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Title:

Strategies of deception: under-informativity, uninformativity and lies – misleading with different kinds of implicature

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Abstract

Conversation is often cast as a cooperative effort, and some aspects of it, such as implicatures, have been claimed to depend on an assumption of cooperation (Grice, 1989). But any systematic class of inference derived from assumptions of cooperation, such as implicatures could also be, on occasion, used to deceive listeners strategically. Here we explore the extent to which speakers might choose different kinds of implicature triggers in an uncooperative game of communication. Concretely, we present a production study in the form of a cooperative or competitive signalling game with the potential of exploiting three kinds of implicatures, namely exact reading of numeral expressions, scalar implicatures and particularised *Ad hoc* implicatures. We find that while the *exact* interpretation of numerals is used similarly to truth-conditional content, scalar and particularised implicatures elicit different strategies. We also observe heterogeneity in individual strategic behaviour. Expecting a distrustful receiver, some participants used high rates of uninformative hints, and equal rates of true and false hints. Other participants used a higher rate of lies and false implicatures, suggesting that they were expecting their interlocutor to infer implicatures as if they came from a cooperative speaker.

Introduction

Grice (1989) famously presents conversation as a cooperative activity in which participants abide a *cooperative principle*, which binds them to make appropriate contributions to the conversation. From this principle follow more specific maxims such as the first maxim of quantity: "Make your contribution as informative as is required" (Grice, 1989, p. 45). Speakers can exploit the maxims in order to communicate implicit propositions (implicatures) of various types. For example, the speaker can violate the first maxim of quality to communicate a quantity implicature. If I tell you that *I used some of your new shampoo* in a context where it would be relevant and more informative to know whether

I used all of your shampoo, you may infer that the reason why I am violating the first maxim of quantity is that the more informative statement is not true and therefore infer the implicature that *I did not use all of your shampoo*. The last two decades witnessed a wave of experimental investigation of how different types of quantity implicatures are processed and interpreted; and in harmony with Grice's account, these investigations have focused on situations where the cooperation and honesty of the speaker is taken for granted. However, conversation also takes place in non-cooperative or competitive situations, where the speaker may be deceptive or uninformative. Politicians are often good examples of unhelpful interlocutors. For instance, consider this evasive answer that Theresa May gave in 2016 when asked whether the UK should have access to the EU single market after Brexit: "What I want to see is the best possible deal for the United Kingdom in trade in goods and services" (Bull, 2016). The use and comprehension of implicatures in non-cooperative settings is a vastly understudied topic. The very few existing comprehension studies on this topic suggest that listeners faced with an uncooperative speaker tend to infer less implicatures than if they are faced with a cooperative speaker (Pryslopska, 2013; Dulcinati & Pouscoulous, 2017). Additionally, to the best of our knowledge no published experiments investigate implicature production in uncooperative contexts. This is precisely what this study will focus on and we will look at the production of different types of quantity implicatures in a non-cooperative setting. It is particularly interesting and timely to fill this gap in the literature, firstly because this method allows us to compare how speakers use explicit and implicit communication strategically, and secondly because it may offer a new perspective on the differences between well studied types of quantity implicatures.

A non-cooperative speaker may differ from a cooperative one in that they may be more likely to deceive or to be uninformative. Although Grice (1989) presents conversation as a cooperative effort, he contemplates both the possibility that speakers may be uninformative by *opting out* of the cooperative principle or of a maxim in an *overt* way, for example by saying "I can't tell you that", and the possibility that they may be deceitful by *covertly* violating a maxim. The paramount example of covert violations of maxims is lying, where the liar covertly violates the first maxim of quality (i.e. "Do

not say what you believe to be false"; Grice, 1989, p. 46) and intends the audience to remain unaware of the violation. Besides lying, the realm of verbal deception includes falsely implicating. While to lie, at least according to traditional definitions (Isenberg, 1973; Primoratz, 1984), is to *say* something that the speaker believes to be false with the intention to deceive; to falsely implicate is to communicate something believed to be false by means of a *conversational implicature* (Meibauer, 2014). For example, if I said that *I used some of your new shampoo* when in fact I believe that I used all of it, I could be falsely implicating that *I did not use all of your new shampoo*. Although there is an ongoing conceptual debate on whether false implicatures should be considered *lies* (Meibauer, 2005, 2014) or not (Dynel 2011, 2015) here we will treat them as separate for the purposes of experiment design and analysis. We let the data speak about any potential difference between false implicatures and lies. Therefore the phenomena which we expect to observe with possibly different behavioural signatures in our study are uninformativity or opting out, lies and false implicatures.

We may expect that explicit and implicit communication[1] (see Cartson, 2002, 2009 and Recanati, 2004 for a review of this distinction), which include lies and false implicatures respectively, are used differently in non-cooperative contexts. One reason for this expectation is that in *cooperative* conversation these two modes of communication are often not interchangeable and in a given context we usually have clear preferences as to whether a piece of information should be asserted or communicated implicitly. Consider the following examples adapted from Russel (2012):

1. Careful! Some of the mushrooms are poisonous!
2. #Careful! Not all of the mushrooms are poisonous!

The utterances in 1 and 2 carry the same content except that the explicit content of the utterance in 1 is implicit in the utterance in 2 and vice versa (see also van Tiel, 2014 for a discussion of a similar example). Since we infer from the expression 'careful' that both utterances are warnings, the key information that the speaker presumably wants to convey is that at least some of the mushrooms are

[1] We will assume that the explicit implicit distinction corresponds to the distinction between Grice's *what is said* and what is *implicated*. However, see Cartson (2002, 2009) and Recenati (2004) for different perspectives.

poisonous, and not that some of them are harmless. Conveying the key information as implicit content rather than explicit content makes the utterance in 2 sound odd. Intuitively, this may be because in this context we would prefer to communicate key information through the relatively '*secure*' channel of explicit information as implicit communication is arguably more prone to misunderstanding (Reboul, 2017). Another reason why we may expect explicit and implicit communication to be used differently in our study is that some features of implicit communication could be advantageous in non-cooperative contexts. For example, implicit communication offers the advantage of *plausible deniability* (Pinker, Nowak & Lee, 2010). Since implicatures are cancellable the communicator can deny having intended to communicate them. For example, after saying that *I used some of your shampoo,* I can claim that I did not mean that I did not finish it, which I could not do if I explicitly said that I didn't use all of it. This feature of implicit communication is useful in cases where the speaker wants to communicate something that may incur them some penalty, such as proposing a bribe or communicating false information. Reboul (2017) proposes that implicit communication may also offer another advantage in that it may be accepted more easily by the hearer than explicitly communicated content. Firstly she claims that hearers are more vigilant towards content that the speaker is strongly committed to, and explicit content carries a higher degree of speaker commitment compared to implicit content (Morency, Oswald & de Saussure, 2008). Secondly she claims that hearers are less vigilant towards content that is the fruit of their own inferences, which is the case for implicatures but not for asserted content.

