases with age, which was confirmed by Harris and Pexman (2003). Their study findings indicated that the appreciation of humour behind the ironic statements continues to develop through middle childhood.

Although it seems that there is a developmental improvement in irony comprehension and its social functions from age five, throughout middle and late childhood (e.g., Filippova & Astington, 2010; Pexman & Glenwright, 2007), not all forms of ironic language are understood with the same ease. What follows is the brief discussion of studies which explored understanding of different forms of irony, such as ironic criticism vs ironic compliments (e.g., Hancock et al., 2000) as well as Simple vs Complex ironies (e.g., Bosco & Bucciarelli, 2008).

### 1.4.3. Understanding of different forms of irony.

***Ironic criticism and ironic compliments.*** In the early studies on irony comprehension, most researchers focused solely on investigating understanding of counterfactual ironic statements that take the form or ironic criticism (e.g., Ackerman, 1981). Dews and Winner (1997) in their review concluded that children are beginning to understand these simple counterfactual forms of irony when they are between five- and six-years-old (e.g., Ackerman, 1981, 1983; Andrews, Rosenblatt, Malkus, Gardner, & Winner, 1986; Demorest et al., 1984; Happé, 1993; Sullivan et al., 1995).

One of the first studies, in which children's ability to detect and interpret not only ironic criticisms, but also ironic compliments (also referred to as ironic praise) was

a study by Hancock et al. (2000). Following Ackerman's (1981) methodology, the authors presented five- and six-year-old children with videotaped short stories in two versions – critical and complimentary – which ended with either literal or ironic statement. Children were asked three questions to test their ability to detect the literalness of the final statements (an example of the first-order belief question – '*Did B really think that A was a good basketball player?'),* speaker's intent (e.g., '*Was B being mean or nice?*'), and understanding of the story context (e.g., '*Do you think that A was a good basketball player?*'). Hancock et al. (2000) confirmed the developmental trend that ironic criticism is much easier for children to understand than ironic praise. Also Pexman and Glenwright (2007) assessed children's ability to comprehend ironic speaker's belief (measured with forced-choice questions, such as '*When Sam said ''That was a great play!'', did he think John made a good play or a bad play?*'), speaker's intent to tease (measured on a three-point teasing/real face scale), and speaker's attitude (measured on a five-point nice/means face scale). They found that for six- to ten-year-old children ironic criticisms are easier to understand than ironic compliments. Similarly, Climie and Pexman (2008) demonstrated that the ability to understand ironic compliments begins to emerge later than the ability to understand ironic criticisms, between the age of eight and nine.

The ability to comprehend ironic criticisms earlier than ironic compliments might be related to the fact that ironic compliments are not so widely used as ironic criticisms, thus are less familiar to the listener (Gibbs, 2000). Also, it might be the case that ironic compliments are more challenging for children to comprehend than ironic criticisms as they require 'double negation', where the listener is forced to negate the already negative surface meaning of the utterance (Giora, 1995).

***Conventional vs novel ironic statements.*** In the previous research on irony comprehension in children, the ironic utterances typically exemplified situation-specific ironic remarks such as:

(13) *I see you won again* (Ackerman, 1981).

(14) *That was a great play* (Pexman & Glenwright, 2007).

Burnett (2015) claims that these type of statements might be more difficult for children to comprehend than more conventional ironies, which have become idiomatic (more available in the lexicon) than novel/situation-specific ironic remarks. Burnett (2015) in his study presented seven- and eight-year-old children with audio-recorded stories that were accompanied by two pictures each. Following each story children were asked a number of open-ended comprehension questions on speaker meaning, speaker attitude, speaker intent and one forced-choice question on speaker intent ('*Did Pat want to make Pat's friend feel [bad/good]?*'). Unsurprisingly, the results showed that children were better able to infer speaker's intended meaning for phrases that were conventionally ironic ('*Smart move'* when someone breaks the vase and spills water everywhere) than for those that were novel or situation specific ('*Great save*' in the same situation). The author emphasises the importance of examining more thoroughly the types of ironic remarks used in empirical studies.

***Simple and Complex Ironies.*** A slightly different approach was proposed by Bara, Bosco and Bucciarelli (1999), who made a theoretical distinction between Simple and Complex communication acts (including indirect speech acts such as deceits and ironies). According to the authors, 'simple communication acts' would comprise of direct and conventional indirect speech acts; whereas, the 'complex speech acts' require a greater number of inferences to be made in order to understand the intent behind ironic/deceitful

statements and are triggered by the violation of expectations by the partner. A couple of studies tested children's performance on tasks involving, among others, Simple and Complex Ironies. Bosco and Bucciarelli (2008) tested children aged between six and a half – ten years and presented them with nine audio-recorded stories (three of which consisted of ironic remarks) that were created in both versions – Simple and Complex communicative acts. Following each story, the children were asked an open-ended question about the speaker's intent (e.g., '*What do you think the teacher meant?*'). Their responses were coded as correct when the child demonstrated the understanding of the discrepancy between literal and implied meaning and noticed that the actual statement was not in line with the speaker's belief; other responses were coded as incorrect. Bosco and Bucciarelli found that Simple Ironies were easier to understand than Complex ones. Understanding of Simple Ironies increased with age: younger children (6;6 – 7) obtained on average 56% of correct responses and older children (9;6-10) – 81 percent. With regards to Complex Irony, the younger group reached on average 40% of correct responses and older – 60 percent. Bosco, Angeleri, Colle, Sacco, and Bara (2013) tested slightly younger children aged from five to eight and confirmed Bosco and Bucciarelli's (2008) findings. They presented each child with a series of videotaped scenes, each of which could end with either Simple or Complex Ironies (among other communicative acts) and then asked an open-ended question about the speaker's intent (e.g., '*In your opinion, why did the boy answer to the girl: "I'm on diet"*?'). The authors did not provide the information about the coding criteria for this speech act. The results showed that children responded to simple speech acts more accurately than to the complex ones. In addition, the participants found it more difficult to comprehend ironic speech acts below the age of seven –the eldest, eight-year-old, children obtained 70% of correct responses for Simple Irony and 66% for Complex Irony.

The presented findings suggest that some forms of verbal irony are easier to understand for children than others. Although many researchers investigate different forms of verbal irony, it is quite evident that children are better at interpreting intentions behind ironic criticisms than ironic compliments (e.g., Hancock et al., 2000; Pexman & Glenwright, 2007; Climie & Pexman, 2008). One of the possible explanations might be that criticism with the use of irony is more frequent in everyday language than ironic compliments (Gibbs, 2000). This assumption was partially confirmed by Burnett (2015) who explored the role of conventionality in irony comprehension by children and found that they were more accurate in interpreting the speaker's intent behind phrases that were conventionally ironic than novel/situation-specific phrases. Also Bosco and Bucciarelli's (2008) findings contributed to the literature on comprehension of different forms of irony suggesting that Simple ironic speech acts are easier for children to understand that Complex ones requiring more inferential steps to be made.

**1.4.4. Methodological challenges.** Researchers investigating irony understanding have developed various ways to test this ability in children. As Filippova and Astington (2010) suggested, the use of different task methodologies between studies might actually be the reason for the variation in the ages when irony comprehension is observed.

The first potentially problematic issue is that the test questions range from yes/no questions differing in complexity, binary forced-choice questions, and open-ended questions (see Table 1). Furthermore, the comprehension questions concerning speaker's intention or belief, usually require different levels of meta-linguistic insight. The more complex comprehension questions, such as open-ended questions or the ones requiring higher level of meta-linguistic insight ('*Does Oliver want Robert to believe that he thinks that?*', Filippova & Astington, 2008) are much more challenging for younger users of language than the binary forced-choice questions and might in fact tap children's

structural language abilities rather than the ability to interpret ironic language. Perhaps this is why some researchers using less syntactically complex test questions or binary forced-choice questions found that it is younger children, around the age of 5, who should be credited with the ability to understand some aspects of irony (e.g., Hancock et al., 2000; Climie & Pexman, 2008; Winner & Leekam, 1991) as opposed to the studies, in which it has been shown that this ability emerges much later in the development (e.g., Demorest et al., 1983). At the same time giving children binary forced choice between a literal vs an ironic meaning (e.g., *'When Sam said ''That was a great play!'', did he think John made a good play or a bad play?')* might mean that the child could pass the test without really understanding the ironic intent.

Another methodological aspect that should be considered here is the way of presenting children with the ironic stories/vignettes, which also vary a lot across studies. For instance, many of the previously mentioned studies presented participants with stories that were either read by the experimenter (e.g., Filippova & Astington, 2008) or pre-recorded (e.g., Winner & Leekam, 1991), which is far from what children experience in everyday life. We can therefore argue whether the testing measures, in which children are presented with the audio-recorded story sometimes accompanied by the picture or two are likely to reveal and accurately assess the child's competence to comprehend irony in real-life, dynamic communicative exchanges. Among very few researchers who wanted to minimalize verbal and pragmatic demands of the irony was a study by Climie and Pexman (2008) who created a puppet show in order to test children's ability to understand ironic remarks and Hancock et al. (2000) who presented children with the video recordings of the stories with four adult actors.

Furthermore, the tasks vary in complexity of verbal input and in most of the studies the scenarios were not controlled for length ('stories…approximately six sentences in

length' in Demorest et al., 1983, p. 125), morphosyntactic complexity, and difficulty of words or there is no information provided about that (e.g., Hancock et al., 2000; Climie & Pexman, 2008). Controlling for the length and the complexity of the stories seems to be essential when investigating any aspect of language in use as it might be the case that, in this case, it is structural aspect of language or working memory that may contribute to the understanding of irony.

It is not only that researchers use various methods to explore the developmental trajectory of irony comprehension, but very often they investigate different aspects of irony using similar tasks. For instance, Hancock et al., (2000) used forced-choice questions to test the children's ability to infer the speaker's *intent* behind ironic criticism or ironic compliment ('*Was B being mean or nice?*') and allowed the children to respond either verbally or non-verbally by pointing to happy/sad face. Similar method with facial expressions was used by Pexman and Glenwright (2007) to address not the speaker's intent but his/her *attitude.* This disparity may lead to inconsistent interpretations of the nature of underlying mechanisms involved in understanding irony in children.

Therefore, there are many methodological issues with studies on the development of irony comprehension ranging from the methods of presenting the stimuli (stories read by the experimenter, audio- or video-recorded), to different types and complexities in the test questions and the lack of the control over the length and morphosyntactic complexity of the stories. These all aspects might be related to the lack of consensus as to when exactly children start to understand different components of irony and what is the exact progression of children's understanding of ironic remarks.

### 1.5. Cognitive underpinnings of pragmatic language and irony

Now that we have briefly discussed the age of acquisition of different forms of irony and the methodological challenges facing the experimental literature on irony

comprehension, it is worth considering what factors might contribute to the understanding of this type of non-literal language. The pragmatic acquisition literature in general has tended to look at the relationships with either socio-cognitive factors (Theory of Mind, empathy) or executive functioning or vocabulary/syntax acquisition. As the literature on the underpinnings of irony comprehension is quite sparse, in this section we will provide a short overview of social and cognitive domains that might explain individual differences in general pragmatic skills in both typically and atypically developing children followed by the cognitive factors contributing to irony comprehension.

### 1.5.1. The role of social cognition in pragmatic language and irony.

***Pragmatic language.*** One of the socio-cognitive skills traditionally believed to underpin the language use in context is mentalising (or Theory of Mind), which can be broadly defined as the ability to reason about the thoughts, desires, beliefs, and feelings of other people (Baron-Cohen, Leslie, & Frith, 1985; Premack & Woodruff, 1978). In typical development, many studies found associations between the ability to take the perspective of a specific interlocutor and general pragmatic skills, such as communicative perspective taking (Bernard & Deleau, 2007) or mindful conversational competence (de Rosnay, Fink, Begeer, Slaughter, & Peterson, 2014). Associations between pragmatic ability and ToM have also been found in studies with atypical populations (e.g., Andres-Roqueta, Adrian, Clemente, & Katsos, 2013; Losh, Martin, Klusek, Hogan-Brown, & Sideris, 2012; Whyte & Nelson, 2015). Yet, as Matthews, Biney and Abbot-Smith (2018) point out, the association between ToM and general pragmatic competences is not quite clear due to the fact that in most of the studies theoretically important covariates, such as age and verbal ability, are not controlled for.

***Irony.*** Irony comprehension is traditionally believed to be dependent on advanced mentalising skills (Happé, 1993). Understanding that a statement, '*What a lovely*

*weather'* when said on a rainy day is meant ironically requires the listener to interpret the perspective of the speaker. For a successful communication exchange, the listener not only needs to consider the ironist's thoughts and knowledge about the current weather conditions ('*I know that he knows it is raining'*) but also his/her thoughts and knowledge about the addressee's knowledge ('*I know that he knows it is an awful weather and that he will understand that I do not think that the weather is good'*)

Several recent studies investigated the relationship between Theory of Mind and irony interpretation in children (e.g., Filippova & Astington, 2008). Although in many of them the relationship between the two has been confirmed, the vast majority did not control for the language abilities, which might explain the relationship between ToM and irony (e.g., Angeleri & Airenti, 2014; Banasik, 2013; Bosco & Gabbatore, 2017; Caillies, Bertot, Motte, Raynaud, & Abely, 2014; Mewhort-Buist & Nilsen, 2017; Nicholson, Whalen, & Pexman, 2013). The role of mentalising in irony comprehension will be further discussed in the Chapter 2.

### 1.5.2. The role of Executive Functioning in pragmatic language and irony.

Executive functions (EFs) refer to the higher order cognitive processes involved in the goal-directed behaviour (Friedman & Miyake, 2017). There is a general agreement that there are three main components of EFs: inhibition, working memory and, cognitive flexibility (e.g., Lehto, Juujärvi, Kooistra, & Pulkkinen, 2003). Nonetheless, it is still not clear whether the EF is a single or multiple construct (Best, Miller, & Jones, 2009), which is one of the reasons for difficulties in establishing a clear picture of the relationship between the components of EF and pragmatic skills. Despite the fact that both EF components (and links between them) and pragmatic abilities undergo changes across development, generally the literature suggests that there is an association between general

pragmatic abilities and EF (e.g., Andres-Roqueta et al., 2013; Rints, McAuley, & Nilsen, 2015).

Executive Functions might be important for pragmatic language development in two different ways. Firstly, there is some evidence that EF might impact Theory of Mind development, which might then impact pragmatics. More specifically, Carlson, Claxton, and Moses (2015) found that inhibitory control predicts performance on false-belief task (typical measure of ToM). Similarly, Fizke, Bartel, Peters, and Rakoczy's (2014) findings implied that self-perspective inhibitory control, which is the ability to supress prepotent mental representations (Diamond, 2013a), is very important factor in the EF-ToM relationship.

Another potential pathway of the relationship between EF and pragmatics is that certain aspects of EF may also impact pragmatics directly. For instance, one might need good inhibitory control to stop monologuing about cricket if you know your listener is not interested in cricket. In fact, some studies suggest that inhibitory control and working memory – the ability to keep the information in an active state (Baddeley, 2007) – might be especially important factors contributing to some aspects of pragmatic language development. Inhibitory control might be crucial for referential communication when one is required to supress their own perspective to take into account the perspective of the interlocutor. For instance, Nilsen and Graham (2009) found in their study with pre-schoolers that inhibitory control was related to reduced egocentric looking during communicative perspective taking. Together with inhibitory control that is necessary for a child to be sensitive to the perspective of communicative partner, working memory might be also required for keeping in mind and recalling linguistic and contextual information. Several studies found support for the relationship between working memory

and general pragmatic skills (Akbar, Loomis, & Paul, 2013) and conversation skills, such as responsiveness (Blain-Briere, Bouchard, & Bigras, 2014).

It also seems that cognitive flexibility – the process that enables us to change perspectives both spatially and interpersonally (Diamond, 2013) and helps us to flexibly shift between multiple mental sets (Monsell, 2003) – might be required for a successful communication to happen (especially in the referential communication), as the child very often needs to flexibly respond to the evolving discourse. Yet, studies show inconsistent results as to the relationship between the two (e.g., Akbar et al., 2013; Bacso & Nilsen, 2017). It is important to note that most of the studies investigating the role of EFs in pragmatic language use have tested children from atypical populations.

***Irony.*** Inhibitory control might be linked to irony comprehension as one needs to supress their own perspective in order to decode the speaker's implied meaning. Furthermore, the listener has to flexibly shift between the two perspectives and decide between the two available meanings – literal and ironic (cognitive flexibility element). Working memory might be important factor for irony comprehension as one needs to follow and update the conversational exchange in order to adequately respond to the ironic statement. The listener also needs to store the information about the two possible meanings (literal and implied). In addition, in the developmental literature, the irony tasks used in the experiments are very likely to burden working memory, as the child is usually asked to listen to the stories and then answer the series of test question.

Although there are some good theoretical reasons for the relationship between EFs and the ability to interpret irony, the evidence for the association between the two is sparse and the results are inconsistent. Filippova and Astington's (2008) study results suggest that irony comprehension might be related to working memory. However, working memory was used in this study as a control variable, therefore it is not possible to

determine the unique contribution of working memory on irony comprehension. The role of working memory and inhibitory control in irony comprehension was investigated by Caillies et al. (2014) who found a correlation between inhibitory control tasks and irony measures in the group of typically developing children. Godbee and Porter (2013) in their study found that typically developing children's non-literal language understanding (including irony) was related to various cognitive measures, such as expressive vocabulary, verbal working memory, perceptual integration, and inferential reasoning. It is therefore impossible to establish which variables are the most important for irony comprehension.

Apart from the possibly of each of the EF components to uniquely contribute to irony comprehension, it has been shown that Theory of Mind may be related to EFs (e.g., Carlson, Moses, & Hix, 1998; Hala & Russell, 2001). Therefore, it is possible that that ToM and EFs can be related to irony comprehension and can both make relatively independent contributions.

### 1.5.3. The role of vocabulary and syntax in pragmatic language and irony.

***Pragmatic Language.*** It seems quite evident that we need words and grammar in order to understand the pragmatics of utterances being spoken to us. The literature shows that there is an association between global pragmatic measures and formal language (vocabulary and grammar) in studies with both typically (e.g., Bernard & Deleau, 2007; de Rosnay et al., 2014) and atypically developing children (e.g., children with ASD Akbar et al., 2013; Whyte & Nelson, 2015). In terms of more specific pragmatic skills, the research shows that formal language is related to conversational ability studied in naturalistic setting (Capps, Kehres, & Sigman, 1998; Hale & Tager-Flusberg, 2005). The studies on referential communication also indicate some, yet mixed, evidence for the relationship (for mixed results see Gillis & Nilsen, 2014; Nilsen & Graham, 2009; strong

association see Davies, Andres-Roqueta, & Norbury, 2016). Matthews et al. (2018) suggest that the findings on a link between formal language and referential communication skills are less consistent due to the fact that referential communication tasks are designed in a way to minimise demands on vocabulary and grammar.

Furthermore, there are also some heated debates among linguists as to whether we can really neatly separate semantics from pragmatics. According to some more contemporary theoreticians (contextualists), it is impossible to distinguish semantics from pragmatics (e.g., Recanati, 2002). Generally speaking, the contextualists' stance is that the meaning of the sentence (semantics) should be always considered in the context of the speech act. Therefore, all language components, both formal and pragmatic, might be related.

***Irony.*** There seems to be an association between formal language abilities and irony comprehension in typically developing children (e.g., Angeleri & Airenti, 2014; Filippova & Astington, 2008; Massaro, Valle, & Marchetti, 2014; Mewhort-Buist & Nilsen, 2017; Nilsen, Glenwright, & Huyder, 2011). Therefore, it seems crucial to control for the formal language when examining the relationships between pragmatic language (including irony), mentalising and executive functioning. Most of the irony tests have very high formal language demands, which might explain the relationship between pragmatics and other cognitive domains (mentalising or EF).

## 1.6. Questions for this thesis

After reviewing the literature on irony comprehension, it seems clear that there is no agreement among theorists as to what utterances should be considered as irony (e.g., Grice, 1975; Sperber & Wilson, 1981). However, there is a general consensus that in ironic statements there is a discrepancy between what is said and what is meant by the speaker. In the developmental literature, the vast majority of studies investigate the

counterfactual forms of irony (either criticisms or compliments) where the implied meaning is the exact opposite to what is said, such as saying '*Well done!*' when someone spills the juice with the implied meaning being that this is *not* 'well done'. It has been demonstrated that children comprehend some forms of counterfactual irony easier than others, such as ironic criticisms (e.g., Hancock, 2000; Climie & Pexman, 2008). Bara et al. (1999) were among a few who offered a slightly different classification of ironic speech acts and distinguished between Simple and Complex Ironies. Using this framework, Bosco and Bucciarelli (2008) and Bosco et al. (2013) found that Simple Ironies are easier to understand for children between six and ten years than Complex form of this non-literal communicative tool which requires more inferential steps. Nonetheless, it is not quite clear from Bara et al.'s (1999) theory how one can actually determine what the 'inferential chain' of the Complex Ironies consist of as even the Simple Ironies required some kind of inferencing, such as in the following example from Bosco and Bucciarelli (2008):

> (15) Anita is with her friend Paolo and is looking for her glasses. She doesn't realize her glasses are right in front of her nose and she asks Paolo: 'Have you seen my glasses?'
>
> (a) Simple: *'Congratulations on your excellent eyesight!*'
>
> (b) Complex: *'I'd ask you if I had to thread a needle'*

Thus in Chapter 2, inspired by Bara et al.'s (1999) theoretical distinction, I propose a new definition of Simple irony and investigate, among others, the following question:

1) ***Do six- to eight-year-olds find Complex forms of irony more difficult than the Simple ones?***

In the same chapter, another important methodological issue of existing irony acquisition literature will be addressed. Namely, most previous studies tended to ask children to choose between literal versus non-literal meaning in the test comprehension questions. This is potentially problematic, because although children may understand that the utterance should not be interpreted literally ('I spilt the juice, so this is not 'Well done!'), they might not necessarily know what the ironic utterance really means. That is, they could reject the literal interpretation and accept whatever available ironic interpretation there is without a full understanding of the communicative intent. Therefore, in the studies presented in the Chapters 2 and 3 a new methodology is presented, in which children are asked a comprehension question about the speaker's actual meaning form the perspective of the hearer and are offered three possible answers (1 target and 2 foils) that are somewhat a translation of the implied meaning behind the ironic utterance from the first person perspective. Thus, presumably choosing between two foil responses and the correct one will require a fuller comprehension of the speaker's actual meaning.

Moreover, even more critical questions still remain to be answered within the developmental literature on irony comprehension. One of them is what the mechanisms of understanding different forms of irony are. Although there seems to be some evidence for the role of ToM in the simplest counterfactual forms of irony comprehension in children (e.g., Filippova & Astington, 2008; Happé, 1995) no one has looked at the mechanisms behind comprehension of more advanced ironic statements. Furthermore, the role of other theoretically plausible factors, such as Executive Functions, is still not clear. Only two studies looked at the relationship between working memory (Filippova & Astington, 2008; Caillies et al., 2014) and their results were inconsistent. Caillies et al.'s (2014) study findings also indicated that inhibitory control might be related to irony

comprehension in children. However, no one looked at the role of third component of EF – cognitive flexibility, which might be an important factor for decoding the actual meaning behind the ironic statements as one needs to flexibly shift between the two perspectives and decide between the two available meanings – literal and ironic. In addition, although there is some evidence that ToM might be related to EFs (e.g., Carlson et al., 1998; Hala & Russell, 2001) none of the previous studies which included both EF and ToM, assessed the unique contribution of each. Thus, the following question will be also investigated in the first empirical study in Chapter 2 on cognitive underpinnings of understanding of Simple and Complex forms of Irony in children aged 6-8:

2) ***Is Simple vs Complex Irony underpinned by different cognitive mechanisms? What is the role of ToM and EF in irony comprehension?***

As it is shown in Chapter 2, Complex Ironies are difficult for six- to eight-year olds to understand, even after controlling for theoretically important covariates, such as formal language and non-verbal reasoning. Furthermore, both ToM and cognitive flexibility predict understanding of Simple Irony in younger children. Therefore, the following question will be addressed in the Chapter 3 with the follow-up study on the cognitive underpinnings of irony comprehension:

3) ***What is the role of ToM and cognitive flexibility in understanding of Complex forms of irony by 11- and 12-year-olds?***

Given the results of the study presented in Chapter 3, which emphasised the role of ToM and cognitive flexibility in irony comprehension in children, it seems justified to further explore the potential of these two cognitive prerequisites for irony interpretation. As it was mentioned in part 1.4.4. of the Chapter 1, there are some problematic aspects of the literature investigating the cognitive underpinnings of irony understanding in

children. Firstly, all studies which looked at the role of ToM and EFs in irony comprehension in children (including the two studies presented in Chapter 2 and 3 of this thesis) rely on correlational designs, which limits their explanatory value as the direction of causality cannot be inferred. Another methodological problem in the irony acquisition literature is the use of test questions that require children to have a certain level of meta-cognitive understanding (e.g., '*When Sam said ''That was a great play!'', did he think John made a good play or a bad play?')*, which is quite unnatural way of establishing understanding of the communicative intent in the real-life conversations. Therefore, I developed a new paradigm, potentially more ecologically valid, in which children had to select (binary choice) how a listener might reply to ironic utterance. Given the results of the study presented in Chapter 3 and the methodological concerns of the previous studies, the Chapter 4 considers the following:

4) ***The role of shared knowledge and cognitive flexibility (switching) in irony interpretation in children – the experimental approach.***

Therefore, the empirical studies[1] carried out in this thesis explore the cognitive underpinnings of irony comprehension in school-aged children and attempt to better understand the developmental trajectories of understanding of different forms of ironic language. This thesis contributes to the existing literature by using novel methods to explore the role of ToM and EFs in irony interpretation in children.

[1] All the experiments conducted in this thesis were approved by the Ethics Committee in the School of Psychology at the University of Kent and adhered to the ethical guidelines of the British Psychological Association

# CHAPTER 2. COGNITIVE SKILLS UNDERPINNING IRONY UNDERSTANDING IN SIX- TO EIGHT-YEAR-OLDS

**Chapters 2 and 3 (combined) are currently in press:**

Zajączkowska, M., Abbot-Smith, K. (2020). „Sure I'll help – I've just been sitting around doing nothing at school all day": cognitive flexibility and child irony interpretation. *Journal of Experimental Child Psychology.*

## 2.1. Introduction

Verbal irony is a communicative tool very frequently used in every day communication (Gibbs, 2000). Children hear ironic statements very often in the family interactions (Banasik-Jemielniak, 2019; Recchia et al., 2010) as well as in the TV programms and in children's books (Dews & Winner, 1997). Therefore, understanding verbal irony seems to be important for developing both social and language competence. Nevertheless, understanding irony can be a real challenge (e.g., Pexman & Glenwright, 2007); in order to successfully interpret the ironic remark, the listener needs to appreciate that the surface-level meaning of the ironic statement can be discrepant to the actual, implied meaning.

**2.1.1. Associations between irony and ToM.** The comprehension of irony is traditionally believed to depend on advanced Theory of Mind (ToM) (Happé, 1995), which is the ability to reason about the thoughts, desires, beliefs, and feelings of other people (Perner & Wimmer, 1985). Advanced (or second-order) Theory of Mind is considered as higher-order understanding of mental states and false-beliefs (e.g., Jon thinks that Mary thinks) (Perner & Wimmer, 1985; Sullivan, Zaitchik, & Tager-Flusberg, 1994). In order to correctly interpret the ironic statement, the listener needs to be able to consider the ironist's thoughts about the addressee's knowledge. For instance, to

understand that the statement *'It's a perfect day for a picnic'* cannot be interpreted literally in the situation when it is raining outside, the listener has to infer that the speaker thinks that the listener will know that it is not the perfect day for a picnic because both parties can see that that weather is bad.