The previous studies that are closest to the one we are presenting are recent studies looking at non-verbal deception in the context of signalling games where signallers have to give non-verbal hints (e.g., images, maps) to a receiver player who has to make choices based on the information provided in the hints. Crucially in some cases the game is competitive and the signaller benefits from the receiver's wrong choices, which provides motivation to deceive. Signallers can give true hints, false hints, uninformative hints and misleading hints, which like false implicatures consist in conveying a true piece of information which leads the receiver to infer something false. Montague and colleagues

(2011) found that their players preferred giving misleading hints rather than false hints. In their game the receiver did not know whether the signaller was cooperative or competitive and they could choose to check whether the hints were false and calibrate their trust accordingly, which was an incentive for the signaller not to be caught lying as it would have reputation consequences for the rest of the game. In a similar competitive game Ransom, Voorspoels, Perfors and Navarro (2017) gave their participants the options to give to the receiver true, misleading or uninformative visual hints, but not false hints, and they manipulated the signaller's expectations regarding how suspicious or trustful the receiver would be. Because the receiver did not know whether their signaller was honest or deceitful, the signaller could pretend to be helping the receiver while in fact feeding them false or misleading information. They found that when signallers expected a trustful receiver they were more likely to mislead, whereas when they expected a suspicious receiver they were more likely to be uninformative. These studies are similar to ours firstly because we also employed a competitive signalling game and secondly because the types of deception they studied follow the same fundamental mechanisms of the kinds of verbal deception we are interested in, which are to cause someone to have a false belief (Mahon, 2007) either by communicating something false (i.e. false hints, lies) or by communicating something true (i.e. misleading hints, false implicatures).

One important complication of studying explicit and implicit cases of verbal deception is that while the studies on non-verbal deception that we mentioned could draw a clear distinction between false and misleading hints; drawing a distinction between lies and false implicature is not straightforward. In two studies (Coleman & Kay 1981, Hardin, 2010) where participants were asked to rate a false implicature on a scale that ranged from an utterance being a lie to an utterance not being a lie the average rating was near the middle of the scale. In parallel to these results, studies on the explicit-implicit distinction in comprehension found that lay people are likely to consider implicatures part of *what is said* under some circumstances (Nicolle & Clark, 1999; Doran, Baker, McNabb, Larson & Ward, 2009; Doran, Ward, Larson, McNabb & Baker, 2012). Doran and colleagues (2012) asked participants to judge whether sentences that could give rise to an implicature were true or false in the light of a

fact that contradicted the implicature (e.g. judging whether the sentence *I used some of your shampoo* is true given that I used all of it). They found that participants incorporated scalar implicatures arising from quantifiers such as *some* and *most* into the truth conditional meaning of the sentence 32% of the time and implicature arising from cardinal numbers (e.g. *I have three cats* implicating that I don't have four) 53% of the time. Because different types of implicatures maybe differ in whether they are considered part of *what is said*, and therefore in whether they would be considered to be lies if used deceptively, in our study we aimed to gain a more comprehensive perspective by using three different types of implicatures.

We used three types of quantity implicatures: implicatures arising from numerals, the scalar implicature arising from the quantifier *most* and *ad hoc* or *particularised* quantity implicatures. The quantity implicatures or upper-bound interpretations associated with scalar terms and numerals are drawn by negating an alternative utterance where a stronger term on the same lexical scale as the scalar/numeral term is used. For example, the implicature of 'I used *some* of your shampoo' arises from negating the alternative that 'I used *all* of your shampoo'. And the implicature or upper-bound interpretation of 'I have *three* cats' arises from negating the alternative that 'I have *four* cats'. This contrasts with *ad hoc* (sometimes called *particularised*) quantity implicatures where the stronger alternative can only arise from the context and not from the lexicon. For example, in the context where Ann and Rose have their birthdays together someone might say 'I bought a present for Ann' and implicate that they did not buy a present for Rose also. The stronger alternative negated is that they *bought a present for Ann and Rose* but it can only arise in this context as 'Ann' and 'Ann and Rose' are not on a semantic scale. Both scalar terms and numerals have been at the centre of theoretical controversies concerning whether their upper-bound interpretation is an actual implicature or whether it is part of their semantic or *default* meaning (Levinson, 2000; Geurts, 2010).

Although some theorists have proposed that the upper-bound interpretation of scalar terms (e.g. *some and not all*) is their default meaning (e.g. Levinson, 2000; Chierchia, 2004), recent experimental evidence suggests that the scalar implicatures of quantifiers (i.e. some *and not all*) are derived in the

same way as particularised quantity implicatures (see Katsos & Cummins, 2010 for a review). The distinction between scalar and particularised implicatures has received particular attention in the acquisition literature, where experimental studies offer mixed results: some studies suggest that pre-school children have more trouble calculating scalar implicatures compared to *ad hoc* implicatures (Barner, Brooks & Bale, 2010; Stiller, Goodman & Frank, 2011) and others suggesting that they calculate these two types of implicatures to the same extent (Katsos, 2009). Katsos (2009) asked participants to evaluate utterances that could give rise to either scalar or particularised implicatures in contexts where the content of the implicature is false. He found that both adults and children reject scalar implicature utterances and *ad hoc* implicature utterances to the same extent, but adults consider an under-informative scalar-implicature utterance to be a more serious violation of informativity than an under-informative particularised implicature utterance.

With regards to numerals we have again two camps, with some theorists claiming that they have a lower-bound or *at least* meaning while the *exact* interpretation is supplied in context via implicature (e.g., Horn, 1972; Gazdar 1979; Levinson, 2000) and others claiming that numerals the *exact* interpretation of numerals is not an implicature but part of their truth conditional meaning (Carston, 1998[2]; Breheny 2008; Kennedy 2015). Both the study of Papafragou and Musolino (2003) and of Huang, Spelke and Snedeker (2013) provide convincing evidence that numerals have an exact truth-conditional interpretation (i.e. three means 'exactly three') by showing that pre-school children, who are notoriously 'bad' at calculating scalar implicatures (Noveck, 2001; Chierchia et al, 2001; Gualmini, Crain, Meroni, Chierchia, & Guasti, 2001; Hurewitz, Papafragou, Gleitman & Gelman, 2006; Pouscoulous, Noveck, Politzer, Bastide, 2007) tend to give exact interpretations of numerals. Furthermore, Huang and Snedeker (2009) found that while processing the upper bound meaning scalar terms like *some* is slower for adults than processing the literal meaning of the quantifier *all*,

[2] Carston (1998) actually argues that cardinals have an underspecified meaning and that whichever sense they assume in context (i.e. at least, at most or exactly) contributes to the truth conditional meaning of the utterance.

processing the *exact* meaning of numerals is just as fast; suggesting that the former involves drawing a pragmatic inference and the second does not.