Several studies which looked at the irony comprehension and ToM in children confirmed the relationship between the two. However, in many of them structural language was not controlled for (Angeleri & Airenti, 2014; Banasik, 2013; Bosco & Gabbatore, 2017b; Caillies et al., 2014; Mewhort-Buist & Nilsen, 2017; Nicholson et al., 2013). Therefore, it is impossible to rule out that the relationship between irony and ToM could be accounted for by language abilities. Controlling for structural language would seem to be crucial when investigating irony understanding and mentalising skills, as tasks measuring them always have high language demands. Massaro et al. (2014) in their study did include the measure of structural language and found no the relationship between irony and ToM found. It is worth noting, that in this study, there was only one task measuring false beliefs which could have led to the lack of variance. In fact, their results revealed that it was the language measures that predicted the irony understanding.

However, a study by Fillipova and Astington (2008), which was a very well controlled study, found a strong positive correlation between irony and ToM, even when age, memory, and structural language were taken into account. As this is the only good quality study which provides evidence for a relationship between irony and ToM, there is not enough evidence for the relationship between ToM and irony understanding in typically-developing children for the field to safely conclude that these two are related.

**2.1.2. Irony and Executive Functions.** Executive Functions (EFs) might be involved in irony interpretation in two different ways. Firstly, many have argued that the Theory of Mind may be related to the Executive Functions (e.g., Carlson et al., 1998;

Hala & Russell, 2001), particularly either to inhibitory control (Carlson, Moses, & Claxton, 2004) or cognitive flexibility (Kloo & Perner, 2003). Therefore, EFs might relate to irony interpretation due to the relationship between Theory of Mind and irony interpretation. It is also possible that the components of EFs might contribute to irony interpretation independently, as outlined in section 1.5.2. of the introduction. There are logical reasons to think that each component of EFs (inhibition, working memory and cognitive flexibility; Lehto et al., 2003) might be implicated in irony interpretation.

First, cognitive inhibitory control, which is the ability to supress prepotent mental representations (Diamond, 2013), may be linked to irony comprehension abilities because the hearer not only needs to understand the ironist's intentions or beliefs, but also, they are forced to inhibit, supress, their own perspective in order to correctly decode the actual meaning of the ironic statement. Furthermore, understanding irony requires from the hearer the ability to store the information about the conversation content as well as maintaining two possible meanings (literal and implied). Therefore, working memory – the ability to keep the information in an active state (Baddeley, 2007) – would seem to be essential in understanding ironic utterance. Cognitive flexibility, the third component of the EFs, is the process that enables us to change perspectives both spatially and interpersonally (Diamond, 2013) and helps us to flexibly shift between multiple mental sets (Monsell, 2003). Cognitive flexibility itself includes an element of inhibitory control, since one has to inhibit the old rule in order to carry out the new rule (e.g., Carlson & Moses, 2001). Cognitive flexibility is also likely to burden working memory in that various rules must be maintained and updated. Switching perspectives in the interpersonal context seems to be especially crucial in irony comprehension as the hearer needs to be able to take the perspective of other person. Furthermore, the addressee of the ironic

statement needs to flexibly decide between two available meanings (literal and implied) and accept the implied, ironic one.

Despite the good theoretical reasons why EFs should be related to irony interpretation, the evidence for the associations between irony comprehension and executive functions is very limited and the results are not consistent. In the aforementioned study on typically-developing children, Filippova and Astington (2008) found that there was a correlation ($r$ = .63) between irony interpretation measures and working memory. However, as the working memory was used as a control variable, it is not clear what the unique contribution of this variable on irony comprehension was (see e.g., Matthews, Biney, & Abbot-Smith, 2018, for discussion). The relationship between irony comprehension and working memory as well as inhibitory control was investigated in the study by Caillies et al. (2014), in which they found that there was a correlation between performance in the inhibitory control tasks and their irony measures in the group of typically developing children but not in children with ADHD, which is a little unexpected since children with ADHD are generally believed to have some EF deficits (e.g., Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005). Godbee and Porter (2013) in their study with individuals with Williams Syndrome, looked at the relationship between different forms of non-literal language understanding (including irony) and other cognitive measures (expressive vocabulary, verbal working memory, perceptual integration, and inferential reasoning). They found that for the typically developing individuals (chronological age and mental age matched combined) all of the cognitive measures were significantly related to the measures of irony understanding, including working memory, therefore it is difficult to know what the key variables are crucial for irony comprehension. These types of findings indicate the necessity of controlling for non-verbal reasoning as it is essential to rule out the possibility that the children who

score high on one task will score high in all other tests (Matthew effect; Merton, 1968). As no study has ever controlled for non-verbal reasoning, this may potentially lead to false effects which do not in fact explain the mechanisms underpinning irony interpretation.

**2.1.3. Types of irony.** The vast majority of previous studies used a form of verbal irony, where the actual meaning of the ironic statement blatantly contradicts the reality that the listener can see and is also a positively worded statement that is meant as criticism, such as:

(1) saying *'What a clever boy you are!'* after the child puts the whole eggs (with shells) in a bowl to make a cake (from Happé, 1993);

(2) saying *'You SURE are a GREAT scorer!'* after someone missed the chance to score several easy goals (from Filippova & Astington, 2008);

(3) saying *'You are a really neat child!'* when the child has left her/his bedroom in a mess (from Massaro et al., 2014);

A slightly different approach was proposed by Bara, Bosco and Bucciarelli (1999) who made an interesting theoretical distinction between two types of ironic speech acts – Simple and Complex. According to these authors, both types of ironic utterances involve the detection of the contrast between the literal ironic utterance and shared belief between interlocutors but they differ in the complexity of mental representations and the inferential chain required to decode the actual meaning of the ironic utterance. The understanding of Complex forms of irony as defined by Bara et al. (1999) is assumed to be acquired later in development due to the longer inferential process involved (Bucciarelli, Colle, & Bara, 2003). However, the authors claim that it is impossible to

predict the specific length of that process. Based on Bara et al.'s distinction, Bosco and Bucciarelli (2008) provide the following example of both forms of irony (p. 592):

> *'Anita is with her friend Paolo and is looking for her glasses. She doesn't realize her glasses are right in front of her nose and she asks Paolo, "Have you seen my glasses?"*
>
> (4) Simple Irony*: 'Congratulations on your excellent eyesight!'*
>
> (5) Complex Irony*: 'I'd ask you if I had to thread a needle'.*

In the only study that tested the children's ability to comprehend those two types of communicative acts (Bosco & Bucciarelli, 2008) it was found that Simple Ironies were easier to understand than Complex ones by children form three age groups: 6:7-7:0, 8:0-8:6, 9:6-10:0. Interestingly, it was only the ability to comprehend Simple, and not Complex, forms of irony that was shown to increase with age. However, as no other measures were used, it is impossible to determine what factors might contribute to Simple versus Complex Irony understanding.

Certainly, there are some difficulties with establishing the exact length of inferential chain required to decode the ironic meaning behind the examples provided by Bosco and Bucciarelli (2008). Moreover, it would appear that the items typically used in the literature, such as in (1) – (3), require less inferencing than what is proposed as Simple Irony by Bosco and Bucciarelli. In the utterances commonly used in the irony acquisition studies, there is a clear conflict between the ironic statement and the visual world (such as in (2)). However, it is not clear from Bara et al.'s (1999) theory how the 'inferential chain' of the Complex Ironies can be determined given that even Simple Irony forms, such as in (4), require quite advanced inferencing. In (2) the hearer knows that he or she missed the goal several times, therefore when the ironist says, '*You SURE are a GREAT*

*scorer!'*, the visual context – not scoring a goal – serves as a cue for the listener to decode the actual meaning behind this ironic statement. However, in case of (4), the listener does not know that the glasses are in front of her, therefore it is much more challenging to interpret the statement (4) as ironic.

### 2.2. Present study

Therefore, one of the aims of the current study is to more clearly distinguish Simple from Complex Irony as well as to investigate the cognitive underpinnings of irony interpretation in children aged 6, 7 and 8 years. Children around that age are typically assessed in the studies on irony understanding in children (e.g., Filippova & Astington, 2008; Caillies et al., 2014).

There is a reasonable body of evidence indicating that irony comprehension might be dependent on advanced Theory of Mind (ToM) (Fillipova & Astington, 2008). Furthermore, EFs may independently contribute to irony comprehension; e.g., one needs to inhibit the literal meaning of the utterance. Only three studies have investigated whether EFs relates to irony interpretation by children (Caillies et al., 2014; Filippova & Astington, 2008; Godbee & Porter, 2013). However, none of the previous studies which included both EFs and ToM, assessed the *unique* contribution of each as the analyses that were carried out were solely correlational. Furthermore, neither of the studies which looked at the relationship between irony comprehension, ToM and EFs, examined whether the EFs measures contributed unique variance to irony comprehension once ToM was controlled for. Importantly, no previous study has controlled for the role of non-verbal reasoning, which seems to be crucial in order to rule out the Matthew effect (Merton, 1968) / general reasoning abilities (Zelazo, Carter, Reznick, & Frye, 1997).

In the present study, inspired by the theoretical distinction made by Bara et al. (1999), I also included both Simple and Complex forms of irony. However, in my

definition, Simple Irony refers to the utterance where the hearer can see from the immediate real-world context that the literal meaning cannot be true (e.g., saying '*It's a perfect day for a picnic'* where both speakers can see that it is raining heavily). I included a Complex Irony condition where there is no obvious conflict between the literal meaning and real-world context that would serve as a cue for the hearer that the utterance should not be interpreted literally. Therefore, the non-literal interpretation of Complex ironic statement cannot be inferred from the visual context:

(6) Speaker A*: I have been invited to a party by the most beautiful girl in my class*

Speaker B*: Yeah, and I have been invited to the Queen's party*

Since Complex Irony presumably relies on knowledge of the real world – one needs to know that the Queen does not invite regular people to parties – we also examined the relationship with a standardized test of general knowledge.

In the present study, I was primarily interested in investigating the relationship between irony interpretation and ToM measures (Strange Stories, Happé, 1994) and the Theory of Mind Inventory (ToMI, Hutchins, Prelock, & Bonazinga, 2012), as well as all three components of EFs (working memory, cognitive flexibility and inhibitory control) whilst controlling for theoretically important covariates for irony comprehension such as structural language and non-verbal reasoning. While there is evidence for the role of ToM (and working memory and inhibitory control) in the interpretation of Simple Irony, to date no study has investigated whether these factors are important for the interpretation of Complex Irony; thus it could be that other mechanisms are at play here.

To examine children's understanding of irony we presented them with 15 videos (5 in Simple Irony and 5 in Complex Irony; 5 Literal) in which one of the speakers made either ironic or literal comment (depending on the type of the vignette). Children were

asked one Forced-Choice question about the speaker's belief ('*What does [the speaker] mean?*') and one Open-Ended question about the speaker's motivation ('*Why did [the speaker] say that?)*. Their task was to answer the Forced-Choice question by choosing one of the three possible answers (1 target and 2 foil answers). This task is notably different than any other used in previous studies, in which children have the two responses to choose from. Commonly used binary choice allows participants to pass the test without actually understanding the ironic intent by working out that the correct answer is the one that is not literally true.

In line with the findings of Filippova and Astington (2008), showing that there is a relationship between irony and ToM when controlling for age, memory, and language, it was expected that irony comprehension will be correlated with both measures of ToM (Strange Stories; Happé, 1994 & ToM Inventory; Hutchins et al., 2012) when controlling for age, structural language and non-verbal reasoning. That is, higher scores on both Simple and Complex Irony comprehension were predicted to be positively correlated with scores obtained in both ToM measures. It was also hypothesized that all three components of EFs (i.e., inhibitory control, working memory, and cognitive flexibility) would also be related to both types of irony (Simple and Complex) after controlling for theoretically important covariates. As some EFs are required in order to acquire ToM (e.g., Carlson et al., 2004; Kloo & Perner, 2003, it is assumed that EFs would predict the performance in both irony types and contribute the unique variance for irony comprehension. It was also hypothesized that children will find Simple Irony easier than Complex Irony and will score higher on the Simple Irony than on the Complex Irony. As Complex Irony may rely on the knowledge about the world, I also investigated whether general knowledge was predictive for Complex Irony.

## 2.3. Method

**2.3.1. Participants.** Fifty-seven neurotypical children were recruited through the parent database held by the Kent Child Development Unit. The parents of children were invited to take part via e-mail and provided with information and consent forms. All participants were native, monolingual British English-speakers. Participants who had a diagnosis of ADHD, ASD, Dyslexia, any language processing difficulties or who had acquired neurological conditions were excluded from the study. Six children who did not pass 'control checks' (i.e. scored less than 4 out of 5 on a 'Literal' control check) were excluded from all analyses. One child whose mother interrupted / helped the test administration was also excluded from all analyses. The resulting dataset consisted of 50 children ($M$ = 90.44 months, $SD$ = 9.68 months; range = 74-109 months; 21 boys). All were within the typically-developing range on the CELF-5 Formulated Sentences sub-test ($M_{\text{T-score}}$ = 57.85, range = 43-80). Four children were excluded from the correlation analyses between irony interpretation and non-verbal reasoning because latter were not administered, which resulted in $N$ = 46 for analyses which controlled for the latter. For the analyses of the relationship between Simple Irony comprehension and Theory of Mind measures, four participants were excluded as the ToM (Strange Stories) test was not administered.

**2.3.2. Materials and Procedures**

***Irony Task.*** In this computer-based task, all participants were presented with fifteen videos; five for Complex Irony, five for Simple Ironies, and five for the Literal Control check (see Appendix A for all examples). The videos were developed based on results from a version of this study which was carried out with adults. The following steps were taken in order to extract fifteen stories that would be the best representatives for Simple versus Complex Irony:

*The development of the video stimuli.* Adult participants ($N = 38$), who were native English-speaking Psychology students and who were naïve to the experimental hypotheses, were presented with 21 written stories for Literal Control, Complex Irony and Simple Irony; hence, each adult rated 63 items in total. They were asked to rank on a 9-point Likert scale the level of difficulty of each presented statement ('How easy do you think would it be for an 8-year-old child to understand that statement?'), with 1 being very easy and 9 – very difficult. Based on the adult ratings, five items that had the highest mean complexity rating were included in the Complex Irony condition; for the Simple Irony condition five items that had the lowest mean complexity rating were selected. Prior to the final selection, all items for which the mean accuracy was 2.5 SD below the mean for irony items were removed from the analysis. This resulted in the removal of five items. Also, across all participants, only the items for which adults responded correctly were included in the analysis of the difficulty ratings. Finally, items that would deemed impossible to film were excluded from the selection process.

The Complex and Simple Irony conditions were then matched in terms of the average number of words and the number of mental state verbs in their vignettes (Table 2). To achieve this, some of the original stories were slightly modified for the purpose of matching. There were three different script orders so that for each vignette across the sample of participants, the target answer could appear either first, second or third.

Table 2

*The Number of Words and Mental State Verbs in Vignettes that Were Used in Videos*

| | Complex Irony | Simple Irony | Literal |
|---|---|---|---|
| Number of items | 5 | 5 | 5 |
| Mean number of words in a dialogue | 18.8 | 18.8 | 18.6 |
| Mean number of words in foil answers and targets | 11 | 10.06 | 9.6 |
| Overall number of mental state verbs in dialogues | 2 | 2 | 2 |
| Overall number of mental state verbs in foil and target answers | 10 | 9 | 10 |

*Note.* All mean scores between items are $p > .05$.

All of the ironic statements, both Complex and Simple, were instances of ironic criticism. The ironic statements in Simple Irony condition were presented in the form of a counterfactual assertion, in which the ironic speaker says something opposite to their implied meaning (Creusere, 1999). Critical Simple Irony is understood here as an explicitly positive utterance that communicates a speaker's negative meaning, such as '*Well done!*' to communicate that someone has done something wrong (Schwoebel et al., 2000). However, ironic criticism may be expressed not only by counterfactual assertions, but also by true assertions, over-polite requests, questions (Kumon-Nakamura et al., 1995) and various forms of language, such as hyperbole or understatements (Gibbs, 2000). For instance, saying '*It looks like Oliver might have dyed his hair*' when your classmate has changed his hair colour into bright green exemplifies irony expressed by understatement. These types of critical ironic statements were considered in this study as

Complex Irony, as the ironic statement is more indirect in the manner than its Simple counterpart.

Each video was a two-to-three line dialogue, ending with one of the previously mentioned language forms, said by one of the speakers. There were two types of dyads in the video stimuli – an adult speaking with an adult and a child speaking with a child. Three of the videos (one in the Simple Irony, one in the Complex Irony and one in the Literal Control) were filmed with child actors. The remaining twelve videos were filmed with adult actors. In each video, there was a male and a female actor. The number of the final (target) utterances that were stated by the male versus a female speaker was counterbalanced. In order to maintain the voice intonation as neutral as possible, the actors first acted out the final statement of each vignette while they were blind to the context of the story. They were also instructed to keep the prosody neutral.

*Procedure.* The participants were tested individually in the child lab. Sometimes the parent was present in the testing room but was instructed to sit behind the child. First, each participant was orally presented with the instructions and two example videos (Literal), which were not scored, on the computer screen. After each video, the participant could either replay the video by clicking on the "reply" button or move on the next section – Open-Ended question. All videos were followed by an Open-Ended question (asked by the experimenter) regarding the speaker's intent underlying the statement ('*Why did [the speaker] say [target statement]?'*). Following this, the child was asked a Forced-Choice question regarding the speaker's intended meaning ('*What does [the speaker] mean?*') whereby there were always three possible answers (one correct-target answer and two incorrect-foil answers). The three possible answers were presented in the form of speech bubbles that were coming out of the speaker's head (see Figure 1). After hearing the Forced-Choice question, the child was asked to click on any of the three speech bubbles

to listen to the possible answer (whereby this was then also simultaneously revealed in written form within the speech bubble). After listening to all possible answers, the child chose the one s/he believed to be correct by clicking on the "pick me" button, which was located on each of the speech bubbles. The child could also play each of the possible answers as many times as they needed by clicking on the speaker icon in each speech bubble. The video screenshot with the text of the conversation, which the child had just seen and heard, was available at the top of the screen during both of the questions. The participant's accuracy of responses and the reaction time for each question was automatically recorded in *PsychoPy* software (Peirce, 2007). Participants were not given any specific feedback after the example videos. The order of the videos was fully random, which resulted in Literal Control items being interspersed between the irony items. The whole session was audio-recorded.

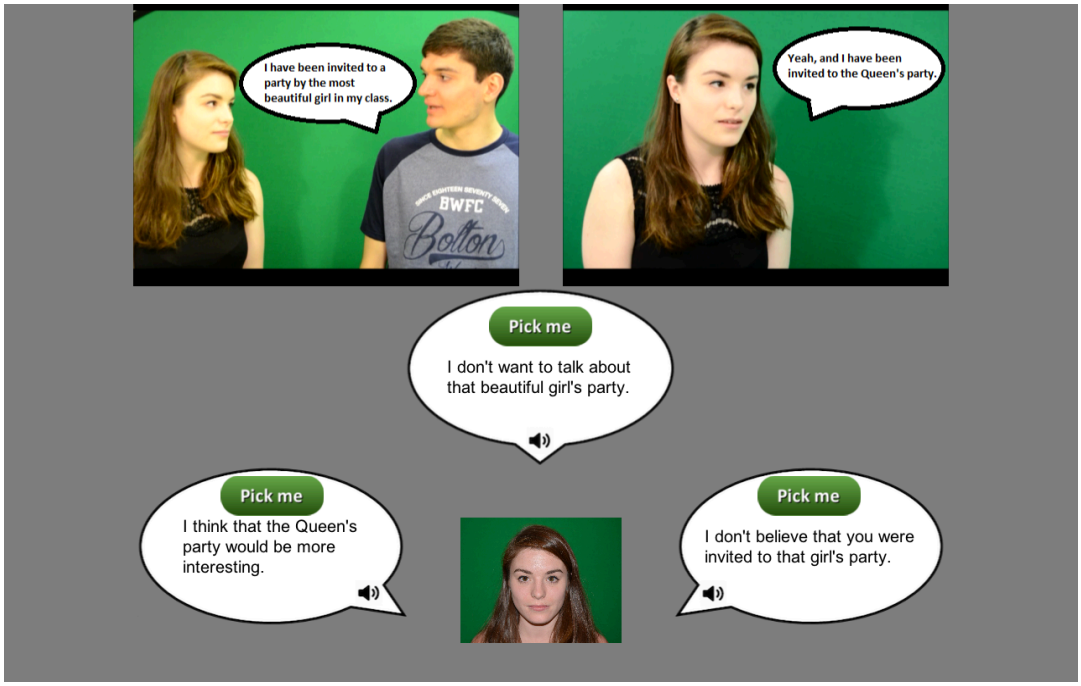


*Figure 1.* The Example of the Response Screen for the Irony Task

*Scoring and coding.* For the irony items, the responses to the Open-Ended question (‘*Why did [the speaker] say [target statement]?*’) regarding the pragmatic function of the ironic utterance were analysed and coded by two independent raters. An interrater reliability for the raters was found to be Kappa = .81; hence, the level of inter-rater reliability should be regarded as “strong”. Three main categories of explanations were noted. Each of the categories reflects the child’s level of reasoning about the speaker’s intention:

0. Answers referring just to the literal meaning of the ironic utterance, repetitions of the context of the story *(e.g., 'because the girl ate the sweet and gave him the wrapper');’I don’t know’;*
1. Responses reflecting simple surface level justifications, or a reference to the correct states or feelings of the speaker (‘*because she was mad*’), or those reflecting learned conventional answers (e.g., ‘*that is not a nice thing to do’*);
2. Responses with a reference made to the speaker’s attitude toward the situation and to the pragmatic function of irony (e.g., ‘*she did not want to be too harsh at her, since she was just a little girl and she didn’t mean to spill it all over the picture*’ or ‘*she wanted to make the accident a little less serious*’).

The following tasks were always presented after the main task and they were carried out in the same order as listed below:

***Stroop Task.*** Computer-based version of the Stroop task (Stroop, 1935) was used to measure one area of executive functioning; that is Inhibitory Control. In this task participant had to decide as quickly as possible whether the font colour matches the meaning of the words. Participants were asked to do it by clicking the corresponding colour on the keyboard in front of them. Stimuli were presented on the computer screen placed in front of the participant. The reaction times for control trials, congruent and

incongruent trials were recorded. For each participant the data from error trials and outliers trials was excluded (i.e., all reaction times under 200ms and above 2.5SD). The difference between mean reaction times in incongruent condition and congruent condition was calculated for each participant. A higher score indicates more inference and thus poorer inhibitory control. The difference between mean reaction times in incongruent condition and congruent condition did not correlate with the Stroop accuracy score ($r(48) = -.03$, $p = .87$) and the majority of children were accurate 95% of the time or more. Therefore, accuracy was not used in analysis.

***Digit Span Backwards subscale of Wechsler Intelligence Scale for Children.*** To examine the children's working memory the Digit Span Backwards (DSB) subscale of Wechsler Intelligence Scale for Children – fourth edition (WISC; Wechsler, 2003) was administered. Due to the fact that the experimenter was not a native-speaker of English, the stimuli (numbers) themselves were pre-recorded by a native speaker of British English and each item was then presented via a laptop's speakers. The instructions and training on repeating in backwards order had been given as per the WISC manual. As in the manual, the first few items consist of a series of two digits and then proceed through items increasing in length, until the final items, which consist of eight digits. Each item was played only once. There were eight items with two trials (digit lists) in each of the items. The participant could score 1 or 0 for each trial. As per the manual, the administration was discontinued after two scores of 0 on both trials of an item. The raw score and the scaled score was calculated for the test. The higher score indicates better performance.

***Formulated Sentences subtest of Clinical Evaluation of Language Fundamentals – Fifth Edition.*** The participants' ability to formulate semantically- and syntactically correct spoken sentences was measured with the Formulated Sentences subtest of Clinical

Evaluation of Language Fundamentals® – Fifth Edition (CELF®- 5; Semel, Wiig, & Secord, 2013). The child was asked to create a sentence using a given word or words (e.g., car, before) and the contextual information provided by the illustration. There were twenty-three items. Following the manual, responses were scored as follows after a period of systematic training and discussion with my supervisor. A response scored 2 points if the answer was a complete sentence that used a stimulus word (s) in a way that was semantically-, syntactically-, and pragmatically correct. A score of 1 point was given to a response included only one or two deviations in syntax or semantics. A response was given a score of 0 if it did not include the stimulus word(s); included three or more deviations in syntax or semantics; was not complete; was neither logical nor meaningful; was not about the presented picture. Following the manual, he administration was stopped after four consecutive scores of 0. The participant's responses were audio-recorded, transcribed and scored by the experimenter. The higher score indicates better performance.

***Wisconsin Card Sorting Test (WCST).*** Another area of executive functioning, namely Cognitive Flexibility, was measured with a computer-based version of the Wisconsin Card Sorting Task (WCST; Grant & Berg, 1948). In this task, participants were asked to classify cards according to various criteria (colour of the symbol, the shape of symbols, and the number of the shapes on each card). The sorting rule changed after ten consecutive correct responses and participant had to sort the rest of the cards utilising a different rule. The participant was informed when the rule switched; 'Now the rule has changed' text appeared on the screen. (Hence this version is sometimes called the 'Modified Card Sort Task'). However, the participant had to determine for him/herself what the new rule was. For each participant the number of perseverative errors was automatically calculated in *PsychoPy* software (Peirce, 2007). Errors were classified as

perseverative when the participant continues with the rule that was consistent with the rule for the previous set despite the negative feedback displayed on the computer screen. The higher score indicats greater perseveration and thus worse performance.

***Information subscale of Wechsler Intelligence Scale for Children.*** To measure participants' degree of general knowledge acquired from culture Wechsler Intelligence Scale for Children – Fourth UK Edition – 'Information' sub-test was administered (Wechsler, 2003). The participants were asked a maximum of 33 questions about their general knowledge, e.g., '*What must you do to make water boil?*'. Following the manual, he administration was discontinued after 5 consecutive scores of 0. The responses were recorded on the standard response form. The raw and the scaled score were calculated for the test. The higher score indicates better performance.

***Matrices subtest of the British Ability Scales – Third Edition (BAS-3***). To measure participants' non-verbal reasoning abilities the Matrices subtest of the British Ability Scales – Third Edition (BAS-3; Elliot & Smith, 2011). In this subtest the child was presented with an incomplete matrix of pictures or abstract figures and was asked to select from four (Matrices A) or six choices (Matrices B) the picture or figure that can complete the pattern. The suggested starting point for children aged 3:00-6:11 is Matrices A; for children aged 7:00 – 10:11 it is Matrices B. There were 51 items (excluding the teaching items for the set B). The decision about stopping the administration was made at the following items: 18, 26, 33, 42, and 51 ('Decision Points'). If at item 18 the child had fewer than 3 wrong answers, the administration was continued to the next 'Decision Point' – item 26. If between any 'Decision Points', the child received at least 3 zero scores and fewer than 3 correct scores, the administration was stopped. The 'Alternative Stopping Point' was executed after four wrong answers in five consecutive items (for set A) and after five wrong answers in six consecutive trials (for set B). If the starting point was at set B and at item 26

the child has received 3 or more zero scores and less than 3 correct scores, then the administration was stopped and the test was re-administered starting from Matrices A. The raw score was used for the analyses but standard scores were also calculated. The higher score indicates better performance.

Twenty-two participants completed the paper version of the BAS; the rest of the children completed a computer-based version[2] using *PsychoPy* software (Peirce, 2007). The difference between the computer-based and the paper-based BAS tests is that the computer-based version has automatic praise regardless of correct or incorrect response. The experimenter pressed 'confirm' ('C') on the keyboard as soon as child choose option. If the child expressed inability, the experimenter said '*Give your best guess'*. If the child chose two items, then the final selection was scored.