In this study we aim to explore how people use explicit and implicit communication in a non-cooperative context. We asked participants to play a signalling game similar to the one employed by Ransom and colleagues (2017) where they had to produce hints for a receiver either in a cooperative or in a competitive scenario. Our game had a number of fundamental differences from the game used by Ransom and colleagues. Firstly, our participants were told that the receiver knew whether the game was cooperative or competitive. This removed the possibility for signallers to pretend that they were cooperative when their actual goal was to misinform the receiver. This feature of the competitive scenario eliminates the possibility of cooperation and, from a Gricean perspective, should push signallers towards the strategy of *opting out* and being uninformative. Secondly, in our game participants gave linguistic hints by completing short descriptions. Since these hints are assertions, the false hints used in the games are lies, in the traditional sense, and the misleading hints give rise to false implicatures. Thirdly, the description templates that signallers completed constrained their hints into pre-determined categories. Half of the description templates pushed participants to convey the hint explicitly and half of them through an implicature – belonging to one of three types: ad hoc quantity implicatures, linked to the scalar quantifier *most* or to the use of cardinals.

Methods

Materials and design

The game used in this paradigm is a signalling game with two players. Each round of the game has two cards such as the cards in ***Figure 1***: a 'winning' card and a 'losing' card. The signaller knows which one is the winning card and they have to describe it. The receiver sees the same two cards but they don't know which one is the winning card. The receiver has to decide which one is the winning card with the help of the description made by the sender.

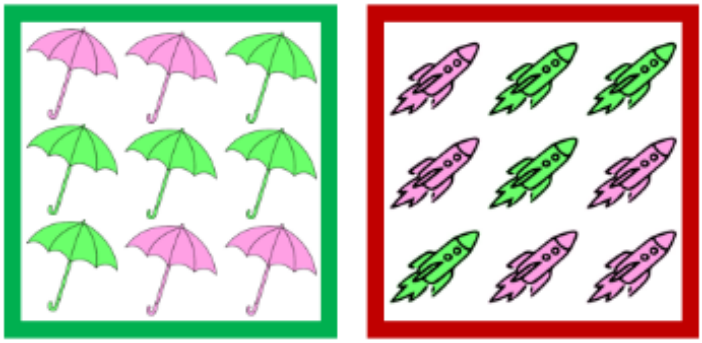


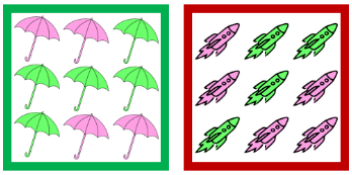
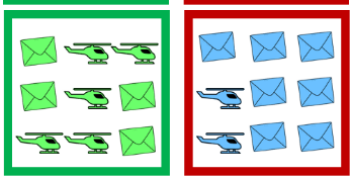
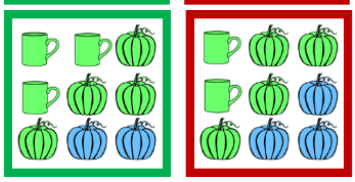
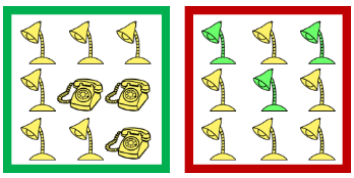
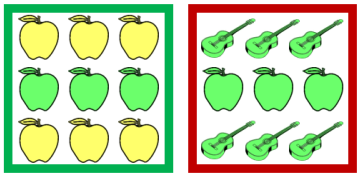
Figure 1 *winning card and losing card associated to the template description "On the winning card all of the objects are ___"*

Participants in our experiment only played the role of the describer, while the receiver player was a virtual player. Participants were assigned to one of two conditions: a cooperative condition or a competitive condition. In the cooperative condition participants were asked to help the receiver find as many winning cards as possible (a game of pure cooperation, in game theoretic terms), while in the competitive condition their goal was to make the receiver click on as many losing cards as possible (a so-called zero sum game).

Materials included in total 36 items (**Appendix A**), which corresponded to 36 rounds of the game: 18 experimental items and 18 control items. Each item consisted of a template description and the two cards: the winning card, marked by a green outline, and the losing card, marked by a red outline (see ***Figure 1***). Rather than write the whole description of the winning card, participants were asked to complete a pre-made description with only one word (e.g. see template description for ***Figure 1***). All items were constructed in such a way that they had two obvious completions, referring either to the shape or the colour of the objects displayed in the cards (green vs. pink and rockets vs. umbrellas in the example in Figure 1). Control items used description templates containing either the quantifiers *all* or *none* and their most obvious completions were a true assertion and a false assertion about the winning card. Experimental items used descriptions that could give rise to three types of quantity implicatures: exact interpretation of numerals, scalar implicatures associated with the quantifier *most* or particularised *ad hoc* quantity implicatures. Experimental items were constructed in such a way that one of the two most accessible completions resulted in a true assertion giving rise to a true

implicature while the other most obvious completion produced a true description giving rise to a false implicature. Within each category of items, control and experimental, we counterbalanced whether it was mentioning the colour or the shape of the object that gave rise to the false assertion for control items or to the false implicature for experimental items. The false assertions and false implicatures in each item were false of the winning card but true of the losing card, so that they could be used to deceive the guesser into thinking that the losing card was actually the winning card. In we **Table 1** provide examples for each category of items.

Table 1 *Examples of each category of items*

Item Type	Description	True completion	False completion	Cards
Control (All)	On the winning card all of the objects are ___	umbrellas	rockets	
Control (None)	On the winning card none of the objects are ___	blue	green	
Experimental (Numeral)	On the winning card two of the objects are ___	blue	mugs	
Experimental (Most)	On the winning card most of the objects are ___	lamps	yellow	
Experimental (Ad hoc)	On the winning card the objects in the middle row are ___	green	apples	

Participants and Procedure

We recruited 103 native English speakers (66 females, Mean Age = 28.73) from the online crowdsourcing website prolific.co.uk and directed them to a Qualtrics website where our experiment was hosted. Participants were told that they would play a game where they would have to complete

descriptions with one word. Since the task required normal colour vision we tested participants using two plates from the Ishihara colour-blindness test (Ishihara, 1917) and participants who failed the test were prevented from continuing the experiment. Each participant was randomly assigned to either a cooperative or a competitive condition in a between-subjects design. Participants in both conditions were told that the other player scored points by clicking on winning cards and that in each round he or she would read their description and use it to decide which card to click on. Participants in the cooperative condition were told that they themselves would score points when the guesser clicked on a winning card. Consequently, their goal was to help the guesser. Instead, participants in the competitive condition were told that they would score points when the guesser clicked on the losing cards. Consequently, their goal was to make the guesser lose. Participants in the competitive condition were explicitly told that the other player knew that the person writing the descriptions was playing against them and vice versa for participants in the cooperative condition. This was to ensure that participants in the competitive condition knew that they could not pretend to be cooperative as the other player would expect them to be uncooperative.