***Theory of Mind – Strange Stories.*** To test the children's ability to mentalise, I administered various items designed to assess Advanced Theory of Mind, namely Happé's (1994) 'Strange Stories'. The particular stories selected assessed the participant's understanding of double bluff, white lie, persuasion, and misunderstanding. The following stories were presented to children:

1. 'Kittens': This followed Malkin, Abbot-Smith, Williams and Ayling's (2018) adaptation which involved simplifying vocabulary (i.e. throw kittens away, not drown them).
2. 'Hidden Biscuits': This is based on a version from Malkin et al. (2018) and is designed to assess understanding of double-bluff (see Appendix B).
3. 'Christmas Present': This is taken from White, Hill, Happé and Frith (2009) and is designed to assess understanding of 'white lies'.

[2] There were no significant differences in the BAS T-scores for the paper-based group ($M$ = 48.91, $SD$ = 10.39) and the computer-based group ($M$ = 48.54, $SD$ = 10.72) conditions; $t(44) = -.118$, $p = .907$.

4. ‘Burglar’: This is also taken from White et al. (2009) and involves a burglar misunderstanding that somebody wishes to return this glove (as opposed to arresting him).

All of the stories were presented on a computer whereby the narrations were pre-recorded by a native, female speaker of British English and were accompanied by many more illustrations than in the original version of Strange Stories. After each story the child was asked comprehension and test questions regarding the character’s intentions. For each story, the child’s response to ‘*What did X mean when she said Y*?’ was transcribed and scored on a 3-point Likert scale, whereby 2 points were given if the child referred to the character’s inference about the mental state of the other person (e.g., ‘persuade’, ‘things that X doesn’t know’, ‘trick’, ‘thought that X knew’, ‘sparing X’s feelings’). 1 point was given if the child referred to the outcome (e.g., ‘getting rid of the kittens’, ‘to stop X eating biscuits’) or trait (‘she’s nice’ or ‘she’s lying’) with no reference to protagonist’s understanding of thoughts. Zero points were given if the child referred to irrelevant or incorrect facts. Since there were four of these items, the maximum possible score was eight[3]. All of the stories as well as the coding criteria can be found in Appendix B. The higher score indicates better performance.

To establish the inter-rater reliability, two independent raters scored the performance of 11 participants on Theory of Mind (Strange Stories) task (24% of the overall participants). The Intra-class Correlation Coefficient (ICC) estimates and their 95% confident intervals that were calculated based on mean-rating, absolute-agreement, 2-way mixed-effects model. The average measure ICC was .994 with a 95% confidence interval from .976 to .998 ($F(10,10) = 158.000$, $p < .001$); hence, the level of inter-rater reliability should be regarded as “excellent”.

[3] Strange Stories had relatively low reliability, Cronbach’s $\alpha = .51$

***Theory of Mind Inventory (ToMI).*** We also used an indirect measure of ToM performance, namely the' Theory of Mind Inventory' (ToMI; Hutchins et al., 2012) which is a standardized test assessing the precursor, first-order, second-order and advanced Theory of Mind. When completing the ToMI, the parent was asked to read 42 statements and indicate the degree to which each of the statements is true or not true for them by placing the mark at the point on the continuum. On the scale there are five points marked at the continuum; definitely not, probably not, undecided, probably, definitely. The score is calculated for each item with a ruler (whereby the possible score range for each item is 0-20) and the mean is calculated for each participant. The higher score indicates better performance.

## 2.4. Results

**2.4.1. Research Question 1: Do children find Complex Irony more difficult than Simple Irony?** All participants responded to an Open-Ended question ('*Why did [the speaker] say [target statement]?*') regarding the speaker's intent behind the ironic statement. Following that, the children were asked a Forced-Choice question regarding the speaker's intended meaning ('*What does [the speaker] mean?*') with three possible answers (one correct-target answer and two incorrect-foil answers). To investigate whether children find Complex Irony more difficult that the Simple Irony, the participants' scores to the Forced-Choice and Open-Ended question were analyzed[4].

***Forced-Choice responses.*** The mean scores for the Simple and Complex Irony were significantly different. A paired sample t-test analysis revealed that for the Forced-Choice questions, the participants had significantly higher scores in Simple ($M$ = 3.78, $SD$ = 1.23) than in Complex Irony ($M$ = 1.28, $SD$ = 1.18), $t(49)$, $p < .001$, $r = .72$. The maximum score for each irony type for the Forced-Choice questions was five.

[4] Means and Standard Deviations for performance on each Irony item are reported in the Appendix C.

***Open-Ended responses.*** The children's open responses could fall into three categories that reflected their level of reasoning about the speaker's intention. The children scored 0, 1, or 2 points for each item with the maximum score being 10 overall for each irony type. For Open-Ended questions, children were again significantly better in Simple Irony ($M$ = 4.69, $SD$ = 2.8) than in Complex Irony ($M$ = 1.02, $SD$ = 1.23), $t(44)$, $p < .001$, $r = .65$.

**2.4.2. Research Question 2: Are Simple vs. Complex Irony underpinned by different cognitive mechanisms? Does EF account for the relationship between ToM and irony?**

***2.4.2.1. Preliminary analyses: Relationship between irony understanding and control variables.*** A series of correlational analyses was carried out to investigate the relationship between the participants' responses to Forced-Choice question and to Open-Ended question for each irony condition (Complex and Simple), on the one hand, and, on the other, participants' Age, Structural Language (CELF Formulated Sentences) and Non-Verbal Reasoning (BAS Matrices). As the accuracy scores on each irony condition were significantly different from a normal distribution (Forced-Choice Simple Irony $D(45) = .24$, $p < .05$; Forced-Choice Complex Irony $D(45) = .27$, $p < .05$; Open-Ended Simple Irony $D(44) = .15$, $p < .05$; Open-Ended Complex Irony $D(44) = .26$, $p < .05$), the Spearman's correlation coefficient was used.

*Forced-Choice responses.*

*Age.* To investigate the relationship between the irony understanding and the Age of participants, a Spearman's correlation was run. The scores obtained in Simple Irony were correlated with Age, $r_s = .36$, $p = .01$. Age also significantly correlated with Complex Irony accuracy in response to the Forced-Choice questions ($r_s = .35$, $p = .01$).

*Non-Verbal Reasoning.* There was a significant positive correlation between Simple Irony interpretation and Non-Verbal Reasoning (BAS Matrices raw score),

$r_s$ = .40, $p$ = .006. The relationship between Non-Verbal Reasoning and Complex Irony understanding was marginally significant, $r_s$ = .27, $p$ = .07. Spearman's correlations were run in order to determine the relationship between the Non-Verbal Reasoning (BAS Matrices raw score) and understanding of irony (both Simple and Complex) when controlling for Age. Non-Verbal Reasoning was positively correlated with Simple Irony interpretation when controlling for age, $r_s(43) = .30$, $p$ = .05. Complex Irony interpretation was not correlated with Non-Verbal Reasoning when controlling for Age, $r_s(43) = .30$, $p$ = .16.

*Structural Language.* In order to examine the relationship between irony understanding (Simple and Complex) and Structural Language (CELF Formulated Sentences raw score), Spearman's correlation was run. The results revealed that there was a positive correlation between CELF Formulated Sentences and Simple Irony, $r_s$ = .28, $p$ = .05. This relationship was no longer significant, when controlling for Age, $r_s(47) = .16$, $p$ = .27. Similarly, the correlation between CELF Formulated Sentences and Complex Irony was marginally significant, $r_s$ = .25, $p$ = .08. However, after controlling for Age there was no correlation between the two variables, $r_s(47) = .01$, $p$ = .93. Thus, for neither irony type was there a relationship with the Structural Language measure (CELF Formulated Sentences raw score), when controlling for Age.

*Open-Ended responses.*

*Age.* There was a significant relationship between the participant's responses to Simple Irony condition for Open-Ended questions and Age, $r_s$ = .56, $p$ < .001 as well as Complex Irony condition and Age, $r_s$ = .46, $p$ = .001.

*Non-Verbal Reasoning.* There was no significant correlation between Open-Ended Simple Irony and Non-Verbal Reasoning (BAS Matrices raw score), $r_s$ = .24, $p$ = .12 (when controlling for Age, $r_s$ = .07, $p$ = .66). However, the relationship between Complex Irony and BAS Matrices was significant ($r_s(42) = .56$, $p$ < .001) even when controlling for Age, $r_s(42) = .41$, $p$ = .006.

*Structural Language.* The correlation analyses revealed that there was a positive correlation between CELF Formulated Sentences (raw score) and Simple Irony, $r_s$ = .36, $p$ = .02. This relationship was no longer significant when controlling for Age, $r$s(42) = .05, $p$ = .76. Similarly, the responses to Open-Ended Complex Irony correlated with CELF Formulated Sentences, $r_s$ = .42, $p$ = .004 but not when controlling for Age, $r_s$(42) = .18, $p$ = .23.

***2.4.2.2. Relationship between Theory of Mind and Executive Functioning variables.*** Table 3 below shows the relationships between the Theory of Mind and Executive Functioning predictor variables, which were of key relevance to my research questions.

Table 3

*Correlations between ToM and EF Measures, Not Controlling for Age, Non-Verbal Reasoning or Structural Language*

| Measures | 1. | 2. | 3. | 4. |
|---|---|---|---|---|
| 1. ToM Direct (SS) | – | | | |
| 2. ToM Indirect (ToMI) | $r_s$ = .33* | – | | |
| 3. Working Memory (DSB) | $r_s$ = -.04 | $r_s$ = -.01 | – | |
| 4. Cognitive Flexibility (WCST; perseverative errors) | $r_s$ = -.22 | $r_s$ = .04 | $r_s$ = -.34* | – |
| 5. Inhibitory Control (Stroop; RT Incongr-RT congr) | $r_s$ = -.07 | $r_s$ = .09 | $r_s$ = .11 | $r_s$ = -.41** |

*$p$ < .05, ** $p$ < .01

*ToM measures.* As presented in Table 3, there was a correlation between the indirect measure of ToM (Theory of Mind Inventory) and the direct measure of ToM (Strange Stories), $r_s$ = .33, $p$ = .03. However, this relationship was no longer significant when Age and Structural Language were controlled for, $r_s$ = .23, $p$ = .14. Both the latter were correlated with the Theory of Mind measures (ToMI and age, $r_s$ = .28, $p$ = .05; ToMI and Structural Language, $r_s$ = .32, $p$ = .02; Strange Stories and Age; $r_s$ = .39, $p$ = .01; Strange Stories and Structural Language, $r_s$ = .51, $p$ < .001).

*EFs measures.* Cognitive Flexibility (WCST; number of perseverative errors) was negatively correlated with Working Memory (Digit Span Backwards; raw score), $r_s$ = -.34, $p$ = .03, and Inhibitory Control (Stroop; RT Incongruent minus RT congruent), $r_s$ = -.41, $p$ = .01. Inhibitory Control and Working Memory were not correlated, ($r_s$ = .11, $p$ = .46).

***2.4.2.3. Key analyses: The relationship between irony interpretation, EFs, General Knowledge, and Theory of Mind.***

The descriptive statistics for the predictors of theoretical interest are shown in Table 4 below.

Table 4

*Descriptive Statistics for Experiment 1*

| | Mean | SD | Min score | Max score | N |
|---|---|---|---|---|---|
| Non-verbal reasoning (BAS) T- score | 49.24 | 11.11 | 21 | 72 | 45 |
| Structural Language (Formulated Sentences scaled score) | 12.42 | 2.5 | 8 | 19 | 45 |
| Theory of Mind Direct (Strange Stories) | 4.22 | 2.29 | 0 | 9 | 45 |
| Theory of Mind Indirect (Theory of Mind Inventory - questionnaire) | 16.80 | 1.62 | 13.20 | 19.70 | 45 |
| General Knowledge (WISC Information Test scaled score) | 11.42 | 2.45 | 5 | 18 | 45 |
| WM (Backwards Digit Span scaled score) | 11.69 | 2.54 | 8 | 18 | 45 |
| IC (Stroop RT Incongr-RT congr) | 190.04 | 141.22 | -71.31 | 533.70 | 45 |

| | | | | | |
|---|---|---|---|---|---|
| Cognitive Flex (WCST) raw perseverative errors | 10.29 | 7.06 | 1 | 33 | 45 |

*Forced-Choice measure.* In order to explore the association between the responses to Forced-Choice questions (FC) in both irony conditions, executive functioning (Inhibitory Control, Cognitive Flexibility, Working Memory), General Knowledge and Theory of Mind, Spearman's correlations were performed. Table 5 below presents the patterns of significance between irony understanding, on the one hand, and the measures of EFs and ToM, on the other.

Table 5

*Correlation Coefficients between Responses to Forced-Choice Irony, EF, General Knowledge, and ToM, Not Controlling for Age, Language and Non-Verbal Reasoning*

| | Simple Irony (FC) | Complex Irony (FC) |
|---|---|---|
| Cognitive Flexibility (WCST; raw perseverative errors) | $r_s$ = -.33* | $r_s$ = -.05 |
| Working Memory (Backwards Digit Span scaled score) | $r_s$ = -.05, | $r_s$ = -.17 |
| Inhibitory Control (Stroop; RT Incongr-RT congr) | $r_s$ = .27 | $r_s$ = -.23 |
| General Knowledge (WISC Information scaled score) | $r_s$ = .18 | $r_s$ = .14 |
| Theory of Mind direct (Strange Stories) | $r_s$ = .20 | $r_s$ = .28 |
| Theory of Mind indirect (questionnaire - ToM Inventory) | $r_s$ = .40** | $r_s$ = .25 |

* $p < .05$, ** $p < .01$

There was a significant negative correlation between the responses to the Forced-Choice question in Simple Irony condition and two EF measures. First, there was a significant negative correlation with Cognitive Flexibility (number of perseverative errors in WCST), $r_s(48) = -.33$, $p < .05$. Second, there was a marginal positive correlation between Forced-Choice Simple Irony and Inhibitory Control (Stroop; RT Incongruent minus RT congruent), $r_s(45) = .27$, $p = .06$. The relationship between Forced-Choice Simple Irony and the direct measure of ToM (Strange Stories) was not significant, $r_s(43) = .20$, $p = .19$. There was a strong correlation between the indirect ToM measure (ToMI) and Forced-Choice Simple Irony, $r_s(43)= .40$, $p < .01$. The Forced-Choice Complex Irony condition, was marginally correlated with Strange Stories, $r_s(43) = .28$, $p = .058$.

*Open-Ended measure.* To assess the relationship between responses to Open-Ended (OE) questions for both Open-Ended Simple and Complex Irony conditions on the one hand and the predictor variables of theoretical interest (measures of EFs, General Knowledge, and ToM) on the other, a series of Spearman's correlations was computed. The results showed that Open-Ended Simple Irony positively correlated with General Knowledge, ($r_s(43) = .32$, $p < .05$) and the direct measure of ToM (Strange Stories) ($r_s(42) = .36$, $p < .01$). There was a significant negative relationship between Open-Ended Complex Irony and the number of perseverative errors (WCST), $r_s(43) = -.41$, $p < .01$. The relationship between direct ToM measure and Open-Ended Complex Irony was also significant, $r_s(42) = .40$, $p = .007$. The correlation results are presented in Table 6.

Table 6

*Correlation Coefficients between Responses to Open-Ended Questions in Irony Condition, EF, General Knowledge, and Tom, Not Controlling for Age, Structural Language or Non-Verbal Reasoning*

| | Simple Irony (OE) | Complex Irony (OE) |
|---|---|---|
| Cognitive Flexibility (WCST; raw perseverative errors) | $r_s$ = -.21 | $r_s$ = -.41** |
| Working Memory (Backwards Digit Span scaled score) | $r_s$ = .21 | $r_s$ = .05 |
| Inhibitory Control (Stroop; RT Incongr-RT congr) | $r_s$ = -.25 | $r_s$ = .07 |
| General Knowledge (WISC Information scaled score) | $r_s$ = .32* | $r_s$ = .23 |
| Theory of Mind direct (Strange Stories) | $r_s$ = .36* | $r_s$ = .40* |
| Theory of Mind indirect (questionnaire - ToM Inventory) | $r_s$ = .21 | $r_s$ = .11 |

*$p$ < .05, **$p$ < .01

***2.4.2.4. Key analyses: Regression Analyses – Cognitive skills contributing to irony interpretation.*** Finally, in order to investigate the impact of EFs and ToM on irony interpretation, hierarchical regression analyses were computed using the Forced-Choice Simple Irony, Open-Ended Simple Irony, Forced-Choice Complex Irony, and Open-Ended Complex Irony as outcome variables. In the regression analyses, Age was always entered first (because this always correlated with all the outcome variables, as we saw in section 2.4.2.1.). The control measures of Non-Verbal Reasoning (BAS Matrices) and

Structural Language (CELF Formulated Sentences) were entered in Step 1 only when there was a significant correlation ($p < .05$) between those measures and the outcome variables when controlling for Age (see section 2.4.2.1.). In Step 2, only the variables that correlated with the IVs ($p < .05$) were entered in the regression analyses, in order to avoid multicollinearity. Preliminary analyses were performed to check whether there was any violation of assumption of multivariate normality, linearity, multicollinearity and homoscedasticity; all assumptions were met.

***Simple Irony.***

*Forced-Choice outcome measures.* A hierarchical multiple regression analysis (enter method) was conducted using total accuracy of responses in Forced-Choice Simple Irony condition as the outcome variable. In the first step Age (in months) and BAS Matrices raw score (Non-Verbal Reasoning) were entered as predictors of Forced-Choice Simple Irony, followed by the number of perseverative errors in WCST (Cognitive Flexibility), and the ToM Inventory mean scores (indirect ToM measure) entered in Step 2.

After entering Age and BAS Matrices at the first stage, the model was statistically significant, $F(2, 41) = 6.58$, $p = .003$ and accounted for 24 percent variance of Forced-Choice Simple Irony. However, only Age made a significant unique contribution to the first model (see Table 7). The inclusion of WCST (Cognitive Flexibility) and ToMI, explained an additional 16 percent of variance in Forced-Choice Simple Irony and this significantly contributed to the model, $F(4, 39) = 6.94$, $p = .01$. In this model Theory of Mind uniquely accounted for 9% of the variance ($\beta = .31$, $p = .02$, $sr^2 = .09$) and Cognitive Flexibility uniquely accounted for 7% of the variance.

Table 7

*Summary of Hierarchical Regression Analysis for Variables Predicting Forced-Choice Simple Irony*

| Predictor | β | *t* | *p* | $sr^2$ |
|---|---|---|---|---|
| Step One: $R^2 = .24$, $p = .003$ | | | | |
| Age | .33* | 2.19 | .03 | .09 |
| Non-Verbal Reasoning (BAS Matrices) | .25 | 1.69 | .10 | .05 |
| Step Two: $\Delta R^2 = .16$, $p = .01$ | | | | |
| Age | .22 | 1.533 | .13 | .04 |
| Non-Verbal Reasoning (BAS Matrices) | .17 | 1.17 | .25 | .02 |
| Cognitive Flexibility (WCST perseverative error) | -.28 | -2.07 | .05 | .07 |
| Theory of Mind Inventory | .31 | 2.43 | .02 | .09 |

*Note.* $N = 43$.

*Open-Ended outcome measures.* Similar procedure was applied using total score obtained for the responses to Open-Ended Simple Irony condition as dependent variable. This time, only Age was entered in the Step 1 because neither core language nor Non-Verbal Reasoning related to Open-Ended Simple Irony, when controlling for Age (see section 2.4.2.1.). This was followed by General Knowledge (WISC 'Information' sub-test raw scores), and the direct measure of Theory of Mind (Strange Stories) (since these correlated with this outcome variable), all entered in Step 2.

At Stage One, Age significantly contributed to the model, $F(1, 42) = 22.58$, $p < .001$ and accounted for 35 percent variance. After adding General Knowledge and Strange Stories in Step 2, the model was not significant $F(3, 40) = 8.95$, $p = .19$. Age was the only significant predictor ($\beta = .59$, $p < .001$, $sr^2 = .35$). The Strange Stories and WISC (General Knowledge) did not contribute to the final model ($p > .05$). See Table 8 below.

Table 8

*Summary of Hierarchical Regression Analysis for Variables Predicting Open-Ended Simple Irony Interpretation*

| Predictor | β | *t* | *p* | $sr^2$ |
|---|---|---|---|---|
| Step One: $R^2 = .35$, $p < .001$ | | | | |
| Age | .59 | 4.75 | .00 | .35 |
| Step Two: $\Delta R^2 = .05$, $p = .19$ | | | | |
| Age | .49 | 3.36 | .00 | .17 |
| Theory of Mind (Strange Stories) | .24 | 1.79 | .08 | .05 |
| General Knowledge (WISC) | .01 | 0.09 | .93 | .00 |

*Note.* $N = 45$.

Therefore, we find a relationship between Forced-Choice Simple Irony, on the one hand and both Theory of Mind (indirect measure) and Cognitive Flexibility (WCST), on the other, even when the crucial control variables are entered in the first step. This suggests that Non-Verbal Reasoning cannot entirely account for the relationship between (Simple) Irony and Theory of Mind, which has been frequently reported in the literature. Moreover, the findings for Open-Ended Simple Irony suggest that any theoretically interesting correlates of Simple Irony are not likely to be accounted for by General Knowledge, although in fact the sample performed poorly ($M = 4.69$ out of 10) on the Open-Ended scoring method overall, indicating that the Forced-Choice scoring method is perhaps more indicative of the children's irony understanding.

***Complex Irony.***

*Forced-Choice outcome measures.* A hierarchical multiple regression analysis was conducted using total accuracy of responses to Forced-Choice Complex Irony condition as the dependent variable. In the first step Age (in months) was entered as a predictor of, as

this was the only significant control variable (see section 2.4.2.1.). In Step 2, only Strange Stories (the direct ToM measure) was entered, as this was the only significant correlate out of the predictor variables of theoretical interest (see Table 8 above).

The multiple regression analysis showed that at Step One, Age significantly contributed to the model, $F(1,44) = 6.18$, $p = .02$ and accounted for 12 percent variance. After adding Step 2, the model was not significant $F(2, 43) = 3.56$, $p = .34$. However, it should be borne in mind that even the Forced-Choice measures of Complex Irony comprehension show performance that was towards floor level ($M = 26\%$ correct).

Table 9

*Summary of Hierarchical Regression Analysis for Variables Predicting Forced-Choice Complex Irony Interpretation*

| Predictor | β | *t* | *p* | $sr^2$ |
|---|---|---|---|---|
| Step One: $R^2 = .12$, $p = .02$ | | | | |
| Age | .35 | 2.49 | .02 | .12 |
| Step Two: $\Delta R^2 = .02$, $p = .34$ | | | | |
| Age | .29 | 1.2 | .06 | .07 |
| Theory of Mind (Strange Stories) | .15 | 0.97 | .34 | .02 |

*Note*. $N = 46$.

*Open-Ended outcome measures.* Using a similar procedure, hierarchical regression analysis was conducted for variables predicting Open-Ended Complex Irony interpretation. Age (in months) and BAS Matrices raw score (Non-Verbal Reasoning) – as the only significant control variables (see section 2.4.2.1.) were entered in Step 1. As the only significant predicators of theoretical interest, this was followed by WCST scores (Cognitive

Flexibility) and Strange Stories scores (direct Theory of Mind measure), which were entered in Step 2.

This hierarchical multiple regression revealed that at Step One, both Age and Non-Verbal Reasoning significantly contributed to the model, $F(2,41) = 9.72$, $p < .001$ and accounted for 32 percent variance. However, when the additional variables were added in Stage 2, the final model was not significant, $F(4, 39) = 5.85$, $p = .20$. At Step 2 BAS Matrices can be identified as the only significant predictor for irony comprehension ($\beta = .34$, $p = .02$, $sr^2 = .09$). However, the theoretically relevant predictors (Cognitive Flexibility and Theory of Mind) entered in the Step 2 do not contribute to the general model (all $p > .05$). Table 10 shows the results of this regression analysis. As for the Forced-Choice Complex Irony, it is important to bear in mind here that performance on Open-Ended Complex Irony interpretation was at floor – in fact, even more clearly so ($M = 10\%$ correct) than for the Forced-Choice variant.

Table 10

*Summary of Hierarchical Regression Analysis for Variables Predicting Open-Ended Complex Irony Interpretation*

| Predictor | β | *t* | *p* | $sr^2$ |
|---|---|---|---|---|
| Step One: $R^2 = .32$, $p < .001$ | | | | |
| Age | .27 | 1.97 | .06 | .06 |
| Non-Verbal Reasoning (BAS Matrices) | .40 | 2.91 | .01 | .14 |
| Step Two: $\Delta R^2 = .05$, $p = .20$ | | | | |
| Age | .19 | 1.30 | .20 | .03 |
| Non-Verbal Reasoning (BAS Matrices) | .34 | 2.40 | .02 | .09 |
| Cognitive Flexibility (WCST perseverative error) | -.17 | -1.24 | .22 | .03 |
| Theory of Mind (Strange Stories) | .16 | 1.17 | .25 | .0 |

*Note.* $N = 45$.

The results indicate that for both methods used to assess Complex Irony interpretation (Forced-Choice and Open-Ended), only the control variables (Age and Non-Verbal Reasoning) significantly predicted Complex Irony understanding. Unlike the Simple Irony condition, there was no relationship found between the EFs and ToM measures and Complex Irony interpretation when controlled for Age and Non-Verbal Reasoning. However, one potential explanation for the latter might be floor-level performance in Complex Irony interpretation in this age group. This will be discussed further below.

***2.4.2.5. Clarifying the relative contributions of Executive Functioning and Theory of Mind to Simple Irony interpretation.*** The Open-Ended assessment method clearly led to poorer performance than the Forced-Choice assessment method. Furthermore, even for the Forced-Choice method, the sample of six- to eight-year-olds

clearly struggled with Complex Irony interpretation. For this reason, in this section, I focus only on the results for Forced-Choice Simple Irony interpretation.

In the section 2.4.2.4. only two of the cognitive skills of theoretical interest – namely the indirect (parental questionnaire) measure of Theory of Mind and Cognitive Flexibility – were identified as independent predictors of Forced-Choice Simple Irony. However, the other EFs and ToM measures were not included in that analysis, as they were not significant in correlational analyses (see Table 5). To ensure that Cognitive Flexibility and ToM (indirect) still hold as independent predictors of Simple Irony even when all theoretically important variables are entered in the regression, an additional analysis was carried out.

In this regression analysis, 45 children were included. We excluded six children who failed the 'Literal' control check, four whose non-verbal reasoning scores were missing, an additional one for the Stroop because his RT difference score was an outlier (800 msc) and one who did not complete the 'Biscuits' item on 'Strange Stories'. The significant control variables (see section 2.4.2.1.) – Age (in months) and BAS Matrices raw score (Non-Verbal Reasoning) – were entered in Step 1. In Step 2, the following were also entered: Cognitive Flexibility (WCST raw perseverative errors), indirect Theory of Mind (ToMI questionnaire), direct Theory of Mind (Strange Stories), General Knowledge (WISC 'Information' sub-test score), Inhibitory Control (Stroop reaction-time difference score subtracting the congruent from the incongruent condition), and Working Memory (Digit Span Backwards) scores. As can be seen from Table 11 below, even though all theoretically important variables were entered in this model, the same result is obtained as in section 2.4.2.4. it was still the case that only ToMI scores ($\beta = .31$, $p = .03$, $sr^2 = .08$), Cognitive Flexibility measure ($\beta = -.34$, $p = .03$, $sr^2 = .08$) and Age ($\beta = .45$, $p = .01$, $sr^2 = .11$) were significant predictors of Forced-Choice Simple Irony comprehension. Therefore, the results of this additional analysis confirm that Theory of Mind (indirect), Cognitive Flexibility and Age relate most clearly to Simple Irony interpretation in six- to eight-year-old children.