Participants in both conditions were told that the other player did not know that they were completing the descriptions instead of writing them freely. This was to prevent participants from anticipating that the other player would think that the reason why they had not uttered a more informative description in experimental items was because the game prevented them, which would effectively block the derivation of quantity implicatures.

Participants in both conditions were told that they must complete the descriptions with only one word and they were explicitly told that they were allowed to lie. Before allowing participants to perform the actual task of the experiment we asked them four multiple choice questions to check their understanding of the game and we prevented participants who answered incorrectly to any of the four questions from continuing. Instructions for both conditions and control questions are reported in **Appendix B**.

Each participant saw all of the 36 items divided into two randomized blocks. Participants were not given feedback on the choices of the receiver as they believed that the receiver would play the game in a second phase. After the last item participants were asked to predict their performance and estimate on an 11-point scale ranging from 0% to 100% which percentage of rounds the guesser who would read their descriptions would click on the winning card.

Results

Descriptions were automatically coded using an R script which classified each entry according to a predefined list of response types for each item. The list was constructed *a priori* and then adjusted after inspection of the data to accommodate spelling variants and unforeseen strategies. Two-word entries, which were explicitly forbidden in the instructions, were excluded from the analysis. Because of a counterbalancing error we excluded two out of the six *ad Hoc* items from the analysis.

We categorised each description in one of four categories: *true* and *false*, which corresponded to the two most obvious completions that we anticipated (see **Table 1**), as well as *uninformative* and *other*. We classified as uninformative those descriptions which could either apply to both the winning card and the losing card or to neither. For example, an uninformative response for the *all* control item in **Table 1** was "On the winning card all of the objects are *quaint*", and for the *none* control items in which both cards contain helicopters "On the winning card none of the objects are *helicopters*". We classified as *other* descriptions that attempted to describe only one card but not through the two obvious completions we expected. These description mainly fell in one of two categories of alternative strategies. One strategy consisted in mentioning an object associated only with one card even though this resulted in a statement that was false of both cards. An example of this strategy for the *most* item in **Table 1** was "On the winning card most of the objects are *telephones*", which refers to the winning card where telephones are present even though most of the objects are lamps. The other alternative strategy consisted in making reference to whether the objects singled out by the description were the *same* or *different* from the other objects in the card and relying on the preferred reading of the statement as referring to the shape of the objects rather than the colour. An example of this strategy

for the *ad hoc* item in **Table 1** was "On the winning card the objects in the middle row are *identical*". Because the amount of data in these two categories was relatively small we decided to group them together under the category of *other strategies* for the purpose of our analysis.

In the cooperative condition (**Figure 2**) we found that participants had an overwhelming preference for true descriptions in both types of control items (*all* and *none* items) and in items containing numerals. In the *most* and *ad hoc* items participants had a preference for true descriptions but they also gave a considerable number of false descriptions. *most* and particularly *ad hoc* items also differed from the other item categories because of the high rate of *other* responses given by participants: 12% of the responses for *most* items and 30% for *ad hoc* items. In the predicted performance question participants in the cooperative condition estimated that the receiver would click on the winning card 78.15% of the time.

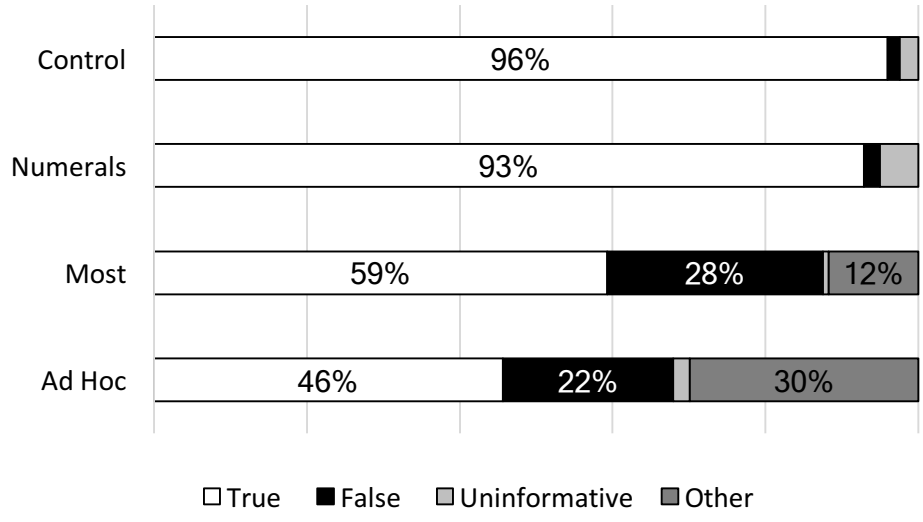


Figure 2 *Proportion of response types in the cooperative condition*

In the competitive condition (**Figure 3**) participants gave mostly equal numbers of true and false descriptions for all types of items. Participants also gave a considerable amount of uninformative descriptions in control items and items with numerals. The rate of uninformative descriptions was lower for *most* and *ad hoc* Items. *Most* and *ad hoc* items also exhibited a higher rate of *other* responses than other item categories but not as large as in the cooperative condition. In the predicted performance question participants in the competitive condition estimated that the receiver would

click on the winning card 49.82% of the time, which was a significantly lower estimate than the one given by participants in the cooperative condition (t(98.81)= -8.351, p<0.001).

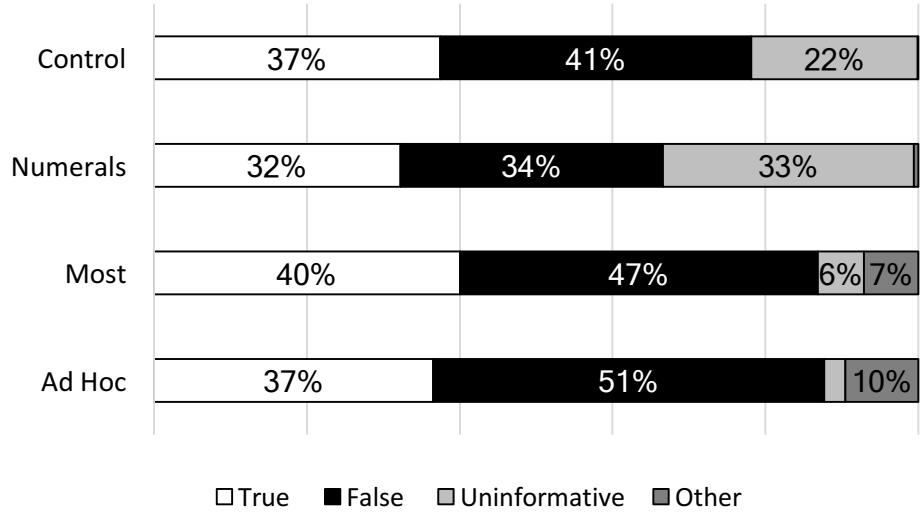


Figure 3 *Proportions of response types in the competitive condition*

We analysed the data by running three binomial regression models. Each model regresses a different outcome variable on the same predictors: condition, item type and their interaction. Item type is a four-level dummy coded categorical predictor with control items as the reference level. Condition is a two-level dummy coded categorical predictor with the competitive condition as the reference level. Therefore, the simple effect of the cooperative condition represents the difference between conditions for control items; the simple effects of Numerals, Most and *ad hoc* represent their difference from control items in the competitive condition, and their interactions with condition factor express how their difference from the control items changes in the cooperative condition.

Model 1 addresses the question of what factors affect the preference for a false description over a true description and the outcome variable was a binary variable where true descriptions were coded as 0 and false descriptions were coded as 1. The details of the analysis are summarised in **Table 2**. The three types of experimental items are not significantly different from control items in the competitive condition. The negative effect of the cooperative condition indicates that participants were less likely to give false descriptions for control items in the cooperative condition compared to the competitive condition. The significant interactions of *most* and *ad hoc* indicate that the difference between these

items from the control items in the cooperative condition is different from their difference in the competitive condition. We do not find evidence that this was the case for numerals.

***Table 2**. Model 1*

	B	*S.E.*	*Z*	*p-value*
(intercept)	0.08	0.07	1.14	.254
Numerals	-0.03	0.15	-0.18	.854
Most	0.07	0.14	0.50	.613
Ad Hoc	0.24	0.16	1.48	.139
Cooperative	-4.22	0.29	-14.62	< .001
Numerals*Cooperative	0.39	0.52	0.74	.459
Most*Cooperative	3.32	0.34	9.77	< .001
Ad Hoc*Cooperative	3.19	0.37	8.53	< .001

Model 2 addresses the question of what factors affect the preference for an uninformative description over all other types of descriptions (true, false and other) and the outcome variable is a binary variable where uninformative descriptions were coded as 1 and all other responses were coded as 0. The details of the analysis are summarised in ***Table 3***. The negative simple effect of the cooperative condition indicates that participants were less likely to give uninformative descriptions for control items in the cooperative condition compared to the competitive condition. The negative simple effects of *most* and *ad hoc* indicate that participants were less likely to give uninformative descriptions for these items compared to control items in the competitive condition. On the contrary, the positive simple effect of numerals indicates that participants were more likely to give uninformative descriptions for these items compared to controls in the competitive condition. The significant interaction indicates that the difference between *ad hoc* items and control items is different in the cooperative condition compared to the competitive condition. In fact, while the rates of uninformative descriptions for control items and ad hoc items is roughly the same in the cooperative condition (i.e. 2%), they are considerably different in the competitive condition.

Table 3. *Model 2*

	B	*S.E.*	*Z*	*p-value*
(intercept)	-1.27	0.08	-16.68	< .001
Numerals	0.55	0.14	3.96	< .001
Most	-1.49	0.24	-6.14	< .001

Ad Hoc	-2.32	0.42	-5.52	< .001
Cooperative	-2.40	0.23	-10.27	< .001
Numerals*Cooperative	0.17	0.38	0.45	0.655434
Most*Cooperative	0.22	0.78	0.28	0.779232
Ad Hoc*Cooperative	2.39	0.66	3.64	< .001

Model 3 addresses the question of what factors pushed participants to resort to *other* descriptions instead of giving true, false or uninformative descriptions. The outcome variable for this model was a binary variable where *other* descriptions were coded as 1 and all other responses were coded as 0. The details of the analysis are summarised in ***Table 4***. The only significant effects are the simple positive effects of *most* and *ad hoc*, which indicate that participants were more likely to give *other* descriptions to these items than to control items in the competitive condition. The fact that their interactions are not significant means that we have no evidence that this trend was any different in the cooperative condition.

Table 4. *Model 3*

	β	*S.E.*	*Z*	*p-value*
(intercept)	-6.915	1	-6.911	< .001
Numerals	1.797	1.226	1.465	0.143
Most	4.35	1.023	4.253	< .001
Ad Hoc	4.747	1.024	4.634	< .001
Cooperative	-13.651	609.583	-0.022	0.982
Numerals*Cooperative	-1.797	1219.166	-0.001	0.999
Most*Cooperative	14.262	609.58	0.02	0.981
Ad Hoc*Cooperative	14.962	609.58	0.02	0.98

Although the overall proportions of true and false descriptions in the competitive condition seem roughly equal for each category of items (see ***Figure 3***), we found that these overall proportions were the result of different, sometimes opposed, individual strategies. For example, some participants consistently gave false descriptions while others consistently gave true descriptions, and we found that these strategies were reflected in the performance predictions that participants gave about the receiver who would read their descriptions. For this reason we performed a clustering analysis on the participants in the competitive condition in order to find out whether these individual strategies could be classified under a number of meaningful strategy profiles. We performed k-means clustering

analysis in R using four variables for each participant: overall proportion of true descriptions, overall proportion of false descriptions, overall proportion of uninformative descriptions and expected performance of the receiver. Using the average silhouette methodology (Rousseeuw, 1987), which allows to visually compare the quality of different clustering solutions in terms of tightness and separation of the clusters in each solution, we determined that the clustering solution that best summarised the data was a three-cluster solution. The three clusters are summarised in ***Table 5*** which reports each cluster's average values of the four variables we used in the analysis (i.e. expected performance, overall proportions of true, false and uninformative descriptions; in the table as *clustering variables*) together with each cluster's average proportions of description types for each category of items.

Table 5. *Clustering variables and proportions of response types for each item category by clustering groups*

Cluster and size	Item type	Response type				Performance
		True	*False*	*Uninformative*	*Other strategies*	
Cluster 1	Clustering var.	59%	17%	16%		69%
N 18	Control	74%	07%	19%	01%	
	Numeral	55%	03%	37%	06%	
	Most	48%	49%	02%	01%	
	Ad Hoc	49%	42%	1%	8%	
Cluster 2	Clustering var.	24%	57%	11%		38%
N 32	Control	21%	66%	13%	0%	
	Numeral	24%	54%	22%	0%	
	Most	37%	51%	3%	9%	
	Ad Hoc	31%	55%	2%	12%	
Cluster 3	Clustering var.	16%	15%	59%		55%
N 6	Control	16%	6%	79%	0%	
	Numeral	6%	19%	75%	0%	
	Most	31%	19%	33%	17%	
	Ad Hoc	21%	50%	12%	17%	

Cluster 1 is characterised by a high rate of true descriptions and a high expected success rate (performance) of the receiver. Participants in this cluster were therefore mostly playing the game as

if their goal was to help the receiver as a high success rate of the receiver in the competitive condition corresponds to a low performance of the signaller, who caused the signaller to make only a few mistkes. Cluster 2, the most numerous, is characterised by a high rate of false descriptions and by the lowest expected performance of the three clusters. Participants in this cluster were mostly lying or falsely implicating and they expected their strategy to cause the receiver to perform worse than chance. In other words, those who believed to perform well as deceptive senders (and better than chance) are exactly those who used misleading implicatures. Cluster 3 is characterised by the highest rate of uninformative descriptions and an expected performance near chance. Although the rate of uninformative descriptions that these participants gave for *most* and *ad hoc* Items is still relatively high compared to the other clusters it is lower than for Control items and Numerals as participants seem to rely more on other strategies and on true and false responses.