Table 11

*Summary of Hierarchical Regression Analysis for Variables Predicting Simple Irony Interpretation (Forced-Choice) when All Variables Are Included*

| Predictor | β | *t* | *p* | $sr^2$ |
|---|---|---|---|---|
| Step one: $R^2 = .25$, $p = .003$ | | | | |
| Age | .42 | 3.07 | .004 | .17 |
| Non-Verbal Reasoning | .22 | 1.59 | .12 | .05 |
| Step two: $\Delta R^2 = .23$, $p = .01$ | | | | |
| Age | .45 | 2.82 | .01 | .11 |
| Non-Verbal Reasoning | .22 | 1.59 | .12 | .03 |
| General Knowledge | -.09 | -0.53 | .60 | .00 |
| Inhibitory Control | .09 | 0.60 | .55 | .00 |
| Working Memory | -.23 | -1.58 | .12 | .04 |
| ToM Strange Stories | -.14 | -0.88 | .39 | .01 |
| Theory of Mind (Inventory) | .31 | 2.29 | .03 | .08 |
| Cognitive Flexibility | -.34 | -2.30 | .03 | .08 |

*Note.* $N = 45$.

## 2.5. Discussion

Until now, no previous study looked at the relationship between understanding both Simple and Complex forms of irony, Theory of Mind and all three components of the Executive Functioning (working memory, inhibitory control and cognitive flexibility). Two main research questions were considered here: (1) *Do children find Complex Irony more difficult than Simple Irony* and (2) *Are Simple and Complex Irony underpinned by different cognitive mechanisms?*

### 2.5.1. Understanding of Simple and Complex Ironies

In line with the predictions, in the current study, 6-8-year-old children found Simple forms of irony easier than the Complex ones. After each video, the participants were

asked one Open-Ended question about the speaker's intent behind the ironic statement ('*Why did [the speaker] say [target statement]?*') and one Forced-Choice question about the speaker's intended meaning with three possible answers ('*What does [the speaker] mean?*'). I found that for the Forced-Choice questions participants scored significantly higher for Simple (on average 76% correct responses) than for Complex Irony (26% correct responses). Similar pattern was found in children's responses to Open-Ended questions; children had on average 47% correct responses for Simple Irony and 10% for Complex Irony. This shows that it is a real challenge for six- to eight-year-olds to interpret more advanced forms of irony, where the implied meaning of the ironic utterance cannot be inferred from the immediate physical context.. This finding is in keeping with previous studies which demonstrated that understanding of more advanced forms of irony, other than simple ironic criticism, continues to develop throughout middle childhood (e.g., Demorest et al., 1984; Pexman & Glenwright, 2007).

In contrast, the six to eight-year-olds in the current study were quite good at interpreting Simple forms of irony, where they could see from the immediate context that the utterance cannot be interpreted literally (e.g., saying '*It's a perfect day for a picnic*' when both speakers can see that it is raining). This aspect of my findings is in line with Bosco and Bucciarelli (2008), who came up with the theoretical distinction between Simple and Complex ironic communicative acts and found that Simple ironies were easier to understand than Complex ones by children aged between six to ten. The results indicate that in order to track the developmental trajectories of irony comprehension, it is important to include more advanced forms of irony when investigating understanding this type of non-literal language by children.

In terms of the factors contributing to understanding Simple form of irony, it was the indirect mentalising measure (ToMI; the parental questionnaire) and cognitive

flexibility (Wisconsin Card Sorting Test) that were identified as independent predictors of Simple Irony comprehension. Mentalising and cognitive flexibility accounted for 9% and 7% of variance respectively when age and non-verbal reasoning were entered in the first step. For the Open-Ended measure, it was only age that predicted Simple Irony comprehension. In the Complex Irony, for both methods used to assess irony interpretation (Forced-Choice and Open-Ended measure) it was the control variables that predicted irony comprehension (age for the Forced-Choice; age and non-verbal reasoning for the Open-Ended measure).

**2.5.2. The role of Theory of Mind in the acquisition of irony interpretation.** As mentioned in the introduction, the vast majority of studies which showed a link between, what we defined here as Simple Irony and advanced Theory of Mind did not control for any theoretically important covariates, such as the structural language or non-verbal reasoning (e.g., Angeleri & Airenti; 2014; Nicholson et al., 2013; Banasik, 2013; Filippova & Astington, 2008). In my study, in which we took these variables into account, a relationship between irony comprehension and mentalising skills was found. That is, I found that some aspects of mentalising evaluated and reported by parents of the young participants (measured with ToM Inventory; Hutchins et al., 2012) make unique contributions to children's understanding of Simple Irony over and above age, verbal skills and non-verbal reasoning. In contrast, it was quite surprising that the direct measure of ToM – measured using Strange Stories (Happé, 1994) – was not related to Simple Irony comprehension. However, when I looked at the relationship between the two ToM measures, the correlation between the two is significant yet surprisingly weak for two measures that are supposed to evaluate the same skill ($r = .33$, $p = .03$). In addition, when theoretically important covariates – age and structural language – were controlled for, the correlation between SS (Happé, 1994) and ToMI (Hutchins et al., 2012) was no longer

significant. One reason for this is that that SS and ToMI measure slightly different ToM competences. Whereas Theory of Mind Inventory taps a wide range of early (e.g., sharing attention) as well as more advanced aspects of ToM, such as understanding humour, counterfactual reasoning, distinction between jokes and lies, or understanding that two people can interpret the same image differently, the four Strange Stories tasks measure understanding of double bluff, white lie, persuasion, and misunderstanding. Moreover, there may be reliability issues concerning 'Strange Stories' (e.g., Jones et al., 2018), which will be discussed further in Chapter 5.

Nonetheless, it would seem that in order to understand the speaker's communicative intent behind a Simple ironic statement, children need some ToM competencies, such as the ability to make accurate social judgments, read mental states and attitudes of others. In the Irony Task, in order to decode the ironic meaning, the children have to consider the ironist's thoughts about the addressee's knowledge to score on the Irony Task. Importantly, these findings suggest that non-verbal reasoning – even though it clearly correlated with measures of irony understanding – cannot account for the relationship between the Theory of Mind Inventory and Simple Irony and therefore cannot account for the relationship with Theory of Mind found in the literature (e.g., Filippova & Astington, 2008).

**2.5.3. The role of Executive Functioning in the acquisition of irony interpretation.** Out of all three components of Executive Functions (working memory, inhibitory control and cognitive flexibility), only cognitive flexibility was related to irony comprehension. Therefore, it is the ability to flexibly shift between mental states that was found to be the only EFs component that predicted interpreting irony by children aged 6-8-years. To correctly decode the ironic meaning, the child has to shift between the interlocutors' perspectives and to understand that the hearer is aware of the speaker's

perspective and the knowledge that they share in the particular context. Furthermore, to accurately interpret the ironic statement and decode the speaker's actual meaning behind '*Well done!'* after someone has spilled the juice over the clean tablecloth, the child needs to flexibly decide between two available meanings, literal and ironic, and accept the latter. In the Irony Task, the children need to choose the correct, implied, meaning out of three options, in which two are the foils that would be true for the literal interpretation of the statement. This means that children not only have to choose the correct, ironic meaning but also to reject the two interfering foils. The relationship between cognitive flexibility and irony comprehension. This a novel finding, as no previous studies looked at the role of cognitive flexibility in irony understanding in children.

Contrary to my predictions, neither working memory nor inhibitory control related to Simple or Complex Irony understanding when age and non-verbal reasoning were controlled for. The results are not in keeping with Filippova and Astington's (2008) findings of a relationship between irony interpretation measures and working memory. However, it is important to note that in their study, working memory was used as a control variable, therefore it was impossible to evaluate whether working memory made any unique contribution. In addition, Godbee and Porter (2013) found that working memory (one of four cognitive skills assessed with Woodcock-Johnson (Revised) Tests of Cognitive Ability; Woodcock & Johnson, 1990) was significantly related to their measures of irony comprehension in their group of typically developing children. However, to assess working memory, Godbee and Porter used a task that tested memory of single words, phrases and sentences. Such task seems to burden verbal skills (not controlled for in the analyses) which might indicate the false positive. Moreover, to test non-literal language comprehension, Godbee and Porter presented children with 13 short stories that were read by the experimenter, which in fact burdens working

memory a great deal. When designing the Irony Task, I tried to minimise the working memory load as much as possible by giving the children a chance to repeat the videos as many times as needed, and by presenting the video screen shots with the key dialogue at the choice screen so that the child could recap the content of the video. It could be that the conflict in findings between the current study and Godbee and Porter's study is due to the differing methods used to measure irony/sarcasm in children.

Until now, only two studies investigated the relationship between inhibitory control, working memory and irony understanding (Caillies et al., 2014; Caillies, Hody, & Calmus, 2012). Both studies found a correlation between irony measures and inhibitory control, but not with working memory. These results are in line with the findings regarding working memory but we failed to confirm any link between irony comprehension and inhibitory control. As the main focus in both of these studies (Caillies et al., 2014, 2012) was to examine the irony comprehension in atypical populations of children diagnosed with cerebral palsy and ADHD, the sample sizes for the typical controls were very small, especially given quite a wide age range ($N$ = 10, range: 7; 6 – 11;6 years and $N$ = 15, range: 6;7 – 10;6 years respectively). Such small sample size – particularly with a wide range in age - indicate that the results should be interpreted with extreme caution, especially given that the literature suggests significant improvements in the inhibition in children between five and eight (Romine & Reynolds, 2005) and even in middle childhood (e.g., Klenberg, Korkman, & Lahti-Nuuttila, 2001). Although in the current study, we did not confirm the prediction regarding the relationship between irony comprehension and inhibitory control in children aged 6 to 8, it is an area worth exploring as there are theoretical reasons why inhibition might be important for irony comprehension in children.

**2.5.4. The role of general knowledge in irony interpretation by children.** The current findings also suggest that the relationship between Simple Irony, ToM, and EFs (cognitive flexibility) cannot be accounted for by general knowledge as it did not correlate with most of the irony measures, nor did it contribute to the final regression model for Open-Ended Simple Irony. One potential explanation of the lack of the relationship between irony comprehension and general knowledge is the choice of the measure. To assess children's general knowledge we used WISC Information sub-test (WISC; Wechsler, 2003), in which the children were asked to answer the questions about the world, such as '*What causes iron to rust?*'. We think that it might be the case that in order to understand that the statement '*Yeah, and I have been invited to the Queen's party*' is meant ironically, the hearer needs to know that the Queen does not invite regular people to the parties. As WISC Information sub-test is a measure of general knowledge, it does not assess the specific knowledge the child needs to have in order to understand the particular statements used in the Irony Task. The child might know what causes iron to rust but they might lack the specific knowledge necessary for interpreting the ironic statement as such. If one does not know that the Queen does not invite regular people to the parties, a literal interpretation of the above statement is very likely. Therefore, we think that perhaps asking children specific knowledge questions related to the utterances used in the Irony Task, might reveal that they do in fact need prior knowledge about the state of the world to comprehend ironic statements. This will be further investigated in the next chapter.

Overall, when investigating underpinnings of irony comprehension, it seems necessary to look at both ToM and EFs (cognitive flexibility) simultaneously, as they both independently contribute to Simple Irony understanding even when age, verbal abilities and non-verbal reasoning are taken in to account. We also found that age has the

greatest impact on Complex Irony understanding, which might suggest a developmental pattern in irony comprehension with younger children (6-8-year-olds) have a long way to go before they can fully appreciate more sophisticated forms of irony. Unlike Simple Irony, there was no relationship found between EFs and ToM measures and Complex Irony interpretation when controlling for age. As children in the current study performed at floor (on average 20% of correct responses for Forced-Choice and 10% for the Open-Ended measure) for Complex Irony it is impossible to draw meaningful conclusions with regards to the relationship between Complex Irony, mentalising and EFs. Therefore in the following chapter I present a follow-up study with older children (11-12-year-olds) which further explored the cognitive mechanisms underlying understanding of more advanced forms of irony.

# CHAPTER 3. COGNITIVE SKILLS UNDERPINNING IRONY UNDERSTANDING IN 11-12-YEAR-OLDS

## 3.1. Introduction

Given the results from the previous study exploring the relationship between six- to eight-year-olds' understanding of both Simple and Complex Ironies, Theory of Mind as well as the three components of Executive Functions (EFs), it is worth further investigating the developmental trajectories of understanding Complex Irony with older children. As six- to eight-year-olds performed at floor for Complex Irony, in the current study I explore the ability to comprehend this form of non-literal language in 11-12-year-olds. Because the only significant EFs component in the previous chapter was cognitive flexibility, this was the only EFs component that I included in the current study. It is assumed that cognitive flexibility will be an independent predictor of irony understanding in 11-12-year-olds as in order to correctly interpret the implied meaning behind the ironic statements, the child needs to flexibly decide between two possible meanings – the literal and the intended one. Because ToM (at least the indirect measure) was also found to be independent predictor of Simple Irony understanding in six- to eight-year-olds in the Experiment 1, in the current study I also included a ToM measure to test whether mentalising plays an important role in Complex Irony interpretation in 11-12-year-old children.

Finally, in the current study, I also explore the role of *specific* world knowledge, that is the knowledge about the state of the world strictly related to the presented ironic scenarios. In the previous study I used a standardised measure of the real world knowledge – WISC Information sub-test (Wechsler, 2003), which is potentially problematic as children were asked general questions about the world, such as '*What causes iron to rust?'*. Therefore, this measure did not actually assess children's

knowledge crucial for interpreting these particular ironic remarks, as the WISC general knowledge questions do not contain information relevant for the vignettes presented in my Irony Task. In the current study, I therefore developed a new measure of the *specific* world knowledge required, assuming that, for instance, the listener's knowledge that the Queen does not invite regular people to the parties might in fact determine how the following exchange (1) will be interpreted by older children.

(1) *Speaker A: I have been invited to the party by the most beautiful girl in my class.*

Speaker B: *Yeah, and I have been invited to the Queen's party.*

The design of the Experiment 2 was similar to the Experiment 1 with some changes made to several measures. Firstly, I presented our participants with seven Complex Irony vignettes instead of five (see section 2.3.2. for details); Simple Ironies were not included in this study as it was assumed that this age group would be at ceiling on Simple Irony (see e.g. Demorest, Meyer, Phelps, Gardner & Winner, 1984; Pexman & Glenwright, 2007). I also replaced the measure of second-order ToM – Strange Stories (Happé, 1994) – with the ToM Animated Sequences (Abell, Happé, & Frith, 2000) which has been shown to tap mental states attribution (Klein, Zwickel, Prinz, & Frith, 2009). Several neuroimaging studies have demonstrated that the brain regions activated when neurotypical adults watch the ToM animations are the same as regions typically activated during the mindreading (see Castelli, Happé, Frith, & Frith, 2000; Castelli, Frith, Happé, & Frith, 2002).

Given the results from the previous chapter it was hypothesised that both Theory of Mind and cognitive flexibility will predict understanding of Complex Irony in older children (11-12-year-olds) after controlling for structural language and non-verbal reasoning. Similarly to the pattern found for younger children, I predict that the

mentalising skills will be necessary for interpretation of the intended ironic meaning. Moreover, it is assumed that cognitive flexibility will be an independent predictor of irony understanding in 11-12-year-olds. It is also predicted that the specific world knowledge relating to the presented irony scenarios might play important role in the performance on the Irony Task.

## 3.2. Method

**3.2.1. Participants.** As children in the Experiment 1 were at floor in their interpretation of Complex Irony, in this Experiment 2 a total of 98 neurotypical monolingual English-speaking 11- and 12-year-olds were tested: 45 boys and 54 girls [$M_{age}$ (*SD*): 143.46 (6.65) months; range: 122-156 months]. Seventy-eight children were recruited through schools in Kent and twenty children were recruited through the parent database held by the Kent Child Development Unit. Thirteen children were excluded from the analyses: two participants due to the diagnosis of ADHD or dyslexia; nine children who failed the attention check; any child who scored more than 4 *SD* above or below the mean on any measure ($N$ = 1); and one child due to the experimenter error. Thus, 85 children were included in the final sample ($M_{age}$ = 143 months, *SD* = 6.39; range 122-156 months). All participants were assessed on their non-verbal reasoning using the Matrix Reasoning sub-test of the Wechsler Abbreviated Scale of Intelligence **(**WASI, Wechsler, 2011) and all scored within the typically-developing range[5] ($M_{T\text{-}score}$ = 45.6, *SD* = 7.53, range = 25-62). To assess Structural Language, the Vocabulary[6] sub-test of the WASI was administered and again all children scored in the typically-developing range ($M_{T\text{-}score}$ = 45.34, *SD* = 6.79, range = 29-61).

[5] One participant obtained t-score of 25 for non-verbal IQ.
[6] Nine participants' WASI Vocabulary data was excluded due to the experimenter error; the administration was stopped before the ceiling was established.

**3.2.2. Materials and Procedures**. The current study followed a similar structure to the study in the previous chapter, with a few tasks being excluded, replaced, or modified (as outlined below). The participants were tested individually in the lab or in a quiet area at school. If a child was tested in the KCDU lab, and expressed the wish, their parent could be present in the testing room. It is important to note that the child could not follow the parent's eye gaze as the parent either could not see the testing computer screen or sat behind the child. All of the tasks were presented on a computer screen and the whole session was audio-recorded. The following tasks were always carried out in the same order as listed below.

***Irony Task.*** The structure of this computer task was similar to the original design from the previous study. Participants were presented with two practice and twelve test videos, five of which finished with literal statements and seven of which finished with ironic utterances. The practice, literal videos and four out of seven irony videos were the same as for the study in the previous chapter. Three new items were developed for Experiment 2: one of the original Complex Irony items (Item (4) in Complex Irony; see Appendix A) was replaced in order to avoid potential critiques from some researchers (e.g., Wilson, 2017) that this is not a prototypical form of irony; two Complex Irony videos were added for a greater variance in the scale (see Table 12 below for all items). The selection of three new stimuli videos followed the same procedure as for Experiment 1; that is, I selected the three items that had the highest mean complexity based on the ratings of 38 undergraduate Psychology students (reported in the previous chapter). Any items that would have been impossible to film was replaced with the next item with the highest complexity mean.

Table 12

*All Items and Possible Responses – Experiment 2*

| Vignettes | Possible Responses |
|---|---|
| *Vignettes taken from the Experiment 1* | |
| 1. Sally: *Could you wash my plate?* Tom: *Do you want me to tidy your room, too?* | A. I definitely will not help you with washing up.<br>B. I like taking care of my little sister.<br>C. I feel sorry for you so I will help you. |
| 2. Tom: *I have been invited to a party by the most beautiful girl in my class.* Sally: *Yeah, and I have been invited to the Queen's party.* | A. I think that the Queen's party would be more interesting.<br>B. I don't believe that you were invited to that girl's party.<br>C. I don't want to talk about that beautiful girl's party. |
| 3. Sally: *Do you think I should package up the phone before posting it?* Tom: *No, just put a stamp on it and pop it into the post.* | A. Of course you need to package it up before posting.<br>B. This phone does not need to be packed before posting.<br>C. I am surprised that you want to package the phone. |
| 4. Tom: *Can you help me cook the dinner? I'm tired.* Sally: *Oh yes, because I have just been sitting around doing nothing at school today.* | A. I'm cross because you do not understand what a bad day I have had.<br>B. I'm actually saying 'no' because I am too tired to cook with you.<br>C. I will help you to make the dinner because I'm really bored. |
| *New vignettes:* | |
| 5. Matt and Emma are in the bathroom. Matt: *Before you brush your teeth, you have to put toothpaste on your toothbrush*. Emma: *No way! Really?* | A. I think that everyone knows what you are telling me about brushing teeth.<br>B. I didn't know that I should put the toothpaste on the toothbrush first.<br>C. I am surprised that you know how to brush your teeth. |
| 6. Matt and Emma are going to the cinema. They are late because Emma is getting ready very slowly Matt*: Don't worry, Emma. Take your time.* | A. I am a bit annoyed that you are not ready yet.<br>B. It's fine that you're slow- we have got plenty of time.<br>C. I am happy that the film starts so early. |
| 7. Matt: *Would you like me to hold the umbrella over you?* Emma: *No, I really like getting wet.* | A. I am upset that you brought an umbrella with you.<br>B. No, I don't want the umbrella because I want to get wet.<br>C. Of course I want the umbrella so I think your question is stupid. |

Each video was a two to three-line dialogue, ending with either literal or ironic utterance said by one of the speakers. All of the ironic statements were instances of Complex ironic criticism (see section 2.3.2. for the distinction between Complex and Simple Ironies). The counterbalancing of the scripts' order and the target answers was the same as for the previous study. Following data exclusions, 32.9% participants were tested using counterbalancing list order one; 36.5% using list order two and 30.6% using list order three.

Three of the final (target) utterances were uttered by the male and four by the female speaker. The means of ensuring neutral intonation were the same as for the previous study.

The experiment was presented on a computer, using *PsychoPy* software (Peirce, 2007). At first, each participant was presented with the instructions and watched the same two practice videos as for Experiment 1. The procedure of running this task was almost the same as described in the Experiment 1. The only difference from the original design was the lack of open-ended questions. These were excluded as the children performed worse in the previous study on open-ended questions than on forced-choice questions. Furthermore, the decision of dropping the open-ended questions was also due to the fact that the coding criteria and the scoring of free answers was not so straightforward. The order of the videos was pseudo-random – there were no more than two consecutive ironic videos presented to the participant. Following the main Irony Task, the subsequent tasks were administered:

***Vocabulary sub-test of Wechsler Abbreviated Scale of Intelligence – Second Edition.*** This WASI – II (Wechsler, 2011) Vocabulary sub-test is used to measure the word knowledge and verbal concept formation. The reason for choosing a different vocabulary measure to the one used in the previous study is due to the age range for which each vocabulary test is standardised. In this test, the child's task is to define each word presented on the computer screen (The instruction was 'Now I'm going to say some words. Tell me what each word means'). For all testing items, the child's verbal response could obtain the

score of either 0, 1, or 2. The administration is stopped after three consecutive scores of 0. However, all verbal responses were audio-recorded and were then rescored offline in close consultation with the manual. Raw scores were converted to standardised scores prior to statistical analyses (for details, see Wechsler, 2011).

***Wisconsin Card Sorting Test.*** The administration of the task measuring Cognitive Flexibility (WCST; Grant & Berg, 1948) was the same as for the study in the previous chapter.

***Matrix Reasoning sub-test of Wechsler Abbreviated Scale of Intelligence – Second Edition.*** To test children's non-verbal intelligence, the Matrix Reasoning subtest of WASI – II (Wechsler, 2011) was administered. The decision of choosing a different non-verbal reasoning measure than the BAS version used in the previous study was due to the age range for which this test is standardised. However, the WASI Matrix Reasoning sub-test is very similar to the BAS 'Matrices' sub-test. In the WASI version, the child's task is to select the response option that completes the matrix or series. Test administration is stopped after 3 consecutive scores of 0. The maximum score was 30, as per the manual. Raw scores were converted to standardised scores prior to statistical analyses (for details, see Wechsler, 2011).

***Theory of Mind.*** Instead of Strange Stories (Happé, 1994), which showed relatively low internal consistency (see section 2.3.2. for details), the ToM animated sequences (Abell et al., 2000), known as Frith-Happé 'Animations' (here: ToM Animations), were administered to test children's mentalising skills.

In ToM Animations, the participants were presented with 1 practice and 4 test videos on the computer. These videos showed one big red triangle and one small blue triangle moving around the screen. In the sequences, the triangles always interact with each other with one character reacting to the other character's mental state. The videos presented to the children included the following actions: surprising, coaxing, mocking and seducing. To familiarize the participants with the task, the practice video was presented three times. During the first screening, the child was asked to watch the video passively; during the

second screening they were asked to describe what was happening in the video; the third screening was the experimenter's feedback on the child's response. In the test phase each of the four videos were presented twice; the feedback part was not present during the test phase. All participants saw the videos in the following order: Seducing, Coaxing, Surprising, and Mocking. The responses were audio recorded, transcribed and then scored. The children could score 0, 1, or 2 based on the degree to which the intended meaning of the animation was accurately captured (the score of 1 was given for partially correct descriptions) accordingly to the scoring criteria from the original paper (Abell et al., 2000). The example responses and their scores are presented in the table below:

Table 13

*The Scoring Criteria from Abell et al. (2000) with the Example Responses to the Coaxing Video*

| Response | Scoring criteria | Given score |
|---|---|---|
| *The red triangle is trying to get out – he's stuck and he's trying to find a way out. The blue triangle comes and like knocks on the door, then runs away. So he's, like, trying to trick him. So the red one comes up to see who it was and no one's there. The blue triangle pushes the gate back so he can't get out, and then just knocks on it again and runs away again. Red opened it again to see if there's someone there – no one is. And then he, like, scares him, and then the gate shuts on him and then they're both trapped in there. And then they just start, like, pushing against each other.* | Any mention of boy tricking, surprising his grandma; hiding, hide and seek | **2** |
| *So he's inside of the box, the house, then the blue one comes along, sees him inside, wants to get in. So he tries going round seeing a way in. But then he comes out because he heard a knock, and then he's like 'oh, noone there, let's go back in'. So, the blue one knocks again and then goes back round the corner. He opens the door, looks round to see who it is. Then he sneaks in while to door's still open, and they dance and spin around.* | Description which gives part of the story but **misses the critical point** (see above) | **1** |
| *I think maybe it could be a teacher, the blue one's the teacher and the red one's a child and the child's been naughty so it's been like sent to the head teacher's office so he has to wait in there and where he's like leaning over, he tries to see where the teacher is and then so he, the teacher keeps shutting the door on him so he don't get out and then so he thinks he's shut the door and he's trying to push out again thinking the teacher's gone this time, he* | Description which gives only minor part of action e.g., knocking on the door, or **does not relate to any of** | **0** |

| | |
|---|---|
| *doesn't so then the door shuts with the teacher in there, so then they're sitting down there and like talking about what he's done.* | **the events** in the sequence. |

The main researcher scored all the responses to the ToM Animations. To obtain inter-rater reliability, an independent rater blind to the other rater's scores scored the performance of 10 participants (12% of included children). The Intra-class Correlation Coefficient (ICC) estimates and their 95% confident intervals that were calculated based on mean-rating, absolute-agreement, 2-way mixed-effects model. The average measure ICC was .921 with a 95% confidence interval from .856 to .958 ($F(39,39) = 23.775$, $p < .001$); hence, the level of inter-rater reliability should be regarded as "excellent".

***Knowledge Questions.*** As the final task, the children were asked seven questions that tested their background knowledge relevant for the ironic videos presented at the beginning of the session (e.g., '*Do most people get invited to the Queen's parties?*'). We assumed that in order for a child to understand that the Speaker's A utterance is ironic (see the example below), the child needs to know that the Queen does not invite regular people to the parties:

Speaker A: *I have been invited to the party by the most beautiful girl I my class.*

Speaker B [ironist]: *Yeah, and I have been invited to the Queen's party.*

The participant's responses were recorded, transcribed and scored by the experimenter. The children could obtain 1 point for the correct answer and 0 for the incorrect one. In two vignettes the score of 0.5 was also given for partially correct responses, in which the child provided an explanation as to why they think it is not a problem to be late for the cinema or why brothers might like helping their sisters to wash the dishes (e.g., '*there are 30min adverts at the beginning anyway/it's not the end*

*of the world if you are late to the cinema and miss some part of the movie/you might not like the movie anyway*). See Table 14 below for the list of questions and correct responses.