Discussion

Our participants played a signalling game in which they were either helping or competing against a receiver. Their task was to complete descriptions that could help the receiver choose the wining card out of each pair of cards. Some items pushed signallers to convey the hint via assertion and others via implicature (numerals, *most,* and *ad hoc*). We categorised the hints used by participants into four types. True hints, that could be either true assertions or true implicatures, false hints, uninformative hints and *other*, where participants used ways of referring to one of the cards that we did not anticipate. The items were constructed in such a way that the descriptions we anticipated were the obvious completions for the description templates, therefore we found it interesting that participants resorted to other strategies for completing the descriptions.

In the cooperative condition participants overwhelmingly chose true completions for the control items and the items containing numerals, with very few uninformative or *other* descriptions. This was expected given that their aim was to help the receiver find the winning card. Participants gave a considerable number of false descriptions for *most* and *ad hoc* items in the cooperative condition. This is in contrast to the goal of helping the receiver and the most likely explanation for the high rate of

false descriptions is that in some cases the potential implicatures of the descriptions were not available to participants and they randomly chose between the two most obvious completions. Furthermore, *most* and especially *ad hoc* items elicited a considerable rate of *other* descriptions. As we pointed out, this is interesting as these alternative strategies were not obviously available. One possible explanation is that participants anticipated the potential implicatures in these items and preferred to choose other strategies for communicating the key information in the description rather than trust the relatively unreliable channel of implicit communication (Reboul, 2017). An alternative explanation, which is also consistent with the high rate of false descriptions, is that this behaviour is also caused by participants not seeing the potential implicatures of the two obvious descriptions, which without the implicatures are simply uninformative for the receiver. And in order to avoid giving an uninformative hint participants may have preferred resorting to other strategies. Previous production studies have investigated situations where speakers needed to communicate information through an inference rather than by asserting it. They found that speakers often, but not always, express themselves in a way that allow the hearer to draw an informative inference. In a study by Davies and Katsos (2010) participants needed to refer to objects in situations where using a bare noun would be underinformative (e.g. 'pass me the apple' in a situation where there are two apples) and their adult participants used expressions that allowed the hearer to draw a contrastive inference (e.g. pass me the *red* apple) almost 80% of the time. In a study by Degen, Franke and Jäger (2013), participants played a signalling game where they could only send messages that did not convey the key information unambiguously. Among the four messages they could choose from, only one conveyed the key information through an inference while the others were ambiguous or incorrect. They found that participants sent the target message on roughly 80% of the trials if the inference was simple and on 50% of the trials if the inference was complex. Our results from the cooperative condition are therefore towards the low end of the spectrum as our participants expressed themselves in a way that would allow a receiver to infer a true inference on 59% for trials for *most* items and 46%

of trials for *ad hoc* items. These rates were probably affected by the characteristics of our items and the complexity of the task.

The competitive condition differed from the cooperative condition mainly in the rates of false and uninformative descriptions. Participants in this condition were more likely to give false hints (i.e. to lie) in control items: they gave false and true descriptions at roughly the same rate. We also found no evidence that the ratio of false to true descriptions was different for any of the other item types in the competitive condition. Items containing numerals, like control items, showed a large increase in the rate of false description in the competitive condition compared to the cooperative condition. The relative increase in the rate of false description was significantly smaller for *most* and *ad hoc* items as these items elicited a considerable amount of false descriptions in the cooperative condition as well. Participants were also more likely to produce uninformative descriptions for control items compared to the cooperative condition. Items containing numerals also elicited more uninformative descriptions in the competitive condition, in fact they elicited even more than control items. For *most* and *ad hoc* items the uninformative descriptions were very few and significantly less than or control items. The fact that control items elicited a higher rate of false and uninformative descriptions in the competitive condition suggests that our manipulation had an effect as participants were aiming to cause the receiver to make mistakes either by lying or by being uninformative. The fact that participants relied either on uninformative hints and on equal ratios of true and false hints suggests that they did not expect to be able to cause the receiver to do worse than chance. This is also consistent with participants in the competitive condition indicating that they expected the receiver to click on the winning card roughly 50% of the time. In a similar non-verbal signalling game, Ransom, Voorspoels, Perfors and Navarro (2017) found that when the signaller expected a distrustful receiver, their participants gave uninformative hints roughly 75% of the time and only a few misleading or helpful hints. Although we can assume that our participants were also expecting a distrustful receiver, we found a much lower rate of uninformative hints than Ransom and colleagues. This is most likely due to the fact that while participants in their study could not lie, our participants were allowed to lie and

therefore they could take advantage of the fact that receivers would not know if informative hints were true or false. Two studies on implicature comprehension in non-cooperative setting found that participants tended to infer less implicatures from the utterances of a competitive speaker compared to a cooperative speaker (Pryslopska, 2013; Dulcinati and Pouscoulous, 2017). Dulcinati and Pouscoulous (2017) employed a competitive signalling game very similar to the one used in the present experiment where participants play role of receiver and knew that the signaller was allowed to lie. They found that both assertions and implicatures communicated by the signaller were interpreted as false half of the time and true half of the time. Therefore, the expectations of their participants seem to match the behaviour of the signallers in our study, who used true and false hints in roughly equal measure both in assertions and implicatures.

One interesting aspect of the way the three types of experimental items were used by participants is the fact that items containing numerals patterned with control items rather than with the other two categories of implicature items: *ad hoc* and *most*. We found no evidence that numerals were used any differently than control items in terms of preference for false descriptions over true descriptions or in terms of the rate of *other* descriptions in either of the two conditions. In contrast to *most* and *ad hoc* items, items containing numerals did not elicit more false hints than control items in the cooperative condition; which suggests that if the *exact* interpretation of numerals is an inference in our study it was as available as the semantic meaning of the quantifiers *all* and *none*. Another difference form *most* and *ad hoc* items is that items with numerals did not elicit more *other* responses than control items in the competitive condition; which may be due either to the availability of *other* strategies for numeral items or due to the motivation to seek alternative strategies for these items. Items with numerals did differ from control items in eliciting more false descriptions in the competitive condition. However, this difference was in the opposite direction as *most* and *ad hoc* items, which elicited less uninformative descriptions compared to control items in the competitive condition. Overall, we interpret this pattern of results to indicate that participants used numeral items in a way that was closer to the control items than to the implicature items. We further take it to suggest that the *exact*

interpretation of numerals is part of their truth-conditional meaning meaning (Carston, 1998; Breheny 2008) and not an implicature (Horn, 1972; Gazdar, 1979; Levinson, 2000).