Table 14

*Knowledge Questions and Scoring Criteria*

| | Question | Correct response |
|---|---|---|
| 1. | Do you think that most people would know that you need to put toothpaste on a toothbrush before brushing your teeth? | Yes |
| 2. | Is it a problem to be late for the cinema? | Yes |
| 3. | Do people usually like getting wet in the rain? | No |
| 4. | Do you think that brothers like washing up after their sisters and tidying up their rooms? | No |
| 5. | Do most people get invited to the Queen's parties? | No |
| 6. | Do you need to package a phone before putting it into the post? | Yes |
| 7. | Is someone who spent the whole day at school probably tired? | Yes |

## 3.3. Results

### 3.3.1. Preliminary analyses: Relationship between irony understanding, control variables and the specific world knowledge

***3.3.1.1. Relationship between irony understanding and control variables.*** The participants responded correctly on average 54% of the time in the Irony Task with the highest score being 7 and the lowest – 0. A series of correlational analyses was carried out to investigate the relationship between the participants' proportions of correct responses in the Irony Task[7] and the control variables – Age, Structural Language and Non-Verbal Reasoning. To investigate the relationship between the irony understanding

[7] Irony proportion of correct responses was included because of the technical problems with one irony item ['package the phone'] for 6 participants, therefore this item's score was excluded for those participants.

and control variables, Spearman's correlations were run as the accuracy scores on Irony Task were significantly different from a normal distribution ($D(84)$, $p < .001$). The proportion of correct responses obtained in Irony Task was related to non-verbal reasoning (T-score) ($r_s(83) = .33$, $p < .01$) and Structural Language ($r_s$ (74) = .41, $p < .001$). No correlation was found between irony understanding and Age of participants ($r_s(83) = .16$, $p = .14$). Therefore, we did not control for Age in further analyses.

***3.3.1.2. Relationship between irony understanding and the specific world knowledge.*** In order to investigate whether having specific knowledge plays a role in understanding irony, a cross-tabulation analysis was conducted to examine the relationship between specific Knowledge Questions items (e.g., '*Do most people get invited to the Queen's parties?*') and performance on the corresponding items in the Irony Task (e.g., here: Item 2 in Table 12.). Children's scores on seven Knowledge Questions items (0, 0.5, or 1) and their score on seven Irony items (0 or 1) were entered into the cross-tabulation analysis, conflating across children and condition.

The results of the cross tabulation analysis revealed that the chi square test of independence was significant: $X^2(2,584) = 6.215$, $p = .045$, which means that having relevant Specific Knowledge does in fact play a role in children's performance on the Irony Task. However, it is important to note that the vast majority of Knowledge Questions were responded to correctly (514 out of 584 responses). In addition, on a substantial number of occasions, the child passed the Knowledge Question but nonetheless did not pass the corresponding item in the Irony Task (220 out of 514 responses). For instance, the children, who responded correctly ('*No*') to the question '*Do most people get invited to the Queen's parties?'*, were still in very many cases unable to decode the irony behind the statement of disbelief ('*Yeah, and I have been invited to the Queen's party'*) as a response to the information that the interlocutor was invited to

the beautiful girl's party. This means that some other factors (besides specific world knowledge) play important role in irony interpretation.

Table 15

*Cross-Tabulation of Knowledge Question (KQ) Score and Irony Task Score*

| | | | Irony score 0 (incorrect) | 1 (correct) | Total |
|---|---|---|---|---|---|
| KQ score | 0 (incorrect) | Count | 25 | 15 | 40 |
| | | % within KQ score | 62.5% | 37.5% | 100% |
| | 0.5 (partially correct) | Count | 15 | 15 | 30 |
| | | % within KQ score | 50% | 50% | 100% |
| | 1 (correct) | Count | 220 | 294 | 514 |
| | | % within KQ score | 42.8% | 57.2% | 100% |
| Total | | Count | 260 | 324 | 584 |
| | | % within KQ score | 44.5% | 55.5% | 100% |

**3.3.2. The relationship between Irony Interpretation, Cognitive Flexibility, and Theory of Mind.** In order to explore the association between the responses to the Irony Task, Cognitive Flexibility, and Theory of Mind, Spearman's correlations were performed. The results are shown in Table 16.

Table 16

*Correlation Coefficients between Proportion of Correct Responses in Irony Task, Cognitive Flexibility, and ToM*

| Variable | 1. | 2. | 3. |
|---|---|---|---|
| 1. Irony (proportion of correct responses) | – | | |
| 2. ToM Animations (total score) | .22* | – | |
| 3. WCST (number of perseverative errors) | -.36** | -.37** | – |

*Notes.* *$p < .05$; ** $p < .01$; Participants that did not receive the feedback phase correctly were excluded from the analysis.

For the Theory of Mind measure, fourteen participants did not receive the feedback phase correctly (i.e. the practice video was played twice not trice). Therefore, the correlation analyses were run both ways, i.e. including these participants and excluding them. There was a significant negative correlation between irony interpretation and Cognitive Flexibility (number of perseverative errors in WCST), $r_s = -.357$, $p < .01$. The correlation between irony understanding and ToM measure was marginally significant regardless of whether we included [$r_s\,(79) = .21$, $p = .07$] or excluded [$r_s\,(65) = .22$, $p = .08$] the participants who have not received the feedback phase correctly. After controlling for vocabulary and non-verbal reasoning (T-scores) the relationship between irony comprehension and Cognitive Flexibility remained significant, $r_s = -.31$, $p = .02$. However, the correlation between irony and ToM was no longer significant after controlling for vocabulary and non-verbal reasoning, $r_s\,(67) = .16$, $p = .19$ and $r_s\,(55) = .16$, $p = .22$. The descriptive statistics for the predictors of theoretical interest are shown in Table 17 below.

Table 17

*Descriptive Statistics for Experiment 2*

| | WASI Matrices T score | WASI Vocab T score | Irony proportion correct | Theory of Mind Animations | Specific Knowledge (out of 7) | WCST N pers. errors |
|---|---|---|---|---|---|---|
| Mean | 45.87 | 45.39 | .54 | 5.14 | 6.35 | 7.04 |
| SD | 7.44 | 6.76 | .31 | 1.91 | 0.59 | 6.16 |
| Min | 25 | 29 | 0.00 | 0 | 4.5 | 1 |
| Max | 62 | 61 | 1.00 | 8 | 7 | 49 |
| N | 77 | 77 | 77 | 74 | 76 | 76 |

**3.3.3. Cognitive skills contributing to irony interpretation.** Finally, in order to investigate the impact of Cognitive Flexibility on irony interpretation, the hierarchical regression analysis was computed using the proportion of correct responses in Irony Task as the outcome variable. Preliminary analyses were performed to check whether there was any violation of assumption of multivariate normality, linearity, multicollinearity and homoscedasticity; all assumptions were met.

In the regression analysis, the control measures of Non-Verbal Reasoning (WASI Matrix Reasoning) and Structural Language (WASI Vocabulary) were entered in Step 1, followed by WCST (Cognitive Flexibility) in Step 2. The measure of Theory of Mind was not included in this particular regression analysis as this variable did not correlate with irony when controlling for formal language or non-verbal reasoning (see section 3.3.2 above).

The hierarchical multiple regression showed that at Step one, after entering WASI Matrix Reasoning and WASI Vocabulary, scores contributed significantly to the regression model, $F(2,72) = 11.00$, $p < .001$ and accounted for 23 percent of the variance in irony comprehension. Introducing WCST (Cognitive Flexibility measure) explained an additional 7 percent of variance in irony comprehension and this contribution was significant to the model, $\Delta R^2 = .07$, $F(1, 71) = 6.76$, $p = .01$. Hence, the primary hypothesis was partially confirmed with the Cognitive Flexibility being an independent predictor of irony understanding even when all the control variables are entered in the first step (non-verbal reasoning and vocabulary). The regression statistics are presented in Table 18.

Table 18

*Summary of Hierarchical Regression Analysis for Variables Predicting Irony Interpretation*

| Predictor | β | *t* | *p* | $sr^2$ |
|---|---|---|---|---|
| Step one: $R^2 = .23$, $p < .001$ | | | | |
| Non-Verbal Reasoning | .30 | 2.74 | .01 | .08 |
| Structural Language | .29 | 2.62 | .01 | .07 |
| Step two: $\Delta R^2 = .07$, $p = .01$ | | | | |
| Non-Verbal Reasoning | .24 | 2.20 | .03 | .05 |
| Structural Language | .24 | 2.27 | .03 | .05 |
| Cognitive Flexibility | -.27 | -2.60 | .01 | .07 |

*Note.* $N = 75$.

**3.3.4. Cognitive flexibility contributing to irony interpretation when specific knowledge is included in the analysis.** As the results of the cross tabulation analysis revealed that having the relevant Specific Knowledge does in fact determine children's performance on the Irony Task, I then included the Specific Knowledge measure (total score – 7) in the regression analyses to check whether the Cognitive Flexibility still holds as an independent predictor of irony comprehension even when Specific Knowledge measure is included. In contrast to section 3.3.1.2., the Specific Knowledge score was here conflated over items and not over children.

Similarly to what was done in the previous regression analysis, the control measures of Non-Verbal Reasoning (WASI Matrix Reasoning) and Structural Language (WASI Vocabulary) were entered in Step 1, followed by Specific Knowledge measure and WCST (Cognitive Flexibility) in Step 2.

The hierarchical multiple regression showed that at Step one, after entering WASI Matrix Reasoning and WASI Vocabulary scores contributed significantly to the regression model, $F(2,71) = 10.772$, $p < .001$ and accounted for 23 percent of the variance in irony comprehension. Introducing the Specific Knowledge and WCST (Cognitive Flexibility measure) in the Step 2, explained additional 11 percent of variance in irony comprehension and this contribution was significant to the model, $\Delta R^2 = .11$, $F(2, 69) = 5.332$, $p = .007$. Hence, we can conclude that Cognitive Flexibility is the independent predictor of irony understanding not only when all the control variables are entered in the first step (Non-Verbal Reasoning and Vocabulary) but also when the Specific Knowledge measure is included in the model. These regression statistics are presented in Table 19.

Table 19

*Summary of Hierarchical Regression Analysis for Variables Predicting Irony Interpretation when Specific Knowledge Measure is Included*

| Predictor | β | *t* | *p* | $sr^2$ |
|---|---|---|---|---|
| Step one: $R^2 = .23$, $p < .001$ | | | | |
| Non-verbal Reasoning | .30 | 2.72 | .01 | .08 |
| Structural Language | .29 | 2.60 | .01 | .07 |
| Step two: $\Delta R^2 = .11$, $p = .007$ | | | | |
| Non-verbal Reasoning | .24 | 2.19 | .03 | .05 |
| Structural Language | .19 | 1.72 | .09 | .03 |
| Specific Knowledge | .20 | 1.94 | .06 | .04 |
| Cognitive Flexibility | -.29 | -2.80 | .01 | .08 |

*Note.* $N = 75$.

**3.3.5. Clarifying the relative contributions of Cognitive Flexibility and Theory of Mind to Complex Irony interpretation.** In section 3.3.2, it was established that the Theory of Mind measure (Animations) did not correlate with Complex Irony interpretation, when controlling for either Non-Verbal Reasoning or Structural Language. Nonetheless, an

additional regression analysis was ran in order to make sure that Cognitive Flexibility is still an independent predictor of Complex Irony comprehension even when all theoretically interesting predictors, i.e., Specific Knowledge and Theory of Mind, are included.

The hierarchical multiple regression showed that at Step one, after entering Non-Verbal Reasoning and Structural Language scores contributed significantly to the regression model, $F(2,71) = 10.319$, $p < .001$ and accounted for 23 percent of the variance in irony comprehension.

Entering the Theory of Mind, Specific Knowledge and WCST (Cognitive Flexibility measure) in the Step 2, explained additional 10 percent of variance in irony comprehension and this contribution was significant to the model, $\Delta R^2 = .10$, $F(5, 71) = 6.425$, $p = .03$. In this second step, only cognitive flexibility and non-verbal reasoning had a significant effect on the model. Hence, even when all theoretically important variables are included in the model, Cognitive Flexibility still holds as the only independent predictor of irony understanding. The regression statistics are presented in Table 20.

Table 20

*Summary of Hierarchical Regression Analysis for Variables Predicting Irony Interpretation when ToM, Cognitive Flexibility and Specific Knowledge are Included*

| Predictor | β | *t* | *p* | $sr^2$ |
|---|---|---|---|---|
| Step one: $R^2 = .23$, $p < .001$ | | | | |
| Non-verbal Reasoning | .3 | 2.72 | .01 | .08 |
| Structural Language | .3 | 2.66 | .01 | .08 |
| Step two: $\Delta R^2 = .10$, $p = .03$ | | | | |
| Non-verbal Reasoning | .24 | 2.19 | .03 | .05 |
| Structural Language | .21 | 1.92 | .06 | .04 |
| Theory of Mind | .11 | 1.03 | .31 | .01 |
| Specific Knowledge | .18 | 1.68 | .10 | .03 |
| Cognitive Flexibility | -.23 | -2.07 | .04 | .04 |

*Note.* $N = 75$.

### 3.4. Discussion

The main aim of the current study was to further explore the developmental trajectories of understanding more complex forms of irony. Furthermore, I investigated which cognitive mechanism may underpin the ability to interpret the intended meaning behind the ironic statements in children aged 11-12-year-old. To be more specific – I looked at the role of Theory of Mind and cognitive flexibility as those two factors were independent predictors of Simple Irony comprehension for younger children (six- to eight-year-olds) as described in the previous chapter.

Contrary to the predictions, mentalising did not relate to Complex Irony understanding in 11-12-year-old children. After controlling for vocabulary and non-verbal reasoning, the correlation between the ToM measure (Animations) and Complex Irony did not reach significance. These results are not in keeping with the findings of Filippova and Astington (2008), who found a strong positive correlation between Simple Irony and ToM in children aged five, seven, and nine, even when age, memory, and structural language were taken into account. However, other studies that looked at irony comprehension and ToM skills in children found mixed results but they did not control for relevant covariates, such as structural language abilities (e.g., Angeleri & Airenti; 2014; Massaro et al., 2014). These inconsistent results might be due to a lack of consensus as to the mentalising measures used in the literature. In the previous chapter I found that mentalising skills measured using a parental questionnaire accounted for unique variance in Simple Irony comprehension (not tested in the current Experiment 2) in younger children. However, I simultaneously found that the direct measure – Strange Stories (Happé, 1994; White et al., 2009) – was not related to irony understanding in this age group. In the current study, I used ToM Animations (Abell et al., 2000), which taps slightly different mentalising skills, namely the ability to attribute the mental states and

intentions behind the movements of the triangles with video scripts suggesting mocking, surprising, seducing and coaxing. Furthermore, although a number of studies investigating Theory of Mind beyond early childhood is growing (for review, see Miller, 2009), the evidence that experimental task performance is related to real-life social experiences and competences is sparse (Bosacki & Astington, 1999; Devine & Hughes, 2013). To my knowledge, the current study is the first to look at the relationship between ToM skills and Complex Irony understanding in typically-developing 11-12-year-old children.

As predicted, having the specific world knowledge did in fact play an important role in Complex Irony interpretation by children. That is, children who passed the specific knowledge question were more likely to pass the corresponding irony item in the Irony Task. However, most of the children passed Knowledge Questions (514 out of 584 responses) and 43 percent of those children failed the corresponding item in the Irony Task (220 out of 514 responses). Therefore, this suggests that perhaps there must be other factors contributing to irony interpretation.

One of these factors that potentially could play a role in irony interpretation in children is cognitive flexibility. In the current study, there was a clear association found between the cognitive flexibility and irony comprehension is 11-12-year-old children. The regression analysis revealed that cognitive flexibility was an independent predictor of irony and uniquely explained 7% of the variance in irony comprehension even when vocabulary and non-verbal IQ were controlled for. More importantly, the additional analyses showed that cognitive flexibility was still an independent predictor (explaining 8% of variance) even when Specific Knowledge was also entered in the regression. Furthermore, in an additional regression analysis, cognitive flexibility held as the only independent predictor of irony understanding when both Specific Knowledge and Theory

of Mind were included. Cognitive flexibility might be crucial for interpreting irony because one has to potentially flexibly switch between the speaker's and one's own perspective and also possibly to flexibly decide between a literal versus an ironic interpretation of the utterance. The current study was the first to ever to investigate whether this component of EF is related to irony interpretation.

Nonetheless, one of the limiting features of the current study is the use of an individual differences design which makes it impossible to infer the direction of causality and to eliminate other variables potentially related to irony interpretation in children. Although our well-controlled study was the first one ever to demonstrate the role of cognitive flexibility in understanding irony, one study is not enough to safely conclude that these two are related. To gain a better understanding of the developmental trajectories of irony comprehension in school-aged children and its cognitive underpinnings, a longitudinal or experimental research is needed.

# CHAPTER 4. USING SHARED KNOWLEDGE TO DETERMINE IRONIC INTENT; A CONVERSATIONAL RESPONSE PARADIGM

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## 4.1. Introduction

Once children reach school age, the domain of language in which development is most obvious is that of pragmatics, which is the ability to take context and knowledge about specific conversation partners into account in order to use and interpret language appropriately (e.g., Airenti, 2017). One aspect of pragmatic competence is the ability to interpret non-literal language such as verbal irony, which is where a speaker's communicative intent does not align with the literal meaning of the utterance (e.g., Dynel, 2019). The current study is concerned with prototypical forms of verbal irony where the speaker intends the opposite of the utterance's literal meaning. For example, where a speaker says '*That was a great shot*!' on seeing a footballer completely miss the goal.

From a very early age, children hear verbal irony from their parents (e.g., Banasik-Jemielniak, 2019; Recchia et al., 2010) and during the school years they are increasingly exposed to verbal irony in children's books and films (Dews & Winner, 1999). Mastery of irony is important in the longer term for social relationships since irony is often used to soften insults (e.g., Dews et al., 1995) and becomes increasingly integral for the banter and insults used by adolescents to maintain social relations with their peers (e.g., Aijmer, 2019).

The degree to which a listener can easily determine whether an utterance is intended ironically depends on a number of factors, some of which can be learnt based on language experience and some of which concern the listener's own cognitive and socio-cognitive abilities. Regarding the role of previous exposure to irony, clearly the frequency with which communities use irony varies cross-culturally (see e.g., Banasik-Jemielniak & Bokus, 2019, for a discussion). In addition, both adults and children take into account factors such as the speaker-addressee relationship (e.g., Whalen, Doyle, & Pexman, 2020) and speaker occupation (e.g., Katz & Pexman, 1997), indicating that they draw on their past exposure to irony to consider the likelihood that a speaker intended an utterance ironically. Indeed, certain utterances (e.g., '*Smart move!*') may be more likely to be interpreted ironically than literally; that is, their ironic intent has become a conventionalised meaning component of that particular word combination (e.g., Burnett, 2015). Even the cue of prosody or 'ironic tone of voice' could potentially be learned on the basis of experience with the input.

In the current study, our focus is instead on those cognitive and socio-cognitive abilities at the level of the individual child, which are highly likely to be implicated in the child's ability to correctly determine if an utterance is intended ironically or literally when additional scaffolding from prosody or conventionality is removed. These cognitive and socio-cognitive abilities have been much discussed as potential causes of difficulties in atypical populations regarding their ability to interpret irony (e.g., Adachi et al., 2004; Caillies et al., 2014). What has received less attention is the potentially important role that these socio-cognitive and cognitive skills may play in the large range of individual differences in irony interpretation ability within *typically-developing* children from the same community (e.g., Zajaczkowska & Abbot-Smith, 2019).

One likely socio-cognitive underpinning of irony interpretation, which has received much attention in the irony acquisition literature to date, is that of mentalising – often termed 'Theory of Mind' (see Filippova, 2014, for a review). Mentalising refers to an individual's ability to understand that others may have desires, knowledge and beliefs which differ from one's own (e.g., Harris, 1992). Traditionally, the method of choice for assessing mentalising has been tests of false belief understanding. Indeed, many studies have found that irony interpretation in children is related to their performance on these types of false belief understanding and related tasks (e.g., Banasik, 2013; Filippova & Astington, 2008; Nilsen, Glenwright, & Huyder, 2011).

However, there are a number of problems which make it difficult to draw firm conclusions from this literature about the role of mentalising in irony interpretation. First, there are a few studies which did not find significant relationships between measures of mentalising and irony interpretation (e.g., Massaro et al., 2014; Zajaczkowska & Abbot-Smith, 2019). Second, many of these studies did not statistically control for core language skills (such as vocabulary), which is well-known to be related to mentalising (e.g., Milligan, Astington, & Dack, 2007) and also to irony interpretation (e.g., Filippova & Astington, 2008; Nilsen et al., 2011; Massaro et al., 2014). Third, arguably the key aspect of mentalising that an individual needs to successfully interpret irony is not false belief understanding but rather an understanding of whether a listener has access to the same knowledge as the speaker. For example, if a speaker says '*That was a great shot*', to interpret whether this is meant ironically, one needs to consider if the speaker saw the footballer score vs. wildly miss the goal. If one is judging whether a third party would interpret the speaker's utterance ironically or not, one needs to know whether this third party listener saw that the speaker saw this. This aspect of mentalising is referred to in

the literature as 'Knowledge-Access' (Pillow, 1989) – and specifically visual knowledge access (see Moll & Kadipasaoglu, 2013, for a discussion).

A relatively underexplored potential cognitive underpinning of irony interpretation is executive functioning, which encompasses the higher order cognitive functions required for cognitive control (Diamond, 2013b). There are numerous findings demonstrating the role of executive functioning in pragmatic language processing by adults (e.g., De Neys & Schaeken, 2007; Dieussaert, Verkerk, Gillard, & Schaeken, 2011; Nieuwland, Ditman, & Kuperberg, 2010; Xiang, Grove, & Giannakidou, 2013). The same is true of certain aspects of pragmatic language usage by children (see Matthews, Biney, & Abbot-Smith, 2018, for a review). In relation to irony, however, only two previous studies have examined the role of executive functioning (Caillies et al., 2014; Filippova & Astington, 2008). Both were correlational and investigated relationships with working memory (and in one case inhibitory control). Further, nobody has investigated whether mental set switching[8] – the ability to switch flexibly between different approaches to the same task – is related to irony interpretation. There are two plausible ways in which mental set switching could work as an important mechanism when interpreting irony in two ways. First, it is well-established that mental set switching is related to the development of mentalising – or at least of first order Theory of Mind (e.g., Kloo & Perner, 2003). Thus, the role of mental set switching may be partially indirect. In addition, mental set switching may also play a direct role in irony interpretation because one has to potentially switch between the speaker's and one's own perspective and also possibly to switch between a literal versus an ironic interpretation of the utterance.

There are also methodological challenges associated with determining which factors are important for children's developing skill with irony interpretation. One

[8] 'Set Switching' corresponds to 'Cognitive Flexibility' from the previous chapters

challenge is that previous studies investigating the role of socio-cognitive and / or cognitive abilities have almost exclusively relied on individual differences designs. A difficulty with individual differences designs is that there are usually numerous potential reasons why a particular measure (of executive functioning, to give one example) may or may not correlate with irony interpretation. Abilities which are not usually measured, such as non-verbal intelligence, may relate to both the particular measure and also the ease with which the child can handle task demands. Furthermore, while it is possible to statistically control for non-verbal intelligence, this variable tends to be so closely inter-related to other developmental variables that this process also removes the requisite variance needed to demonstrate the relationship of interest (see Jones et al., 2018, for discussion of this issue).

Therefore, in the current study we use an experimental design to investigate the role of two potential cognitive underpinnings of irony interpretation; a) mental set switching and b) mentalising. Our investigation of the role of mentalising focusses specifically on knowledge-access, i.e. the ability to take into account what other people know or do not know (and how this knowledge may differ between specific individuals). We call this variable Shared Knowledge. To manipulate this, we adapt a paradigm previously used by the only previous study to experimentally manipulate a proposed socio-cognitive or cognitive underpinning when investigating irony interpretation in children (Nilsen et al., 2011). In Nilsen et al.'s (2011) study, children were asked to judge whether a listener understood ironic intent, whereby the key variable manipulated whether the listener had (visual) access to the crucial information (e.g., when hearing 'that was a great shot!', whether the listener witnessed the goal). Eight- to ten-year-olds correctly differentiated the Shared Knowledge from the Non-Shared Knowledge condition by being more likely

to state that the listener would interpret the utterance as ironic in the Shared Knowledge condition. However, seven-year-olds did not distinguish these conditions in this manner.

This brings us to the second methodological challenge in the irony acquisition literature, which concerns the development of test questions, which are sufficiently easy for children to understand. Nilsen et al. (2011), for example, asked children four questions following each vignette, two of which related to speaker and listener knowledge. To assess the child's understanding of the speaker's knowledge, children were asked '*When [SPEAKER] said (a) did [SPEAKER] think that was good or bad?*'. This type of "explicit judgement" question is very frequently asked the field of child irony acquisition. To assess whether children utilised information about speaker-listener shared knowledge to interpret irony, Nilsen et al. (2011) also investigated children's understanding of the listener's knowledge by asking '*When [SPEAKER] said (a) did [LISTENER] think that was good or bad?'*. Questions asking for explicit judgements require a child to have an understanding of what she does or does not know, i.e. a certain level of meta-cognitive understanding. Importantly, a child does not need this level of explicit knowledge in order to understand and respond appropriately to the use of irony in conversation. Rather, what a child (or adult) needs to be able to do as a proficient pragmatic language user is to respond in an appropriate manner.

A handful of studies have utilised in addition to a judgement task a measure of irony interpretation by asking children to respond to an ironic comment (e.g., Glenwright & Agbayewa, 2012; Whalen & Pexman, 2010). For example, Whalen and Pexman (2010) presented children with vignettes and on hearing the speaker's ironic statement, the experimenter asked the child for example '*When I said "what a wonderful way to end the day", what would you like to say back to me?*'. Children's responses were coded as either agreement (e.g., 'Yeah'), disagreement, ambiguous, reconciling (e.g., 'Yeah, that

sandcastle looked good but it's terrible when that happens') or mode adoption, which is when a child used irony themselves to respond to the ironic statement. While this method has the advantage of being ecologically valid, generating a verbal response is potentially burdensome for children. Indeed, planning a response creates a greater cognitive load even in adults than does listening and interpreting the language of the conversation partner (e.g., Boiteau, Malone, Peters, & Almor, 2014) and can also create coding difficulties (e.g., Glenwright & Agbayewa, 2012). More problematically, it is generally the case that from a large proportion of spontaneous responses, it is not clear whether the participant interpreted the target utterance ironically or literally.

Therefore, for our main study we developed a new dependent variable, which we hoped would combine the simplicity of a binary forced choice measure with the advantages of assessing children's understanding of the type of conversational statement which can serve as an appropriate response to irony. After viewing and hearing each video-recorded vignette, children were asked how they thought the listener would respond to the ironic speaker. To manipulate the role of mentalising, we followed Nilsen et al.'s (2011) by comparing within-subjects whether the listener in a particular vignette shared the requisite knowledge to know that the speaker intended the statement to be ironic. To illustrate, for the vignette in which the speaker said 'That was a great shot!', in the Shared Knowledge condition, both the speaker and listener saw that the footballer had wildly missed the goal, whereas in the Non-Shared Knowledge condition, the listener had fallen asleep during that crucial moment of the football game. The novel element here concerned how children were asked to respond. That is, instead of using the aforementioned judgement task, we asked children to choose between an Irony-Consistent Response (e.g., for the missed-goal vignette '*I know! It's a pity that he missed!*') versus a Literal-Consistent Response (e.g., for the missed-goal vignette '*Was*

*it? So our team won?*'). We selected seven-year-olds specifically as we believed, against Nilsen et al.'s (2011) study findings, that children at this age should be able to take the listener's knowledge into account in order to determine whether an utterance is intended ironically or literally. We predicted that with our new dependent variable seven-year-olds would be significantly more likely to select an Irony-Consistent response in the Shared Knowledge than in the Non-Shared Knowledge condition. We also compared performance on this across three between-subjects conditions designed to manipulate the role of Set Switching. Here, we predicted that children who heard Shared Knowledge vignettes intermingled with Non-Shared Knowledge vignettes would find it harder (than children in 'blocked' conditions) to demonstrate their ability to take Shared Knowledge into account when interpreting irony, simply because of the increased switching load.

## 4.2. Pilot Study: Comparing our 'conversational response' DV with the traditional DV

It is of course possible that our new 'conversational response' dependent variable might – contrary to our predictions – be more taxing to working memory and language processing than are the meta-pragmatic judgement measures used in the literature on irony interpretation in children. That is, in our 'conversational response' dependent variable, the participant must track whether the speaker and listener shared visual access or not and then evaluate the speaker's statement as well as the two possible conversational responses. Therefore, in a pilot study we first compared within the same group of children (and for the same vignettes) performance on our conversational response dependent variable ('New' DV) against performance on a meta-pragmatic judgement measure ('Old' DV).

### 4.2.1. Participants

The first author tested 20 monolingual, British English-speaking children aged between 6;02 and 7;11 years individually in a quiet location. Six were tested in a separate room at their school and the remainder were tested in a university developmental lab in England.

### 4.2.2. Method for ironic vignettes

The experimenter enacted five vignettes using two puppets (King and Queen) and some small props. In each vignette, both the speaker and listener (for which we counterbalanced the assignment of the King vs. the Queen) shared the knowledge (through shared visual access) required to understand that the speaker's remark was intended ironically. For example, one vignette was adapted from Nilsen et al.'s (2011) 'football' vignette as follows.

> (1) The King and the Queen play for the same football team. They really want to win this match. The Queen kicks the ball, clearly missing the net. [Experimenter simultaneously enacts this with the two puppets, a ball and a small goal]. King: "That was a great shot". [Note that both the speaker and the listener could see the missed goal].

At the end of each vignette each child's understanding was assessed using two types of forced-choice question. (See Appendix D for the other pilot irony vignettes). One was our new 'conversational response' dependent variable (New DV), which the experimenter introduced by saying '*What would you then say, if you were LISTENER?*'.

(A) Conversational response (Correct / Irony-Consistent): *'Yeah, but you know that I'm trying my best'*.

(B) Conversational response (Incorrect / Literal Consistent): *'No, it wasn't actually a good shot'.*

The other was a 'meta-pragmatic judgement' dependent variable (Old DV), as in (C) and (D), which the experimenter introduced by saying, '*When CHARACTER says X, is s/he saying…..*'

(C) Old DV (Correct): *The king is not happy with how the queen kicked the ball.*

(D) Old DV (Incorrect): *The king is happy with how the queen kicked the ball.*

For each DV for each of the binary forced-choice options, the experimenter read each option aloud and also presented each option in a visual format. The two options for the 'Old DV' (e.g., ((C) and (D)) were read by the experimenter and accompanied by the pictures of a 'thumbs up' or 'thumbs down'. For the 'New DV' the two options were read by the experimenter accompanied by speech bubbles containing the two options written down. For each dependent variable, the child could either point at the correct visual depiction out of the two or could answer verbally (or both). For each DV for each vignette a correct response was scored as 1 (see options (A) and (C) above), whereas the incorrect choice was scored as zero (see options (B) and (D) above). There were five vignettes in total and thus each child could obtain an overall maximum score of five correct responses for each of the dependent variables. We counterbalanced both within and between subjects whether the 'conversational response' (New) DV was presented first or whether the 'old DV' was presented first.

### 4.2.3. Pilot Results

For each dependent variable we calculated (in contrast to the main study) whether the participants choose the correct versus the incorrect response (see (A) – (D) above). The mean response accuracy was numerically slightly higher for our 'New'

conversational response DV ($M$ = 3.05, $SD$ = 1.32) than for the 'Old' DV ($M$ = 2.8, $SD$ = 1.77). However, this difference was not statistically significant and the effect size was very small ($t(19) = -0.84$, $p = .41$, $d = 0.16$). Therefore, we can assume that our new conversational response DV is at least not more challenging for six- to seven-year-old children than is the meta-pragmatic judgement method used in previous studies. Moreover, performance on the two DVs was highly inter-correlated ($r(20) = .66$, $p = .002$), indicating that they assess essentially the same construct. We therefore decided to further explore the utility of our new measure.

#### 4.2.4. Method and Results for Pilot testing of Literal Control condition

For 13 out of our 20 pilot children, we also included the following two 'literal interpretation = correct" vignettes, the presentation of which was interspersed between the irony vignettes.

(2) The King and the Queen have a new member of their football team. King: "What do you think of the new boy?". Queen: "He is very kind. He gave me an apple yesterday".

Old DV: E said "When the queen says 'He is very kind. He gave me an apple yesterday', does she think that the new boy is very kind [shows 'thumbs-up' picture] or does she not think that the new boy is very nice [shows 'thumbs-down' picture]?".

New DV: E said "What would you say if you were King?" Would you says "I'm going to my swimming lesson after school today" [shows speech bubble] or would you say "That was very nice of him" [show other speech bubble].

(3) [E makes the puppets speak as follows]. The King: “Would you like to go to the cinema with me this Sunday?”. The Queen: “Yes, sure. Should we go to see the new Lego Batman movie?”.

New DV: E said “What would you say if you were the King? Would you say “Yeah, I’d love to see that movie” [E showed one speech bubble] or would you say “This pizza is really good” [E showed other speech bubble].

Old DV: E said “When the Queen says “Yes sure. Should we go to see the new Lego Batman movie?”, does she really not want to go to the cinema with the King [E showed ‘thumbs-down’ picture] or does she want to go to the cinema with the King [E showed ‘thumbs-up picture].

For these two ‘literal’ vignettes, performance across the 13 children was 100% correct for the ‘new’ DV and 96% correct for the ‘old’ DV.

## 4.3. Main Study

### 4.3.1. Pre-study: Generation of materials from adult conversational responses

To generate our ‘conversational response’ dependent variable for the main study, the first author tested 21 adult native speakers of British English, most of whom were university students. All were naïve to the aims of the study. Participants were presented with vignettes (see examples (4) and (6) below) ending with the speaker’s utterance. The participants were then asked to write down how they would respond as a listener. Ten of these participants were only presented with vignettes which would require a ‘literal-consistent’ response, as in example 4 below. None of the responses of the participants in this condition indicated that they interpreted the speaker’s statement ironically (see (5) for their responses to (4)).

(4) Imagine that you and your friend really want to go for a picnic. While you are having a nap, your friend peeks through the curtains. When you open your eyes, the curtains are still closed. He says, “It’s a perfect day for a picnic”. What would you say in response?

(5)

Participant 1: “Let me wake up first, then we’ll think about going”.

Participant 2: “I would ask him when he would like to go and where he would like to go”.

Participant 3: “I would be a bit annoyed that I got disturbed during my nap. However, since I really wanted to go on the picnic, I would probably wake up and get ready to go”.

Participant 4: “That’s great! Let’s go”.

Participant 5: “Shall we go out for one then and go to the park?”

Participant 6: “Great! Why don’t we go out then!”

Participant 7: “Is it sunny out there?”

Participant 8: “Let me see first”.

Participant 9: “How do you know?”

Participant 10: “What’s the weather like?”

The remaining eleven participants were exposed to versions of the same vignettes, where the adaptation made it clear that the speaker intended the utterance ironically (see

(6) below for the ironic version of (4)). The speaker's statements were identical across these two conditions. It was never the case that the utterance was a phrase which is used ironically with very high frequency in English (e.g., 'Well done!').

(6) Imagine that you and your friend really want to go for a picnic. You open the curtains and you both see that it's raining. Your friend says, "It's a perfect day for a picnic". What would you say in response?

The most frequently occurring responses were selected as the dependent variable options for our study. Thus, from the responses in (5) above, we derived the response 'Great! Let's go then'. For some conversational response options additional words were added to ensure that sentence length was equated between response options.

### 4.3.2. Method for main study

#### *Shared Knowledge manipulation*

There were ten video-recorded vignette types (e.g., 'picnic', 'goal', 'vacuum cleaner'), each with a male and female actor, whereby for each we created both a Shared and a Non-Shared Knowledge variant. Thus, there exist 20 vignettes in total (see Appendix E). Both the number of words and the length of the videos across the two conditions were matched. Importantly, for each version of a vignette type (e.g., for both the Shared and Non-Shared version of 'picnic') the speaker's statement and the binary-choice dependent variable options were identical. Moreover, the speaker's intonation and facial affect was also identical at this point; the actors were instructed to keep the facial and prosody slightly positive, as if the statement that they uttered were literal and this part was filmed prior to the rest of the vignette (and thus they were ignorant as to whether they were in an ironic or literal context). To ensure that the intonation was the same in the corresponding videos across conditions, we used the same audio recording of the final utterance for both videos.

The only way in which the Shared versus Non-Shared versions of each vignette type differed related to visual access to knowledge. For example, in the 'goal' vignette in the Shared condition, both the speaker and listener witnessed the goal whereas in the Non-Shared condition, the listener was asleep when the footballer attempted to score.

Vignettes were presented via a laptop using *PsychoPy* software (Peirce, 2007) and participants clicked on the response options. Regardless of condition, the selection of an Irony-Consistent response (e.g., '*I know! It's a pity he missed*' for the goal vignette) was scored by *PsychoPy* as 1, whereas the selection of a Literal-Consistent response (e.g., '*Was it? So our team won!*') was scored as 0. Therefore, if participants did not distinguish the Shared vs. Non-Shared conditions, there should be identical performance in both.

Each child was presented with vignettes from both the Shared and Non-Shared conditions, although never with items from the same vignette-type (e.g., s/he only saw the goal vignette in one of these conditions). Thus, each child saw five vignettes in each condition. (The specific items were counterbalanced within each between-subjects Switching group).

Practice phase: Each child participated in three practice trials, none of which included an ironic statement. These trials also differed from the test trials in two ways. First, children were asked *"Which one do you think the boy/the girl would answer?"*. Second, when the children were not sure which answer to choose, the content of the story was repeated and the prompt question was asked again. All of the children passed the second and the third example trials without the need for repetition.

Test trials: After each video vignette, the participant could either replay the video or move on the next section where s/he was asked to select a binary forced-choice reply on the part of the listener (i.e. Irony-Consistent vs. Literal-Consistent). Participants could

both see and hear the pre-recorded response options. See FIG 2 below for an example of how the response options were displayed.


*Figure 2.* The example of the video vignettes and the response screen.

**4.3.3. Study 1.** Study 1 was carried out to verify that adult native speakers of English would in fact tend to select the Irony-Consistent response in the Shared Knowledge condition, as opposed to selecting to the Literal-Consistent response. This was carried out to rule out the possibility that adults show a tendency towards to 'mode adoption' in the Shared Knowledge condition; that is, it is possible that they might select a Literal-Consistent utterances if they had a tendency interpret them as an ironic response to irony (see e.g., Whalen & Pexman, 2010).

***Method.*** The first author tested 14 native British English-speaking adults, most of whom were university students. None of the 14 participants had participated in the Pre-Study. Each participant saw video-recorded versions of vignettes in the Shared

Knowledge and Non-Shared Knowledge conditions. The Shared Knowledge vignettes were interspersed with Non-Shared Knowledge vignettes, as in the 'Mixed' condition in Study 2 below.

***Results.*** It was not the case that adults assumed that the literal-consistent responses (e.g., (3)) were 'mode adoption'; rather, this only consisted of 6% of responses in the Shared Knowledge condition. In fact, adults showed an extremely clear differentiation between the Shared Knowledge and Non-Shared Knowledge conditions; in the Shared Knowledge condition, they selected the ironic-consistent response 94% of the time, whereas in the Non-Shared Knowledge condition, they only did this 9% of the time ($t(13) = 17.55$, $p < .001$, $d = 6.81$). Thus, as expected, native English-speaking adults are extremely proficient at taking the listener's knowledge state into account when interpreting ironic remarks and do not engage in mode adoption in our type of task.

#### 4.3.4. Study 2

***Method.***

*Shared Knowledge manipulation.* The method for study was exactly the same as for Study 1. The only difference was that in addition, we also investigated the role of mental set switching by assigning participants to one of three between-subjects conditions as follows. (To ensure that the three conditions were 'matched', we assessed each child using standardised measures of vocabulary and non-verbal IQ).

*Switching manipulation.* To investigate the role of switching, each child was pre-assigned to one of three Switching conditions, which only differed from one another in terms of the task order, as illustrated in Table 21 below.

Table 21

*Task Order by Switching Condition*

| Task order | Mixed | Shared First | Non-Shared First |
|---|---|---|---|
| 1 | Shared / Non-Shared intermingled (*10 items*) | Shared condition (*5 items)* | Non-Shared condition (*5 items*) |
| 2 | | Non-verbal IQ task | Non-verbal IQ task |
| 3 | Non-verbal IQ task | Expressive vocabulary | Expressive vocabulary |
| 4 | Expressive vocabulary | Non-Shared condition (*5 items*) | Shared condition (*5 items*) |

The position of the foil vs. target answer was counterbalanced across each of the conditions and also within each participant. Each version (Shared vs. Non-Shared) of each vignette-type was presented equally often across each of the three Switching conditions. The order of vignette-types (e.g., 'picnic', 'vacuum cleaner') within each condition in the Shared-First and Non-Shared-First conditions was randomized.

*Child Participants.* Seventy-eight typically-developing children took part in the study ($M_{age}$ = 88.89, range = 6;10 – 7;11), all of whom were tested by the first author. None had participated in the pilot study. Ten children in each Switching condition were recruited through and tested in a university developmental lab in England. The remaining participants in each Switching condition were recruited from local primary schools. All participants were monolingual speakers of British English with no suspected developmental disorders. The three Switching conditions were matched on chronological age, expressive language, and non-verbal IQ (see Table 22 below – all $p > .38$). Expressive language was assessed with the Expressive Vocabulary sub-test of the Clinical Evaluation of Language Fundamentals® – Fifth Edition (CELF®- 5; Semel, Wiig, &

Secord, 2013). In order to assess non-verbal IQ, we carried out the Matrices subtest from the British Ability Scales – Third Edition (BAS-3; Elliot & Smith, 2011).

Table 22

*Means (SD) for the Age, Non-Verbal IQ, Expressive Vocabulary plus Gender Ratio for the Three Switching Conditions*

| | **Mixed Condition** ($N = 26$) | **Shared First** ($N = 21$) | **Non-Shared first** ($N = 22$) |
|---|---|---|---|
| **Chronological age in months** | 88.77 (4.31) | 89.10 (3.43) | 89.00 (3.88) |
| **Non-verbal Reasoning: British Ability Scale T-score** | 43.58 (9.75) | 47.24 (13.43) | 46.71 (7.71) |
| **Expressive Vocabulary CELF – 5 Scaled Score** | 10.54 (2.06) | 11.24 (2.64) | 11.23 (2.47) |
| **Gender** | 10 male; 16 female | 7 male; 14 female | 9 male; 13 female |

***Design.*** Thus, our study had a mixed two (Knowledge: Shared vs. Non-Shared) x three (Switching: Mixed, Shared-first, Non-Shared-first) design.

***Main Study Analysis.*** We fitted the data with a binomial mixed-effects regression model predicting ironic interpretation responses, using the lme4 package (Bates, Maechler, Bolker, & Walker, 2015) in R (R Core Team, 2018). The model included fixed effects of (a) the within-subjects factor of Knowledge (Shared, Non-Shared), (b) the between-subjects Switching Condition (Mixed, Shared-First, and Non-Shared-First), and the interaction of Knowledge and Switching Condition. The Switching Condition was coded with Helmert contrasts[9], whereby the Mixed condition was coded as the baseline

[9] Our Helmert contrast with 'Mixed' as baseline was as follows: glmer(Ironic ~ cKnowledge + C(CondFactor,contr.helmert) + (1+cKnowledge|Participant) + (1+cKnowledge|Item), common, family="binomial")

for the first contrast, following our switching hypothesis. The second contrast compared the two 'blocked' condition: Shared-First vs. Non-Shared-First.

Following Barr, Levy, Scheepers and Tily (2013) we included the maximal random effects structure supported by the data. The maximal model included random intercepts for participants and items, by-participants random slopes for Knowledge State, and by-items random slopes for Knowledge, Switching and their interaction. The random effects structure was reduced one term at a time beginning with the highest order term, until the model converged, resulting in a final model with only random intercepts for participants and items.[10].

***Main Study Results.*** Table 21 shows the proportion of responses that were consistent with the ironic interpretation by Knowledge State and by each of the three Switching Conditions (Mixed, Shared-First, Non-Shared First).

Table 23

*The Proportion of Responses Consistent with an Ironic Interpretation by Knowledge State and Switching*

| | **Mixed** Mean (*SD*) | **Shared-First** Mean (*SD*) | **Non-Shared First** Mean (*SD*) |
|---|---|---|---|
| **Shared** | .55 (.50) | .68 (.47) | .54 (.50) |
| **Non-shared** | .27 (.45) | .38 (.49) | .28 (.45) |

We found a significant main effect of Knowledge ($\beta = 1.65$, SE = .21, $p < .001$), such that responses consistent with the ironic interpretation were (appropriately) more likely in the Shared than in the Non-Shared condition. There were no significant effects

[10] Our final model was as follows: IronicResponse ~ KnowledgeState + Switching + KnowledgeState: Switching + (1|Participant) + (1|Item).

for the Switching Condition (contrast 1 (Mixed condition vs Blocked conditions): β = .33, SE = .24, $p$ = .16; contrast 2 (Shared Knowledge First vs. Shared Knowledge second): β = -.15, SE = .14, $p$ = .30). No interactions between Knowledge and Switching were significant (for contrast 1: β = .024, SE = .23, $p$ = .92; for contrast 2: β = -.030, SE = .14, $p$ = .84).[11]

### 4.4. Discussion

In the current study, we developed a novel measure for irony comprehension in children. Rather than being asked to judge what a speaker thinks or means (or to verbally formulate their own response), children were instead asked to select how they thought a listener might respond. The binary forced-choice 'conversational' response options were developed from spontaneous responses by adults to the items. In addition, the current study is one of very few which has attempted to experimentally manipulate suspected cognitive underpinnings of the irony interpretation in children. Using our novel dependent variable, we found a role for one cognitive underpinning that we manipulated (i.e. mentalising) but not the other cognitive underpinning that we manipulated (set switching) in how seven-year-olds interpret ironic utterances.

Regarding switching, ours is the first study (whether correlational or experimental) to investigate whether this plays a role in how children interpret irony. One possibility is that our null result for this variable indicates that switching is not of particular relevance. An alternative possible explanation might be that the switching element is always implicitly present when processing ironic utterances (e.g., De Neys & Schaeken, 2007). To clarify, even if the child had a block of videos including only ironic utterances, it is

[11] A mixed factorial 2 (Knowledge State) x 3 (Switching Condition) ANOVA found the same pattern of results, with a main effect for Knowledge State ($F$(1,66) = 43.25, $p$ < .001, $\eta_p^2$= 4), no effect for Switching ($F$ = 2, 66 = 1.39, $p$ = .26, $\eta_p^2$= .04) and no interaction ($F$(2,66) = .08, $p$ = .92, $\eta_p^2$ = .002). None of the pairwise comparisons between switching conditions were significant (all $p$ > .6, all Cohen's d < .3).

possible that the literal meaning would still be activated at some level – even if only weakly. While this 'literal-first' view of irony interpretation is hotly contested (e.g., Gibbs, 1983; Kowatch, Whalen, & Pexman, 2013), eye-tracking studies with adults certainly indicate that multiple processes are required for irony-interpretation, but that the integration of these proceeds extremely fast in real time (e.g., Barzy, Filik, Williams, & Ferguson, 2020). Thus, it is certainly possible that our design was too simplistic and that online measures such as eye-tracking are necessary in order to detect the role of mental set switching in irony interpretation – at least in an experimental paradigm.

Regarding mentalising, our experimental findings fit with findings from numerous individual differences studies, which found correlations in children around this age between irony interpretation and second-order false belief understanding, which is the ability to understand that another individual can have a false belief about a third party's knowledge state (e.g., Filippova & Astington, 2008). However, we by no means wish to claim that second-order false belief understanding is necessary in order to successfully determine whether an utterance is intended ironically or literally. Even in situations where prosodic and other 'likelihood' indicators (such as speaker-listener relationship) are removed or controlled – i.e. situations where the listener is more reliant on mentalising than is always the case – we would argue that second-order false belief is nonetheless not essential to interpret irony correctly. That is, to understand in our task (and Nilsen et al.'s, 2011, task) that – for example – Emma might interpret Matt's utterance literally, a child does not need to understand that Emma might have false beliefs. Rather, the child merely has to understand that Emma does not have access to the same knowledge (e.g., the ball is flat) to which Matt has access. Thus, the requisite aspect of mentalising here is in fact knowledge-access, which is typically demonstrated by children well before they pass traditional first-order false belief tasks (e.g., Wellman & Liu, 2004). We follow the view

that adult-like mentalising is acquired in a gradual fashion (see e.g., Tomasello, 2018), where different components of mentalising are likely to correlate with one another in development.

***Limitations.*** Our Pilot Study results indicate that our novel 'binary forced choice conversational response' dependent variable was not in fact easier for children than the traditional forced choice judgement tasks (e.g., 'When the King said "that was a great shot!", was he happy with how the Queen kicked the ball or not happy with how the Queen kicked the ball?'). There are several potential reasons for this. First, with our new response type, the child – as in all previous studies – must maintain the relevant event schemas in working memory. Then, as for traditional judgment tasks, the child has to simultaneously evaluate the statement as well as two possible responses. Furthermore, as in Nilsen et al.'s (2011) study, the child has to represent not only the speaker's mental state but also that of the listener in the story in order to decide how the listener might respond. Thus, as for all previous measures of irony interpretation in children, our task still burdens working memory, vocabulary – and also syntax to a degree. Future studies are needed to devise irony interpretation tasks for children which minimise this load.

***Conclusion.*** What is unambiguous in our findings is that seven-year-olds clearly take the knowledge state of the listener into account in order to determine whether an utterance is intended ironically or literally. Moreover, they are able to select an appropriate response based on their assessment of this shared knowledge. Ours is the first experimental study to show that children this age use their mentalising abilities in this way to interpret irony and such experimental evidence is essential to move the field forward, given the inherent difficulties with interpreting correlational findings.

# CHAPTER 5. DISCUSSION

## 5.1. A summary of the current findings

This thesis investigated children's understanding of Simple and Complex forms of irony and aimed to explore the role of cognitive skills (Theory of Mind and Executive Functions) essential for irony interpretation as well as other factors (such as general and specific knowledge) when controlling for theoretically important covariates – formal language and non-verbal reasoning. The first chapter provided a review of the relevant theories of verbal irony and an overview of the literature on production and comprehension of different forms of irony in children. The overview of the literature from Chapter 1 suggests that the irony research to date has mostly focused on investigating the understanding of Simple, counterfactual forms of irony, in which the immediate context of the utterance indicates that the statement should not be interpreted ironically (e.g., saying '*It's a perfect day for a picnic*' when it is raining cats and dogs). It is potentially problematic as in real-life children encounter more sophisticated ironic statements which means that other commonly used forms of ironic language use are not investigated in the literature. In Chapter 2, in order to address this issue, I investigated, alongside Simple Ironies the comprehension of more advanced, Complex, forms of irony and their cognitive underpinnings. In Chapter 3 the interpretation of Complex Ironies (not Simple) was explored as well as the role of the cognitive skills in understanding of this irony type. I defined Complex Ironies as statements in which there is no clear immediate physical context serving as a cue for ironic interpretation of the statements. Hence, the non-literal interpretation of Complex ironic statement cannot be inferred from the visual context, as in:

(1) Speaker A: *I have been invited to a party by the most beautiful girl in my class*

Speaker B: *Yeah, and I have been invited to the Queen's party*

Furthermore, in Chapter 1 some methodological challenges of the irony acquisition literature were identified, such as an almost exclusive reliance on correlational designs and the issue of the test questions used in the experiments, which require children to have meta-cognitive knowledge in order to answer them. These, were addressed in the experimental study summarised in the Chapter 4.

It is evident from the findings from Chapter 2 that six- to eight-year-olds found Complex forms of irony more difficult than the Simple ones and performed at floor in my Irony Task on Complex ironic utterances. Therefore, to explore the cognitive underpinnings of more advanced forms of irony the follow-up study with older children (11-12-year-olds) was carried out and summarised in the Chapter 3. The findings of the experiments from Chapters 2 and 3 revealed that when controlling for formal language and non-verbal reasoning, one of the most important components of Executive Functions for irony interpretation by six- to eight- and 11-to-12-year-olds is cognitive flexibility, which is the ability to switch between different approaches to the same task. The other two EFs components – working memory and inhibitory control – were not found to be related to irony interpretation in the group of six- to eight-year-olds tested in Experiment 1. With regards to mentalising, the study findings suggest that the indirect measure of ToM (ToM Inventory – parental questionnaire; Hutchins et al., 2012) is also an independent predictor for irony comprehension in children aged 6-8 (Chapter 2). However, for older children (Chapter 3) the mentalising measure (Animations; Abell et al., 2000) was not predicting the performance in Complex Irony Task. This will be addressed at length later in the discussion in section 5.3.1.

To address some methodological issues with irony acquisition literature identified in Chapter 1 and to further explore the role of mentalising and cognitive flexibility in

children's ability to understand irony, I carried out an experimental study, the findings of which are presented in Chapter 4. In this study, I manipulated the role of shared knowledge between the two speakers as well as the switching load of the presented Irony Task. It was evident from the findings that children at the age of seven clearly take the knowledge state of the listener into account in order to determine whether an utterance is intended ironically or literally, therefore 7-year-olds are using their mentalising skills in irony interpretation task. The findings from Experiment 3 confirm the causal direction suggested by the individual differences studies found in the literature showing the role of mentalising in the irony interpretation in children. Yet, contrary to what was found in the studies reported in Chapters 2 and 3, the experimental study form Chapter 4 did not confirm the role of cognitive flexibility which will be discussed at length in a later section (5.3.3.).

In the following sections, I will consider the interpretations and implications of the findings on Simple and Complex Irony understanding. It will be discussed whether these findings are in line with the existing literature on irony interpretation in children. Then, I will discuss what I can and cannot conclude regarding the roles of mentalising and cognitive flexibility and the implications of this for theory.

## 5.2. Simple and Complex Ironies – definitional issues, the role of knowledge and the age of acquisition

**5.2.1. What is a good definition of Simple and Complex Irony.** One of the aims of the current thesis was to explore and perhaps question the types of irony tested in the irony acquisition literature. As mentioned, the vast majority of studies testing irony understanding in children focuses on investigating the comprehension of very basic ironic statements that take the form of counterfactual statements (either critical or complimentary), such as saying "Well done!" when someone spills the juice. In addition,

the addressee of the ironic utterance usually can rely on the visual cue the ironic interpretation (e.g., the big stain on the tablecloth).

One of the few researchers who went beyond this traditional typology of irony is Bara et al. (1999) who made the theoretical distinction between Simple and Complex ironic speech acts, which was further experimentally tested by Bosco and Bucciarelli (2008) in their study with six- to ten-year-olds. In this thesis, following Bara et al.'s approach to irony, I also explored the understanding of these two types of ironic statements by children. What is of a great importance, however, is that I defined Simple and Complex Ironies slightly differently to the authors of the original theory. I will now briefly describe what constitutes Simple and Complex ironic speech acts in Bara et al.'s (1999) distinction.