As we mentioned, *most* and *ad hoc* items were used differently than control and numeral items. They elicited a higher number of false descriptions than controls in the cooperative condition, which may be due to a lower availability of their upper bound interpretation. These items were also less likely to elicit uninformative descriptions compared to control items in the competitive condition. This may also be attributed to a lower availability of the upper bound interpretation, as the lower bound interpretation of *most* and *ad hoc* description resulted in a description that was as unhelpful and indeed equivalent to an uninformative. In our view, these differences can be attributed to the fact that the key information was conveyed through assertion in control and numeral items, and through an implicature in *most* and *ad hoc* items. The similarity in the way participants used *most* and *ad hoc* items instead suggests that there was no difference in the way participants computed these two types of implicatures. Our interpretation is therefore in support of the view that scalar implicatures and particularised implicatures are computed in the same way (Sperber & Wilson, 1995; Carston, 2002; Breheny, Katsos & Williams, 2006; Geurts, 2010), and is in contrast with the idea that implicatures arising from lexicalised scales are default meanings computed differently from implicatures arising from *ad hoc* scales (e.g. Levinson, 2000; Chierchia, 2004).

Although in the competitive condition the rates of true and false responses are overall equal, our cluster analysis suggests that this is actually the result of different opposing strategies that participants tended towards. One tendency was for participants to give more true hints, at least in control and numeral items, and expect the receiver to have a better performance as a result. The simplest explanation for why some participants chose this strategy, which is in contrast with their goal in the competitive condition, is that they were not following the instructions in this respect. In contrast, the largest group of participants tended to give more false descriptions and they expected the receiver to perform worse than chance as a result. These participants gave a higher rate of false descriptions for control items as well as for experimental items, suggesting that they were expecting the receiver to

draw implicatures from their utterances. Although this is only a numerical observation as there were not enough data to perform meaningful statistical tests on this subgroup of participants, it would be interesting to investigate this preference further. If participants did expect their receiver to draw false implicatures they must have expected the receiver to see them not as opting out but as cooperative enough (in a Gricean sense) to be communicating implicatures. A third smaller group of participants tended to give more uninformative descriptions. An interesting feature of this strategy is that by giving an uninformative hint participants made the unhelpfulness of their descriptions manifest to the other player. In Gricean terms, while giving false responses might be a case of a *covert* violation of the maxim of quality, giving uninformative responses signals that the speaker is *opting out* of the cooperative principle. On one hand, this strategy might be a calculated way of forcing the receiver to choose at random. On the other hand, some participants might prefer to be seen as opting out because they have an aversion to lying. In fact, multiple studies have found that people have an aversion to lying even in economic games where they would benefit from deceiving their interlocutor (Lundquist, Ellingsen, Gribbe & Johannesson, 2009; Gneezy, Rockenbach & Serra-Garcia, 2013). In other words, our participants may have given uninformative hints in order to be honest about the fact that they were being unhelpful.

In conclusion, we found that uncooperative speakers tend to be more uninformative and to lie more than if their goal was to help their interlocutor, at least in the kind of competitive situation we set up in our study. Knowing that their interlocutor could be completely distrustful seems to push speakers towards the strategy of telling as many truths as lies, which seems to match the expectations that hearers have (Dulcinati & Pouscoulous, 2017). However, we found that our participants are not uniform in their strategy and a large group of our participants used a higher rate of lies and false implicatures, which suggests that they expected their interlocutors to draw implicatures from their utterances. We hope that further research will find clearer indications as to whether speakers expect their interlocutors to infer implicatures in uncooperative situations. Our results also suggest that the *exact* interpretation of numeral expressions is part of their truth conditional meaning and that

particularised implicatures and the implicatures of scalar expressions are used and computed in a similar way. Further experimental research on the use of implicatures in non-cooperative situations is needed as we believe that this could provide information on factors that influence the speakers' decision on whether to communicate something implicitly or explicitly as well as about the nature of the implicature themselves and the role of cooperation in their derivation.

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Appendix A

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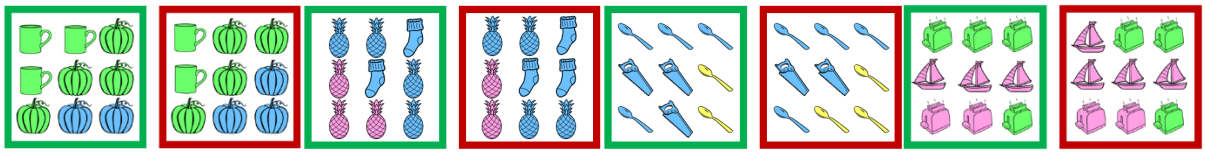

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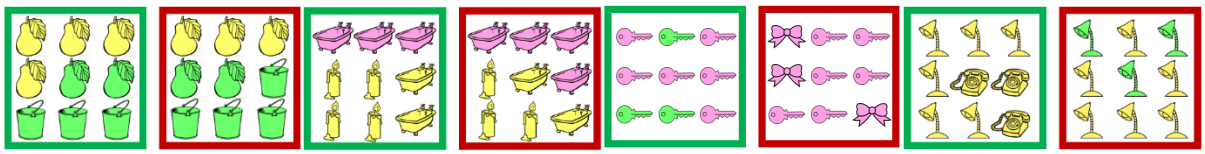

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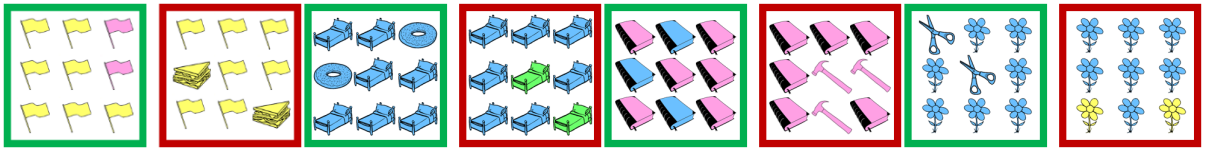