Bara et al. (1999) claim that what differs Simple and Complex forms of this non-literal language is the inferential load required for the interpretation of the actual meaning. In their theory, the authors refer back to the classic philosophy of language, more specifically to Searle's (1975, 1979a) distinction between direct and indirect speech acts, who argued that the length of the inferential path of direct speech acts, as in (2) is not the same as for the indirect ones, as in (3):

(2) '*Pass me the salt*'

(3) '*Could you pass me the salt?*'

According to Searle, direct speech acts are always easier to comprehend than indirect ones as they are straightforward, whereas understanding of indirect speech acts requires some kind of common knowledge and because the length of the inferential chain is not the same for the two types of speech acts. Inspired by other psycholinguists – mostly Gibbs (1986) and Airenti, Bara, and Colombetti (1993) – Bara et al. (1999) suggested

that direct and indirect speech acts with conventionalised meaning as in (4) require less complex inferential chains than indirect and nonconventional speech acts as in (5):

(4) '*Would you like to sit down?*'

(5) Response '*It's raining*' to the proposal '*Let's go out and play*'

Bara et al. (1999) decided to abandon the distinction of *indirect* and *direct* speech acts and proposed the distinction between Simple and Complex speech acts, which also holds for ironies (alongside deceits and 'standard' communicative acts). According to the authors, Simple ironies refer to the utterances that immediately contrast with a belief shared by the two speakers, which is similar to the Gricean understanding of irony where a person says *p* meaning *not-p.* Complex Ironies, however, are classified as such "(…) because a series of inferences is needed to detect their contrast with the belief shared by the agents" (Bara et al., 1999; p. 516). I find this definition of Complex Ironies problematic as it is not entirely clear how it is possible to actually "count" the number of requisite inferences, especially in the case of irony. As Bosco and Bucciarelli (2008) stated themselves, there is no way that one could theoretically predict the length of the process. Bosco and Bucciarelli in their experimental study provide some examples (as in (6) and (7)) of the two irony forms and it can be seen that it is not only difficult to establish the exact length of inferential chain behind the ironic statements but also their examples of Simple ironies require quite an advanced inferencing:

*'Anita is with her friend Paolo and is looking for her glasses. She doesn't realize her glasses are right in front of her nose and she asks Paolo, 'Have you seen my glasses?'*

(6) Simple irony*: 'Congratulations on your excellent eyesight!'*

(7) Complex Irony: *'I'd ask you if I had to thread a needle'."*

Therefore, in this thesis (Chapter 2) I discussed whether in fact the distinction between Simple and Complex Ironies developed by Bara et al. (1999) actually allows for determining the difficulty of comprehension of this pragmatic phenomena. This led to re-definition of Simple and Complex Ironies in this thesis in way that avoided having to count the number of inferences.

As it was mentioned at the beginning of this Discussion Chapter, my definition of Simple Irony partially followed what was suggested (yet not exactly executed in the experimental research) by Bara et al. (1999), namely in the instance of Simple Irony the utterance immediately contrasts with a belief shared by the interlocutors (the speaker says *p* meaning *not-p*). Furthermore, I extended this definition by pointing at the immediate context of the utterance which indicates that the statement should not be interpreted ironically. In case of Complex Irony I stated that there is nothing in the immediate context that would help the hearer to decode that the meaning should be interpreted ironically. What the hearer needs is the knowledge about the world, as in (8) where the hearer needs to know that people who spent the whole day at school are tired and therefore not very willing to help out in the kitchen. There is nothing in the immediate visual context that could help Tom understand that Sally is being ironic and in fact she is not happy to help him cook the dinner tonight:

(8) Tom*: Can you help me cook the dinner? I'm tired.*

Sally: *Oh yes, because I have just been sitting around doing nothing at school today.*

In fact, the researchers from the field of discourse processing, proposed that the real-world knowledge has a substantial role in one's ability to infer the implied meaning

of the statements (Kintsch, 1988). In order to fully understand the actual meaning behind the Complex ironic statements and to generate essential inferences, the hearer might need to integrate the knowledge they possess about the real-world.

**5.2.2. The role of knowledge in Complex Irony understanding.** In the Experiment 1 and 2 I tested the role of real-world knowledge and the specific knowledge in Complex Irony comprehension in children.

In the first experiment I looked at the relationship between understanding of Complex Ironies and the real-world knowledge that was measured by the standardised measure of the general knowledge – Information subscale of Wechsler Intelligence Scale for Children (Wechsler, 2003). Children were asked the questions such as *'What must you do to make water boil?*'. I predicted that as general knowledge is presumably an essential part of Complex Irony, it will be an independent predictor of irony comprehension in six- to eight-year-olds. However, the final results of the first study did not confirm that relationship. I think that one of the reasons for the lack of the relationship between irony comprehension and general knowledge is the choice of the measure.

Perhaps, it is not *general* knowledge about the world that is the prerequisite for irony interpretation but rather it is *specific* knowledge that the hearer needs to have in order to decode the ironic meaning behind the statement. To test that, in the Experiment 2, I asked my participants questions that were specifically related to the Complex Irony scenarios that were presented to them. I assumed that the accurate interpretation of the Complex ironic statements will depend on the participant's background knowledge relevant for the ironic videos presented at the beginning of the session (e.g., '*Do most people get invited to the Queen's parties?*'). The results indicated that, in fact, having relevant specific knowledge determines children's performance on my Complex Irony Task.

We can therefore conclude that *specific* background knowledge is of a great importance for Complex Irony interpretation in children. Although in Simple Irony children can rely on the immediate context which indicates that the ironic statement should not be interpreted literally, in the case of Complex Irony the immediate physical context usually does not serve as a cue for ironic interpretation of the utterance; the interlocutors therefore rely on some other factors crucial for irony interpretation.

This brings us back to Kintsch (1988), who stated that the discourse is always interpreted in a specific context, of which knowledge about words, syntax and the world in general, is a part of. My findings and this new understanding of the role of knowledge that might contribute to interpretation of different irony forms may be an indicator for other researchers from the field of how irony tasks are designed. I think that it is worth taking into account the specific knowledge which might be a prerequisite of correct interpretation of more advanced irony forms.

**5.2.3. When do children learn Simple and Complex Irony.** Apart from exploring the role of knowledge in children's understanding of Complex Ironies, one of the aims of Experiment 1 and 2 (Chapters 2 and 3) was to investigate the age at which children are capable to interpret the two irony forms – Simple and Complex.

Experiment 1 measured six-to-eight-year-olds performance in my Irony Task, in which I presented the participants with 5 videos in two irony types, each ending with ironic comment uttered by one of the speakers. The children were asked to answer two types of questions – forced-choice about the speaker's meaning (*What does she/he mean?)* and open-ended question about the pragmatic aspect of irony understanding (*Why did she/he* say [ironic utterance]?). The results from Experiment 1 indicated that younger children, aged from six to eight, found it challenging to decode the actual meaning behind more advanced ironies, and performed at floor in the measure of Complex Irony for both

question types. For forced-choice questions, overall accuracy for Simple Irony in the group of six- to eight-year-olds was 76%. By contrast, overall accuracy for Complex Irony was 26%. For open-ended questions the children decoded accurately the pragmatic function of Simple Ironies in 47% and of Complex Ironies in 10% of cases. These findings are partially in keeping with Bosco and Bucciarelli (2008) – the research that inspired my distinction between Simple and Complex Ironies in this thesis. Namely, Bosco and Bucciarelli found that Simple Ironies are easier to comprehend than Complex Ironies by children form three age groups: 6:7-7:0, 8:0-8:6, 9:6-10:0, which is a similar finding to mine from the Experiment 1 with six- to eight-year-olds. However, contrary to what was found in Bosco and Bucciarelli's study, the results from Experiment 1 indicated that the performance on irony measure (both Complex or Simple) was clearly related to age of the participants. Six- to eight- year olds found more advanced irony form challenging and were unable to decode the actual meaning behind utterances classified as Complex Irony.

Therefore, the follow up study with 11-12-year-olds reported in Chapter 3 was carried out to explore at what age children become more proficient irony users. The results revealed that in fact older children reached on average 54% of the correct responses for the forced-choice questions on the Complex Irony measure. Although in the Experiment 2 I could notice the improvement in understanding more complex forms of irony in 11-12-year-olds (54% of the average correct responses as compared to 26% in the group of younger children), the direct comparison of the performance is not possible as the Irony Task was slightly modified in the Experiment 2 (one vignette was replaced and two new added).

It is therefore evident from the Experiment 1 and 2 that not all irony forms are equally easy for children of different ages to understand. The literature suggests that the ability to recognize the incongruity behind ironic statements begins at the age of five or

six (Ackerman, 1983; Glenwright & Pexman, 2010; Hancock et al., 2000; Harris & Pexman, 2003; Sullivan et al., 1995; Winner & Leekam, 1991). In this prior research, the irony phrases used in the irony tests mostly included ironic remarks, in which both of the speakers could see from the immediate, in most cases visual, context that the utterance should not be interpreted literally. My findings confirm that children at the age of six-eight are in fact able to decode the actual meaning behind Simple ironic statements, where there is an obvious conflict between the statement and the immediate physical context.

However, more advanced irony forms which lack such a blunt emphasis on the incongruity between the ironic statement and visual context (Complex Ironies in this thesis), are too difficult for six- to eight-year-olds to understand. These findings thus tie into the research showing that the ability to interpret different forms of irony, such as ironic criticisms or compliments, develops with age (e.g., Filippova & Astington, 2010; Pexman & Glenwright, 2007). As the 11-12-year-olds tested in Experiment 2 on average reached 54% of correct responses I can assume that even older adolescents would show full comprehension of Complex Irony forms. This is definitely worth exploring in the future studies. Clearly my findings that children's ability to understand more complex forms of irony develops with age and that children as young as 6-8 are not able to understand these more advanced irony forms adds to the current irony acquisition literature. It is argued that Complex Ironies are more challenging for younger children as they need a specific background knowledge to decode the actual meaning behind the ironic statements.

Furthermore, in everyday life we encounter all sorts of ironic statements such as these requiring the speaker to have the specific knowledge about the world or about the interlocutor to correctly interpret the actual meaning behind the ironic utterance. For

instance, in order to understand that when the speaker says '*Yeah, and I have been invited to the Queens party'* he or she actually means that they do not believe that I were invited to the party by the most beautiful girl in the class, one needs to know that the Queen does not invite regular people to the parties; there is nothing in the immediate context that may help the reader to understand the implied meaning.

The studies summarised in Chapters 2 and 3 demonstrated that not all types of irony are interpreted by children in the same manner. In the following sections I will discuss the role of cognitive skills that may underpin irony comprehension in children aged 6-8 and 11-12.

## 5.3. The role of mentalising in irony comprehension

**5.3.1 The role of mentalising in irony comprehension – findings from correlational studies.** The key purpose of the studies reported in this thesis was to investigate not *when* children understand different forms of irony but primarily *how* they learn to understand them, which is perhaps even more unexplored area in the developmental literature than as to when the ability to comprehend irony is acquired.

One of the cognitive skills which is traditionally believed to be related to irony comprehension (e.g., Happé, 1993) and which probably has received most of the attention in the irony acquisition literature is mentalising (Theory of Mind). The term mentalising used in this thesis refers to the individual's ability to understand that others may have desires, knowledge and beliefs which differ from one's own (e.g., Harris, 1992). It seems logical to assume that the full comprehension of the dialogue which includes ironic statement should involve taking into account the conversational partner's mental perspectives. For instance, if one hears:

(9) *"It's a perfect day for a picnic"*

said on a rainy day, then for a successful communication to happen (decoding of ironic meaning), the addressee needs to understand that the speaker knows that the hearer knows it is raining and that he beliefs that it is actually not a good day to go out, which is quite an advanced mentalising operation (Happé, 1993). The ability to reason about other people's thoughts should be required for both Simple and Complex Irony comprehension as in both cases the hearer needs to take the speaker's knowledge state into account to interpret the ironic utterance correctly.

As already mentioned, the literature supports the suggestion that there is a relationship between irony comprehension in children and higher-order Theory of Mind, even when statistically controlling for core language skills (e.g., Astington & Filippova, 2008). As all the ironic statements used in the previous literature on the role of mentalising were the instances of what I would classify here as Simple Irony, I expected to find similar effects for Simple Irony in my correlational Experiment 1 with six- to eight-year-olds. However, the findings from the Experiment 1 only partially support these claims. To clarify, only one of the two mentalising measures that were used – parental questionnaire (Theory of Mind Inventory; Hutchins et al., 2008) – was found to be an independent predictor of six- to eight-year-olds' performance on Simple Irony Task. There was no relationship found between children's scores on Strange Stories (direct measure; Happé, 1994) and Simple Irony measure. With regards to the role of mentalising in Complex Irony understanding, the findings of the Experiment 2 with older children (11-12-year-olds) also indicated that the direct measure of mentalising (ToM Animations; Abell et al., 2000) was not related to Complex Irony measure.

The mixed findings from the correlational studies (Chapter 2 and 3) raise questions regarding the methods used to assess mentalising competencies in children.

First of all, it could be that the indirect measure of mentalising – ToM Inventory – might in fact tap different mentalising skills than the other two direct measures – Strange Stories and ToM Animations – used in Experiment 1 and 2 respectively. In fact, Jones et al. (2018) in their study on the association between ToM, EFs and symptoms of ASD also found similar patterns in their correlational analyses. That is, in their study, Strange stories and ToM Animations did not correlate with the measure of Social Communication whereas Reading the Mind in the Eyes (Baron-Cohen, Wheelwright, & Hill, 2001) and their false-belief measure did. Thus, it might be that the direct measures of mentalising used in my study, i.e., Strange Stories and ToM Animations, do not assess the same set of mentalising skills as the indirect measure, ToM Inventory.

The Strange Stories used in the Experiment 1 evaluate solely the understanding of the effect and the intentions of double bluff, white lie, persuasion, and misunderstanding. Similarly to Strange Stories, ToM Animations used in Experiment 2 (Chapter 3), assess quite limited range of higher-level ToM competencies – children are expected to provide a verbal explanation of the triangles' interaction (based only on movement patterns) in four clips which requires the attribution of intentions behind mocking, surprising, coaxing, and seducing. In contrast, the ToMI (the parental questionnaire) taps on a wide spectrum of mentalising skills, ranging from the early ones, such as shared attention to the ones emerging later in the development – understanding humour, counterfactual reasoning, distinction between jokes and lies, or understanding that two people can interpret the same image differently. Therefore, it might be that the mixed results obtained across the two correlational Experiments (Chapter 2 and 3) might actually stem from the fact that the measures assess different aspects of mentalising.

There were some more differences identified between the used measures. One of them is that a parental questionnaire potentially captures a range of behaviours in many

contexts (rather than a once-off as it is the case with Strange Stories and ToM Animations). Also, ToM Inventory is not dependent on situational factors and child's motivation unlike ToM Animations and Strange Stories. In addition, if a measure has 42 items (like ToM Inventory does), one is more likely to find a correlation simply because the measure has a greater degree of potential variability. Also regarding the scale properties, out of the three measures, ToM Inventory is the only standardised one. Very little is known about other ToM tests' (including Strange Stories and ToM Animations) validity or test-retest reliability (Devine & Hughes, 2016).

Another difference between the methods used to assess ToM competencies in the Studies 1-2 might be that that ToM Inventory as a parental questionnaire evaluates mentalising skills irrespective of children's language and cognitive functioning. Whereas both – the ToM Animations and Strange Stories – may load to such a great degree on verbal fluency, vocabulary knowledge and executive functioning that this may not necessarily be a sensitive enough measure of advanced ToM skills. These great demands on non-social aspects of cognition make the interpretation of the performance in ToM tasks difficult as it is not quite possible to rule out the influence of non-social cognitive skills (Apperly, Samson, & Humphreys, 2009).

One of the non-social cognitive skills that might account for the relationship between ToM and irony comprehension in children is core language; one of the reasons being large language demands of the irony tasks. Previous studies investigating ToM and irony understanding suggest that formal language is related to irony interpretation in typically-developing children (Angeleri & Airenti, 2014; Filippova & Astington, 2008; Massaro et al., 2014; Mewhort-Buist & Nilsen, 2013; Nilsen et al., 2011). These findings are in line with what was found in the Experiment 2 of this thesis – core language was shown to be an important factor in irony comprehension. However, in my Experiment 1

with six- to eight-year-olds the measure of formal language (Formulated Sentences CELF; Wiig et al., 2013) was not correlated with neither Simple nor Complex Irony when the age was controlled for. This was quite surprising especially given that the results of the follow-up study with 11-12-year-olds (Experiment 2) did indicate that the proportion of correct responses obtained in Complex Irony Task was related to structural language. Perhaps Formulated Sentences subtest of CELF used alone is not a sensitive measure of formal language skills in children of that age (six- to eight-yeards-old) as it assesses the ability to produce complete and grammatically correct spoken sentences overlooking other core language competencies, such receptive language and vocabulary, which may be more essential for irony interpretation and mentalising vignette interpretation. Although there are some inconsistencies in the findings from the studies presented in this thesis with regards to the role of language in irony interpretation, the literature and most of the findings in this thesis suggest that irony comprehension is very closely related to structural language ability. Hence, it seems necessary to control for structural language abilities when investigating relationship between irony comprehension and other cognitive skills, such as Theory of Mind.

Problematically, the vast majority of studies that also used the direct measures of mentalising and have found that these correlate with irony interpretation did not control for the structural language (Angeleri & Airenti; 2014; Nicholson et al., 2013; Banasik, 2013; Bosco & Gabbatore, 2017; Mewhort-Buist & Nilsen, 2013; Caillies et al., 2014). Therefore, it is impossible to rule out that the relationship between irony and ToM found in these particular studies is accounted by language abilities.

Nonetheless, in one of the few very well controlled studies, Filippova and Astington (2008) found that receptive vocabulary (measured with PPVT – III; Dunn & Dunn, 1997) and advanced ToM were independent predictors of irony interpretation. Massaro et al.

(2014) who also included in their study the measure of receptive vocabulary (PPVT-R; Dunn & Dunn, 1981; Stella, Pizzoli, & Tressoldi, 2000) did not find the relationship between irony and ToM. In fact, their results revealed that it was the language measures that predicted the irony understanding. Therefore, although many previous studies found the relationship between direct measures of ToM and irony comprehension (e.g., Angeleri & Airenti, 2014; Filippova & Astington, 2008 ), it is impossible to rule out that statistical relationships between ToM and irony comprehension could to a large degree be accounted for by core language competencies.

In addition to the potential influence of language competencies, it might be the case that the relationship between Theory of Mind and irony comprehension in children is influenced also by other non-social cognitive skills, such as non-verbal reasoning. In fact, the studies in Chapters 2 and 3 are the first studies to control for non-verbal reasoning in the irony acquisition literature. It seems important to rule out the possibility that the children who score high on one task will score high in all other tests (Matthew Effect; Merton, 1968). In the Experiment 1 I found that the performance on Strange Stories did correlate with the measure of Open-Ended Simple and Complex Irony when non-verbal reasoning (and age) is not controlled for. Also, for the Forced-Choice outcome measure, when age and non-verbal IQ were not included in the analyses, the performance on Strange Stories was correlated with Complex Irony comprehension. Similarly, Jones et al. (2018) found that attempting to control for performance IQ in their analysis of relationships between ToM and social communication meant that the relationships became no longer significant. Therefore, if I had followed the procedures of previous studies in the child irony interpretation literature and had not controlled for non-verbal IQ, my Chapters 2 and 3 results regarding relationships ToM and irony interpretation would have been line with those from the majority of previous studies. What is not

entirely clear is whether controlling for the child's visual-spatial intellectual abilities is the correct approach.

With regards to irony task, it might be the case that children who are better at solving abstract and conceptual tasks measured by non-verbal IQ tests (here – the Matrices subtest of the British Ability Scales – Third Edition; Elliot & Smith 2011**)** are more capable of working out of what is expected from them in this particular Irony Task. On the other hand, as Jones et al. (2018) argue, IQ might be so highly intercorrelated with ToM that controlling for it may lead to non-significant results regarding relationship between ToM and social communication measures. Therefore, given sparse evidence and the lack of unanimity as to whether to control for non-verbal IQ in irony studies or not, it might be worth to explore the role of non-verbal IQ in future studies.

**5.3.2. The role of mentalising in irony comprehension – findings from experimental study.** The findings from my experimental study reported in Chapter 4 draw slightly different picture of the relationship between irony and the ability to reason about others' thoughts to what was found in my correlational research. The results of the experimental study clearly indicate that children at the age of seven are definitely using mentalising at some level in order to assess whether the listener would interpret the ironic statements as such. The participants in this study did show the ability to take the knowledge of the interlocutors into account when choosing the most appropriate response to the ironic comment made by one of the speakers.

The results of the experimental study, in which the large effect of shared knowledge was found, support the claims regarding the important role of mentalising in irony comprehension found in the literature (e.g., Filippova & Astington, 2008). In my experimental manipulation of shared knowledge the participants are asked to follow the ongoing dynamic social interaction and then to apply their knowledge of social

contingency to provide a correct response to the Irony Task. In order to choose the correct possible speaker's response to the ironic statement in my task, the child needs to be able to evaluate their knowledge and the knowledge possessed by both of the interlocutors and then to supress their own perspective, clearly demonstrating their mentalising skills.

In addition, almost all widely used measures of ToM require children to make explicit and reasoned mental state attributions (evoked mental state attributions; Frith & Frith, 2008). Again, my experimental manipulation and questions used in the irony task, unlike Strange Stories and ToM Animations used in correlational research, remove this required effort to make explicit judgements as children are asked to consider the mental state (and the knowledge state) of the interlocutors without being prompted to do so.

Together, the Experiments 1-3 provide the evidence that mentalising may play important role in irony comprehension in children. The findings from the experimental study are especially valuable as they confirm the causal direction implicated by individual differences studies showing correlations between second-order false belief understanding and irony interpretation in children around the age of seven. There might be several reasons for inconsistent findings of the correlational studies (Experiment 1 and 2). Perhaps Strange Stories and ToM Animations were not sensitive enough measures of ToM competencies of my participants or it could be the case that controlling for non-verbal IQ might have confounded the results.

### 5.4. The role of Executive Functions in irony comprehension

As mentioned in Chapter 1 Theory of Mind may contribute to understanding of irony. Another potential factor that may underpin irony interpretation in children that was investigated throughout all of the experiments in this thesis is Executive Functioning. In Experiment 1 I explored the role of all three main components of the EFs – working memory, inhibitory control and cognitive flexibility when controlling for non-verbal IQ

to rule out the possibility of the Matthew effect (see Chapter 1). Based on the results from this study, in Experiment 2 I solely looked at the relationship between irony comprehension and cognitive flexibility. Following that, in the experimental study reported in Chapter 4 I manipulated the role of cognitive flexibility in irony comprehension in children.

**5.4.1. The role of working memory and inhibitory control in irony comprehension.** I had predicted that both inhibitory control and working memory would be necessary for irony interpretation as one needs to maintain the two possible meanings – literal and ironic – and inhibit the literal one. However, neither inhibitory control nor working memory were significantly related to irony comprehension in the group of younger children, in which this was tested (six- to eight-year-olds from Experiment 1). These findings regarding the lack of relationship between working memory and irony comprehension are in keeping with the studies that investigated the relationship between inhibitory control, working memory and irony understanding (Caillies et al., 2014). However, my results did not confirm the relationship found in these two studies between inhibitory control and irony understanding.

Regarding working memory, Filippova and Astington (2008) included in their study the measures of working memory (as control variables), which were found to be correlated with irony understanding by children aged from 5-9. In contrast, my results did not confirm the relationship between working memory and irony understanding found in Filippova and Astington's study.

Concerning inhibitory control, Caillies et al.'s (2014) was the only study which looked at the role of inhibitory control in irony comprehension. The results from the Experiment 1 of this thesis were not in keeping with what was found by Caillies et al. (2014). Apart from the fact that the sample size was very small ($N$ = 15), Cailies et al.'s

findings were rather surprising as they found a correlation between performance in the inhibitory control tasks and their irony measures in the group of typically developing children but not in children with ADHD (who are believed to have some EF deficits (e.g., Willcutt et al., 2005)). Another possible reason for differences between Cailles et al. (2014) and the current findings are that in my study I measured slightly different aspects of inhibitory control to what was assessed in Caillies et al.'s study. To clarify, I used the Stroop task which examines the response inhibition, whereas, Caillies et al. looked at the selective auditory attention, inhibition of previously learned responses (Auditory Attention and Response Set subtests from NEPSY; Korkman, Kirk, & Kemp, 2007), and motor persistence and inhibition (Statue subtests from NEPSY; Korkman et al., 2007).

With regards to the tasks used to measure inhibitory control in the literature, the issue of test reliability might be of a great relevance in the investigation of the role of executive functions in irony comprehension. That is, while Digit Span Backwards (the measure of working memory used in my Experiment 1) is a standardised test and we know that it has pretty good test reliability and it can capture individual differences, the reliability characteristics for tests of inhibitory control, such as Stroop, are not so well known (Hedge, Powell, & Sumner, 2017). Although Stroop task is commonly used inhibitory control measure, it does require working memory as one needs to remember to press the colour (in the computer version of the task) that matches the colour of the font (and ignore the meaning of the word, which described a different colour), which might raise question about the 'purity' of this EF construct measure.

To sum up, Experiment 1 did not find a relationship between inhibitory control and irony comprehension nor between working memory and irony understanding in children

aged from six to eight. Yet, the null results are based on one study (Experiment 1) and using only one measure for each construct. Therefore, it would be well worth replicating using multiple working memory and inhibitory control measures. As there are theoretical implications as to why working memory and inhibitory control might be of significance for the development of irony comprehension in children, it might be worth to further explore this link given that there were only handful of research exploring the role of working memory in irony and the inconsistencies in the findings across ours and the three studies which looked at working memory.

**5.4.2. The role of cognitive flexibility in irony comprehension.** The literature on the role of all three components of EFs in irony comprehension is sparse and inconsistent (see e.g., Matthews et al., 2018, for a review). In fact, no one had ever investigated the relationship between cognitive flexibility and irony interpretation in children. This component of EFs might be especially important for irony as the listener has to flexibly shift between the two perspectives and decide between the two available meanings – literal and ironic.

The results from both correlational studies summarised in Chapters 2 and 3 indicated that cognitive flexibility was an independent predictor of irony interpretation in both 6-8-year-olds (Experiment 1) and 11-12-year-olds (Experiment 2). In contrast, in the experimental study (Experiment 3), in which we manipulated cognitive flexibility by changing the order of the presented irony stimuli, it was found that the manipulation of cognitive flexibility has not impacted the ability to interpret irony.

To determine exactly why Experiments 2 and 3 have apparently contradictory findings, it is important to first look more closely at the theoretical construct of cognitive flexibility. Cognitive flexibility is defined in the literature in multiple ways. Generally speaking, it is an ability to adjust one's behaviour to changing demands of the

environment (Scott, 1962). This component of EFs is believed to involve working memory as well as inhibitory control (Diamond, 2013). According to Diamond (2013) a key aspect of cognitive flexibility is to be able to change perspectives spatially and interpersonally. Changing perspectives interpersonally would involve looking at something from the other person's point of view. Presumably, in order to change the perspectives, one needs to deactivate (inhibit) their own perspective and activate a new perspective (load into WM).

One of the standard tasks used for assessing cognitive flexibility is Wisconsin Card Sorting Task (Grant & Berg, 1949), which is the measure that was used in the correlational studies (Experiment 1 and 2). In the Studies presented in this thesis, WCST scoring involved looking at the number of perseverative errors performed by participants (i.e. repetitive sorting the cards by the category that was correct in the previous set and had changed or by repetitive sorting the cards by another incorrect category). In order to complete WCST, participant needs to construct the plan to sort the cards according to one of the dimensions, one needs to keep the plan in mind to perform the action; the next step is to perform the behaviour and if necessary, detect an error and correct an error, which would also involve cognitive control. As Zelazo and Muller (2007) point out, the perseverative performance on the WCST and inflexibility might occur at any stages (mentioned above) of completing a task.

Therefore, one of the possible explanations of the mixed results of the two correlational and the experimental study is that in fact the task used in the experimental study (Experiment 3) did not necessarily measure the same aspects of cognitive flexibility as WCST (used in correlational Experiments 1 and 2). It could be that the performance in WCST (perseverative error measure) reflects other components of EFs rather than cognitive flexibility, such as inhibition as one needs to inhibit the urge to apply the sorting

rule used in the previous set. Alternatively, perhaps, the irony task from the Experiment 3 did not measure cognitive flexibility at all. In my experimental study (Experiment 3) I manipulated cognitive flexibility by assigning children to one of the three switching conditions – they were either presented with the videos from the Shared and Non-Shared Knowledge condition (5 of each type) intermingled at the beginning of the session or they could see five Shared Knowledge videos first followed by control tasks and then five videos from the Non-Shared Knowledge condition (or vice versa). I assumed that children who heard Shared Knowledge vignettes intermingled with Non-Shared Knowledge vignettes would find it harder (than children in 'blocked' conditions) to demonstrate their ability to take Shared Knowledge into account when interpreting irony, simply because of the increased switching load.

Given the complexity of the construct of cognitive flexibility laid out earlier in this section, it might be the case that in fact my experimental manipulation does not inform us about the role of cognitive flexibility in children's understanding of irony. That is, in the 'blocked' conditions the participants are presented first with five videos in a row from either Shared or Non-Shared Knowledge conditions, followed by control tasks and then again five consecutive videos from the condition they have not seen before (either Shared or Non-Shared). Therefore, although it might be easier for a child to realise whether the utterance should or should not be interpreted literally due to the knowledge state of the interlocutors (what would be reflected in the proportion of the ironic responses they choose) when they are watching the videos from the 'blocked' conditions, this may not be an accurate indicator of the influence of the cognitive flexibility on irony interpretation. Perhaps the experimental manipulation was unable to completely remove the requirement for cognitive flexibility in the non-intermingled conditions and thus it

was not possible to test whether or not cognitive flexibility plays a role in irony interpretation.

Another reason of why my experimental manipulation might not have captured the effect of cognitive flexibility is that implicit switching between the literal and ironic meanings always occurs. That is, even if one only had a block of ironic utterances, the literal meaning would still be activated at some level (e.g., De Neys & Schaeken, 2007). Although this view of irony interpretation is hotly contested (e.g., Gibbs, 1983; Kowatch et al., 2013), it could not have been explored further within the current experimental manipulation as the measures used in Experiment 3 were offline. Therefore, it could be that by the time the child made the forced-choice response, he or she must had already processed both the literal and the ironic meaning – so the switching had already occurred. Perhaps using online measures, such as eye-tracking, would enable detecting the role of mental set-switching in irony comprehension. Therefore further research is required to rule out this possibility.

Summing up, in my correlational studies (Experiments 1 and 2) I also explored the role of cognitive flexibility in irony understanding and I did find a relationship between the two. However, the link between cognitive flexibility and irony comprehension was not confirmed in the experimental study (Experiment 3). Therefore, although there are theoretical implications for the role of cognitive flexibility in irony comprehension by children, perhaps the manipulation used in Experiment 3 did not completely remove the requirement for cognitive flexibility in the non-intermingled conditions. Also, the inconsistent results might indicate that in the experimental and correlational studies I tested different aspects of cognitive flexibility. In future research, it might be worth to explore the relationship between cognitive flexibility and irony understanding further.

**5.5. Irony comprehension in children with ASD.** One way of exploring the cognitive factors involved in the development of irony comprehension in children is to look at the atypical populations. Individuals with Autism Spectrum Disorder have deficits in various domains of pragmatics and social cognition, such as having difficulties with referential communication, narration, and understanding of humour or figurative language (e.g., metaphors, idioms, indirect speech acts or irony) (for the review see Kalandadze, Norbury, Nærland, & Næss, 2016). Impairments in pragmatics, particularly in the ability to interpret non-literal language, might cause real difficulties for naturalistic social interaction(e.g., Aijmer, 2019). However, it is still not clear whether all types of non-literal language are equally impaired in the individuals with ASD.

There were twelve studies found which have investigated how children and adolescents with Autism Spectrum Disorder comprehend irony. The results of the studies were inconsistent regarding the differences in irony comprehension between individuals with ASD and typically developing children. Eight studies found that children with ASD performed worse on the tasks measuring irony comprehension (i.e., Adachi et al., 2004; Happé, 1993; Huang, Oi, & Taguchi, 2015; Kaland et al., 2005; Kaland, Mortensen, & Smith, 2011; Li, Law, Lam, & To, 2013; Peterson, Wellman, & Slaughter, 2012; Wang, Lee, Sigman, & Dapretto, 2006). In the other four studies there were no differences found between the ASD and typically developing individuals (i.e., Bara, Bucciarelli, & Colle, 2001; Glenwright & Agbayewa, 2012; Pexman et al., 2011). It is important to note that although children with ASD very often are reported to perform worse on irony tasks as compared to typically developing children, their performance in many studies is still above chance (e.g., Wang et al., 2006).

One of the factors influencing between-study differences might be the group matching strategy (see Kalandadze et al., 2016 for a meta-analysis). Out of eight studies

in which it was found that children with ASD perform worse on the irony tasks than typically developing children, only Kaland et al. (2011) matched their participants well for chronological age, full-scale IQ, performance IQ, and verbal IQ. In three studies the groups are well matched for chronological age but not for verbal abilities (Kaland et al., 2005; Peterson et al., 2012; Wang et al., 2006). In Happé's (1993) study participants were neither matched for chronological age nor for verbal IQ. In two studies typically developing children were assumed to have intelligence scores within 'typical' scale and were not tested for their verbal abilities at all (Adachi et al., 2004; Huang et al., 2015). In one study the authors present mean ages and language measure's scores together for both groups (Li et al., 2013).

Overall, although individuals with ASD are believed to perform worse on the irony tasks than typically developing children, less obvious differences between the two populations are seen when the irony tests used have less verbal and social demands. It has been shown that when the tasks measuring irony comprehension minimize these demands children with ASD can understand irony (for instance, in the context of computer-mediated tasks; Glenwright & Agbayewa, 2012).

Therefore, given the inconsistent results of the research to date on irony comprehension in children with ASD, I think that it is worth it for future studies to investigate this phenomenon further. Firstly, it might be the case that children with ASD will be able to demonstrate their abilities to understand some forms of irony when the irony tests are adjusted to their verbal skills and are less demanding as some of the researchers suggest (e.g., Glenwright & Agbayewa, 2012). It would also be interesting to explore the role of other factors in irony comprehension in children in ASD, such as Executive Functions as it might be the case that the difficulties with understanding this form of non-literal language are driven by other cognitive variables such as cognitive

flexibility. Furthermore, looking at more specific pragmatic skills, such as irony comprehension might provide more insight into the mechanisms and processes explaining the pragmatic development in both ASD and typically-developing children.

### 5.6.Conclusions and future directions

The literature to date has predominantly focused on the comprehension of Simple forms of irony and the role of mentalising, neglecting other forms of this non-literal language and other cognitive factors that may contribute to irony comprehension. In this thesis I moved away from paradigms which give participants Simple ironic criticism and ask them to decide whether the utterances are meant literally or not. Especially in Experiment 3 (Chapter 4) I developed a novel measure for irony comprehension in children, in which children were asked to select how they thought the listener might respond to the ironic or literal utterance. In addition, in this thesis I attempted to investigate the cognitive underpinnings of the irony interpretation in children controlling for theoretically important covariates such as formal language and non-verbal IQ. Together, the findings from Experiments 1-3 raise questions about the role of mentalising and Executive Functions in understanding of different forms of irony by school-aged children. The two correlational studies constituted a step-change for the literature by indicating the potential influence of cognitive flexibility in how children learn to interpret Simple and Complex forms of irony. Yet, the findings form the correlational studies regarding the role of mentalising are not consistent. The experimental manipulation form Experiment 3 showed the importance of mentalising, but not cognitive flexibility, in how seven-year-olds interpret ironic utterances. The evidence presented in this thesis provides scope for further research, in which the measures used to test irony comprehension in children should be revised and other non-social cognitive factors underpinning irony comprehension should also be considered.

Following this, it is essential for the field of irony interpretation in children to focus on the experimental work given the patchy picture from the correlational studies. This approach would advance understanding of the mechanisms and cognitive processes behind irony comprehension in children. One of the possible experimental means of testing whether EF, or more specifically – cognitive flexibility, is involved in irony interpretation is the depletion of cognitive flexibility in children and measuring its impact on performance in irony interpretation tasks. Powell and Carey (2017) recently demonstrated that phenomenon of EFs depletion can be observed in children as young as five and that the reduction of available EFs resources interferes with successful reasoning about false beliefs. Perhaps similar experimental paradigm could be used in irony interpretation studies to test whether cognitive flexibility is needed for children's irony interpretation competencies.

With regards to the role of mentalising in irony comprehension, it might be interesting to see whether the ToM training programme could increase children's irony interpretation competencies. The results of the meta-analysis conducted by Hofmann et al. (2016) revealed that ToM training procedures are effective in improving children's ToM skills. Therefore, it might be possible that if mentalising is in fact essential for irony comprehension, such training would enhance performance in irony tasks.

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## APPENDIX A.

## SCRIPTS OF THE VIDEO STIMULI FOR CHILDREN – EXPERIMENT 1

### COMPLEX IRONY:

**1.**

Sally: Could you wash my plate?

Tom: Do you want me to tidy your room, too?

*DV (forced choice): "What does he mean?"*

A. I definitely will not help you with washing up.
B. I like taking care of my little sister
C. I feel sorry for you so I will help you

**2.**

Tom: I have been invited to a party by the most beautiful girl in my class.

Sally: Yeah, and I have been invited to the Queen's party.

*DV (forced choice): "What does she mean?"*

A. I think that the Queen's party would be more interesting.
B. I don't believe that you were invited to that girl's party.
C. I don't want to talk about that beautiful girl's party.

**3.**

Sally*:* Do you think I should package up the phone before posting it?

Tom: No, just put a stamp on it and pop it into the post.

*DV (forced choice): "What does he mean?"*

A. Of course you need to package it up before posting.
B. This phone does not need to be packed before posting.
C. I am surprised that you want to package the phone.

**4.**

Boy: Is your new teacher nice?

Girl: He has nice shoes.

*DV (forced choice): "What does she mean?"*

A. My teacher's shoes were much nicer than his shirt.
B. His shoes were the only thing I liked about him.
C. I am surprised that a teacher has such cool shoes.

**5.**

Tom: Can you help me cook the dinner? I'm tired.

Sally: Oh yes, because I have just been sitting around doing nothing at school today.

*DV (forced choice): "What does she mean?"*

A. I'm cross because you do not understand what a bad day I have had.
B. I'm actually saying 'no' because I am too tired to cook with you.
C. I will help you to make the dinner because I'm really bored.

**SIMPLE IRONY:**

**1.**

*Boy*: Can I have a sweet?

*Girl*: [hands him an empty wrapper]

*Boy*: Thanks a lot!

*DV (forced choice): "What does he mean?"*

A. It's kind of her to give me the wrapper.
B. It's selfish of her to give me the wrapper.
C. She has helped me not to get fat.

**2.**

Tom knocked over a glass and spilt the juice over the clean tablecloth.

Sally: "Well done!"

*DV (forced choice): "What does she mean?"*

A. I am glad that you didn't break the glass.
B. I am cross that you knocked over the juice.
C. The tablecloth looks better with stains from juice.

**3.**

Sally wants to help Tom with maths. But he does not follow her instructions.

Sally: "You are a great listener."

*DV (forced choice): "What does she mean?"*

A. You didn't interrupt me when I was giving the instructions.
B. You listened to me and you are great at following the instructions.
C. You weren't listening to me when I was giving the instructions.

**4.**

Sally and Tom are eating crisps in the park. One crisp falls on the ground. Sally picks it up and eats it.

Tom: 'Yummy!'

*DV (forced choice): "What does he mean?"*

A. I wish I could eat a crisp, too.

B. I am disgusted that you ate a dirty snack.

C. I am very worried about your health.

**5.**

Sally and Tom want to go for a picnic. It has just started to rain.

Tom: It's a perfect day for picnic.

*DV (forced choice, reaction time): "What does he mean?"*

A. I like it when it's sunny when we go for a picnic.

B. I don't like when it's hot and sunny in the park.

C. I am upset that we can't go out because it's raining.

**Literal Check:**

**1.**

Sally can't find her book. 'Where is my new book?'

Tom: It's on the kitchen table.

*DV (forced choice) What does Tom mean?*

A. I don't really know where your new book is.

B. I'm telling you that I wanted to read this book too.

C. I'm telling you where you can find your book.

**2**.

Tom: What are you watching?

Sally: I am watching the new talent show.

*DV (forced choice,): What does Sally mean?*

A. I'm watching a new TV series.

B. I'm watching the new talent show.

C. I'm not watching TV right now.

**3.**

Sally and Tom are going to visit their friend.

Sally: 'What time does the bus leave?'

Tom: I'm sure it leaves at 10:45.

*DV (forced choice, reaction time): What does he mean?*

A. I don't know what time the bus leaves.
B. I'm telling you what time the bus leaves.
C. I think that this bus stop is not in use.

**4.**

Boy: What do you think about our new boy?

Girl: He is very kind. He gave me an apple yesterday.

*DV (forced choice): What does she mean?*

A. I don't think that the new boy is nice.
B. I think that the new boy is very kind.
C. I'm glad the new boy helped me with homework.

**5**.

Tom: Would you like to go to the cinema with me this Sunday?

Sally: Yes, sure. Should we go to see a new Lego Batman movie?

*DV (forced choice): What does she mean?*

A. I don't really want to go to the cinema with you.
B. I think that going to the cinema is a waste of time.
C. I want to go to the cinema with you to see that movie.

**ADDITIONAL PRACTISE STORIES:**

**1.**

Tom: Where are you going?

Sally: I am going to the toilet.

*DV (forced choice, reaction time): What does she mean?*

A. I want to tell you that I'm going to the shop.
B. I want to tell that I'm going home.
C. I want to tell you that I'm going to the toilet.

**2.**

Sally: Where did you buy your shoes?

Tom: In the shoe shop around the corner.

*DV (forced choice, reaction time): What does he mean?*

A. My sister bought me the new pair of shoes.

B. This is not my new pair of shoes.

*C.* I bought them in the shop around the corner.

## APPENDIX B.

## WORDING AND SCORING FOR STRANGE STORIES

1. **Kittens (persuasion)** (maximum score = 2)

Adapted from 'Strange Stories' (Happé, 1994) to make language age appropriate (i.e. throw kittens away, not drown them)

*Tom wanted to buy a kitten, so he went to see Mrs Smith. Mrs Smith had lots of kittens she didn't want. Mrs Smith loved the kittens, and would never hurt them, but she couldn't keep them all herself. When Tom visited he wasn't sure if he wanted one of Mrs Smith's kittens. All of Mrs Smith's kittens were white and Tom wanted a black kitten. Then Mrs Smith said, "If no one buys the kittens I'll have to throw them away with the rubbish"*

**Mental State Question:** *Why did Mrs Smith say that to Tom*?
Scoring for mental state question:

2 points—reference to persuasion, manipulating feelings, trying to induce guilt/pity (e.g., "*she was trying to make her feel sorry for the kittens so she would buy one*")

1.5 points— responses which clearly indicate a causative (e.g., make X buy / get X to buy) – that is, making Tom buy the kittens – even if Tom's mental state not referred to. (e.g., "to make him get one because she wouldn't actually put them in a bin" or "to get him to buy one")

1 point—reference either to outcome (to sell them or get rid of them) <u>in a way which implies not hurting</u> (e.g., 'because she wanted him to buy them" or "so he could take them all" ) or reference to inducing a mental state in the other protagonist, where this is not quite the right mental state (e.g., "*to make Tom sad*")

0.5 points—reference to the dilemma (e.g., "she has too many kittens") where is it not clear from this statement alone whether she would hurt the kittens.

0 points—reference to general knowledge or statement which implies that the child thinks she WOULD throw the kittens away with the rubbish (e.g., "*she's a horrible woman*")

**Check Question**: Was it true, what Mrs Smith said? Would Mrs Smith really have thrown the kittens away with the rubbish?
0.5 points – no
0 points – yes

***Scoring rules for check question:***

- The score for this check question is 0.5.
- If the child says 'no' to this question, despite scoring 0 for the first question, the child would score 0.5 overall for this item.
- Likewise, if the child would have scored '1' (because e.g., s/he said 'to get her to buy them'), then if this control question is passed, the child gets 1.5 overall.
- If the child would have scored 1.5 points, then if this control question is passed, the child gets 2 points overall.
- If the child would have scores 2 points for the test question, then if control question is passed, the child gets 2.5 points overall.
- IMPORTANT: If the child FAILS this question (zero), then the score of the first question is changed so that the child scores zero overall).

**2. Hidden Biscuits (Double Bluff)** (maximum score = 3)

*Adapted from Happé's original 'Prisoner's Double-Bluff' Strange Story item (acccompanied by pictures).*

*Lucy has a big brother who is called David. David is always eating Lucy's biscuits so she has hidden them from him. David knows Lucy put the biscuits either in the bedroom or in the garden. David thinks that Lucy will not want to tell him where the biscuits are because she will want to eat them herself. David thinks she will lie about where the biscuits are. Lucy is very clever, she will not let David find her biscuits. The biscuits are in her bedroom. When David asks Lucy where her biscuits are, she says, "They are in the bedroom".*

**Mental State Question:** Why did Lucy say that?

Scoring for mental state question:

2 points—reference to fact that David will not believe and hence look in other place, reference to Lucy's realization that that's what he'll do, or reference to double bluff (and also give two points if this information is actually revealed in the answer to '*Where will David look for Lucy's biscuits?' e.g., if child says 'to trick him' in response to this question but 'he would look in the garden because he would think she played a trick on him*'

Also count '*to trick him that they are in the garden*'
Also count '*because he would think she is lying*'.

Also score as 2 if this is expressed in a syntactically odd manner as in '*so [because] he would think she was lying so he would think they aren't [in the bedroom]*.'

1 point—reference to outcome (to stop David eating the biscuits) or to stating that she wanted to trick him (without any further explanation). Also score as one if the child answers '*Because she might be lying*' as long as the child states that David will look in the garden for the follow up question.

0 points—reference to motivation that misses the point of double bluff (e.g., "*she was angry*") or thinks Lucy is trying to get him to go to the correct location or that Lucy thinks he will look in the bedroom but will still nonetheless not find them (because they are up on a high shelf).

**Check Question 1: Is it true what Lucy said?**
**1 point** – 'Yes'
**0 points** – 'No'
**Check Question 2: Where will David look for Lucy's biscuits**?
**1 point** – 'in the garden'
**0 points** – 'in the bedroom'/elsewhere

**3. Christmas present (from White, Hill, Happé, Frith, 2009)** (maximum score = 2)

*Helen waited all year for Christmas, because she knew at Christmas she could ask her parents for a rabbit. Helen wanted a rabbit more than anything in the world.*
*At last Christmas Day arrived, and Helen ran to unwrap the big box her parents had given her. She felt sure it would contain a little rabbit in a cage.*
*But when she opened the present, with all the family standing round, she found her present was just a boring pile of books which Helen did not want at all!*
*Still, when Helen's parents asked Helen how she liked her Christmas present, she said, ''It's lovely, thank you. It's just what I wanted.''*

**Q: Why did Helen say this?**

**2 points**—reference to white lie or wanting to spare their feelings; some implication that this is for parent's benefit rather than just for her, desire to avoid rudeness or insult

**1 point—**reference to trait (she's a nice girl) or relationship (she likes her parents); purely motivational (so they won't shout at her) with no reference to parent's thoughts or feelings; incomplete explanation (she's lying, she's pretending)

**0 points**—reference to irrelevant or incorrect facts/feelings (she likes the present, she wants to trick them)

**4. Burglar (from White, Hill, Happé, Frith, 2009)** (maximum score = 2)

*A burglar who has just robbed a shop is making his getaway. As he is running home, a policeman on his beat sees him drop his glove. He doesn't know the man is a burglar, he just wants to tell him he dropped his glove. But when the policeman shouts out to the burglar, ''Hey, you! Stop!,'' the burglar turns round, sees the policeman and gives himself up. He puts his hands up and admits that he did the break-in at the local shop.*

**Q: Why did the burglar do that?**

**2 points**—reference to belief that policeman knew that he'd burgled the shop/ the child would need to demonstrate that the protagonist misconstrued the mental state of the policeman (e.g., 'thought he knew that he'd stolen...' or 'because he thought that he is gonna get arrested but the policeman wasn't going to' or 'cause he didn't notice that he had dropped his glove and he thinks that policeman saw him out of the shop').

**1 point**—if the child merely mentions the burglar's mental state (e.g., 'because he knew that he couldn't get away from the policeman' or 'because he knew the policeman was going to get him', then the child would get a score of '1'.

**0 points**—factually incorrect／irrelevant answers/A statement like 'because he was telling the truth that he broke into the shop' would get zero.

## APPENDIX C.

## MEANS AND SDS FOR ALL IRONY ITEMS – EXPERIMENT 1

| Irony Item | Mean (SD) |
|---|---|
| **Simple Irony** | |
| *1.* Boy: Can I have a sweet?<br>Girl: [hands him an empty wrapper]<br>Boy: Thanks a lot! | .90(.30) |
| *2.* Tom knocked over a glass and spilt the juice over the clean tablecloth.<br>Sally: 'Well done!' | .82(.39) |
| *3.* Sally wants to help Tom with maths. But he does not follow her instructions.<br>Sally: 'You are a great listener.' | .90(.30) |
| *4.* Sally and Tom are eating crisps in the park. One crisp falls on the ground. Sally picks it up and eats it.<br>Tom: 'Yummy!' | .59(.50) |
| *5.* Sally and Tom want to go for a picnic. It has just started to rain.<br>Tom: 'It's a perfect day for picnic'. | .59 (.48) |
| **Complex Irony** | |
| *1.* Sally: Could you wash my plate?<br>Tom: Do you want me to tidy your room, too? | .24(.43) |
| *2.* Tom*:* I have been invited to a party by the most beautiful girl in my class.<br>Sally: Yeah, and I have been invited to the Queen's party. | .25(.44) |
| *3.* Sally: Do you think I should package up the phone before posting it?<br>Tom: No, just put a stamp on it and pop it into the post. | .20(.40) |
| *4.* Boy: Is your new teacher nice?<br>Girl: He has nice shoes. | .55(.50) |
| *5.* Tom: Can you help me cook the dinner? I'm tired.<br>Sally: Oh yes, because I have just been sitting around doing nothing at school today | .08(.27) |

## APPENDIX D.

## VIGNETTES USED IN PILOT STUDY WITH CHILDREN IN EXPERIMENT 3.

1. The King and the Queen want to go for a picnic. It has just started to rain. They both look out of the window.

   King: '*It's a perfect day for a picnic*'

2. The King and the Queen are in the kitchen. The King knocks over a glass and spills the juice over the clean tablecloth.

   The Queen looks at the stain and says: '*Well done.*'

3. Queen wants to draw a beautiful picture for her friend's birthday. She is trying to draw a beautiful butterfly. While she is drawing, the Queen's crayon breaks in half.

   Queen: *'I am so lucky today!'*

4. The King and the Queen are eating cake. The Queen has some chocolate on her face but she doesn't like to be dirty. Queen: "Can you pass me a napkin?" [King moves very, very slowly]

   Queen: 'You are so fast.'

5. The King and the Queen play for the same football team. They really want to win this match. The Queen kicks the ball, clearly missing the net.

   King: '*Great – now we're definitely going to win.'*

## APPENDIX E.

## VIGNETTES USED IN MAIN STUDY OF THE EXPERIMENT 3

| | Shared Knowledge | Non-Shared Knowledge | Possible listener's responses |
|---|---|---|---|
| *1.* | [12]It is Sunday. Matt and Emma really want to go for a picnic in the park. They open the window curtains and they can both see that it is raining. Matt says, '**It's a perfect day for a picnic**.' | Matt and Emma really want to go for a picnic in the park. Matt peaks through the closed curtains and he can see that it is raining. Emma cannot see the rain. Matt says, '**It's a perfect day for a picnic**.' | *a) That's great. Let's go then.*<br>*b) We could always have one inside.* |
| *2.* | Matt and Emma want to play football in the garden. Matt and Emma go to the room to bring the ball. They can both see that the ball is flat. Matt says**, 'That's a great ball we have here!** | Matt and Emma want to play football in the garden. Matt goes to his room to bring the ball. Matt can see that the ball is flat. But Emma cannot see it. Matt says, **'That's a great ball we have here!'** | *a) We might need another ball then.*<br>*b) Great, bring it over and let's play!* |
| *3.* | Matt and Emma are going to their friend's house. They are walking together. When they are at the gate, they can both see a very old house. Emma says to Matt, '**Wow, this house is so new!'** | Emma is going to see her friend's house. Emma is at the gate and she can see a very old house. But Matt cannot see it. Emma says to Matt over the phone, '**Wow, this house is so new!'** | *a) I think it needs some work!*<br>*b) Do you like the style?* |

[12] The 'Shared Knowledge' version of the picnic vignette is adapted from Happé (1994).

| | | | |
|---|---|---|---|
| *4.* | Emma and Matt are eating crisps. They can both see that one crisp falls into the bin. Emma takes the crisp from the bin and eats it.<br><br>Matt says, **'That must be yummy!'**[13] | Emma is eating crisps. One crisp falls into the bin. Emma takes it from the bin and eats it. Matt did not see the crisp falling to the bin. Matt says, **'That must be yummy'** | *a) Do you want one, too?*<br>*b) I don't like wasting food.* |
| *5.* | Emma and Matt just got their maths homework back. Emma asks Matt, 'Did you do well?' Emma can see Matt's notebook with the red crosses on it. Matt says,<br>'**I have got so many right answers'.** | Emma and Matt just got their maths homework back. Emma asks Matt, 'Did you do well?' Emma cannot see Matt's notebook with the red crosses on it. Matt says,<br>'**I have got so many right answers'.** | *a) Maybe the teacher got it wrong?*<br>*b) I am happy for you!* |
| *6.* | Emma and Matt are eating chocolate cookies. Emma and Matt can see that Emma's face is all dirty. Matt says, '**You look great'** | Emma and Matt are eating chocolate cookies. Emma's face is all dirty but she cannot see it. Matt says, '**You look great"** | *a) Thank you, that's really nice of you.*<br>*b) I know, I really need to clean up.* |
| *7.* | The washing machine has been working and now is finished. Emma and Matt are taking out the laundry from the washing machine. They can both see that the laundry that they took out is still all dirty.<br>Matt says, '**Our washing machine works so well!'** | The washing machine has been working and now is finished. Matt is taking out the laundry from the washing machine. The laundry that he took out is still all dirty. But Emma cannot see Matt taking out the laundry.<br>Matt says, '**Our washing machine works so well!'** | *a) I think it needs fixing.*<br>*b) Yes, we are lucky to have it!* |

[13] The idea for the Shared Knowledge version of this vignette originates in an item from Bucciarelli, Colle & Bara (2003).

| | | | |
|---|---|---|---|
| *8.* | Matt and Emma are trying to vacuum the living room now. They can both clearly see that the vacuum is not working properly. All the dirt stays on the floor!<br><br>Emma says, ' **It's so nice to see all the dirt disappearing so quickly'** | Emma is trying to vacuum the hallway. But she can see that the vacuum is not working properly. All the dirt stays on the floor!<br><br>But Matt cannot see the dirt. Emma says, '**It's so nice to see all the dirt disappearing so quickly!'** | *a) Good job, thanks for vacuuming!*<br>*b) We need a new vacuum cleaner.* |