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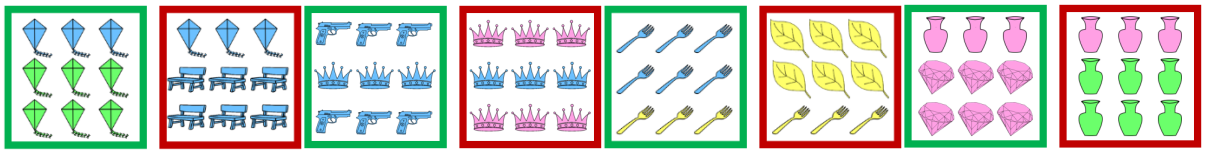

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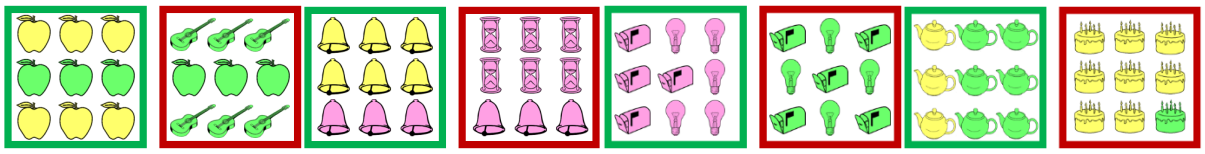

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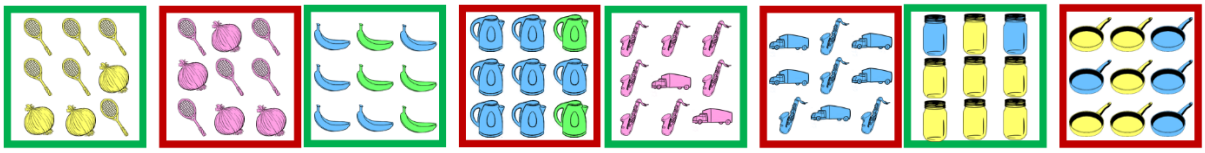

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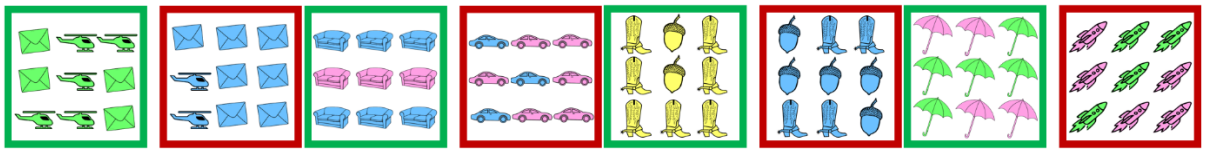

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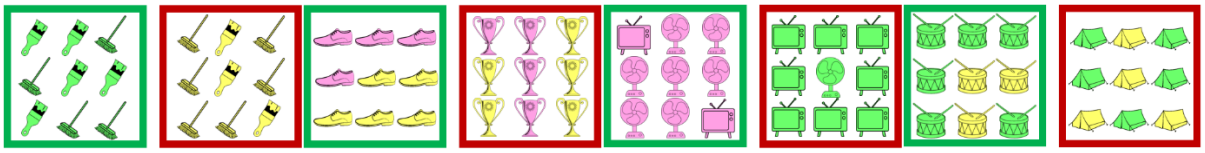

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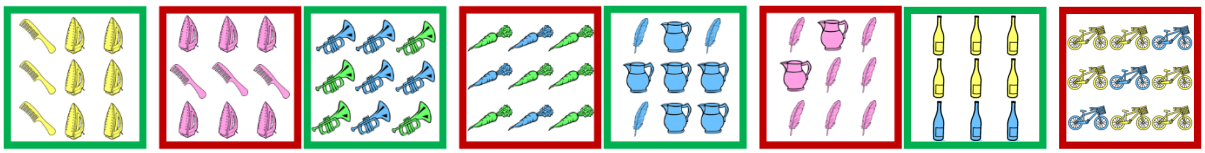

Item	Description: "On the winning card…"	True	False	Item Type	Description: "On the winning card…"	True	False
Num_01	two of the objects are	blue	Mugs	None_19	none of the objects are	green	pink
Num_02	two of the objects are	socks	Pink	None_20	none of the objects are	cakes	teapots
Num_03	two of the objects are	yellow	saws	None_21	none of the objects are	pink	yellow
Num_04	three of the objects are	Boats	green	None_22	none of the objects are	kettles	bananas
Num_05	three of the objects are	Buckets	yellow	None_23	none of the objects are	Blue	pink
Num_06	three of the objects are	Pink	candles	None_24	none of the objects are	Pans	jars
Most_07	most of the objects are	Pink	keys	None_25	none of the objects are	Blue	green
Most_08	most of the objects are	lamps	yellow	None_26	none of the objects are	cars	sofas
Most_09	most of the objects are	yellow	flags	None_27	none of the objects are	Blue	yellow
Most_10	most of the objects are	beds	blue	All_28	all of the objects are	umbrellas	Rockets
Most_11	most of the objects are	pink	books	All_29	all of the objects are	green	Yellow
Most_12	most of the objects are	flowers	blue	All_30	all of the objects are	Shoes	trophies
Ad hoc_13	the objects in the top row are	blue	kites	All_31	all of the objects are	Pink	green
Ad hoc_14	the objects in the middle row are	crowns	blue	All_32	All of the objects are	Drums	tents
Ad hoc_15	the objects in the bottom row are	yellow	forks	All_33	all of the objects are	yellow	Pink
Ad hoc_16	the objects in the top row are	vases	pink	All_34	all of the objects are	Trumpets	Carrots
Ad hoc_17	the objects in the middle row are	green	apples	All_35	all of the objects are	blue	Pink
Ad hoc_18	the objects in the bottom row are	pink	bells	All_36	all of the objects are	bottles	Bikes

Appendix B

Instructions for the [cooperative/competitive] condition:

HOW THE GAME WORKS (please read carefully)

This is a [cooperative/competitive] game with two players: a describer and a guesser.

In this game you are the describer. (the guesser will play in a second phase)

In each round of the game you'll see a winning card (with a green border) and a losing card (with a red border) and you'll have to complete a description of the winning card.

The guesser will read your description and they'll see both cards but they won't know which one is the winning card.

[In this game both you and the guesser score points when the guesser clicks on winning cards. / In this game both you and the guesser score points when the guesser scores points when they click on winning cards whereas you score points when the guesser clicks on losing cards.]

The guesser knows that this is a competitive game but they don't know that you are completing the descriptions instead of writing them freely.

Please complete the instruction with ONLY ONE WORD. You can talk about a colour or a type of object.

You can write false descriptions [and/but] remember that you are [helping / playing against] the guesser so your goal is to make them [win/lose].

Control questions [and answers] for both conditions:

Before you play, let's check that you know the rules:

(You won't be able to play if you get these wrong)

The winning card is... [The red one / The green one]

Your descriptions can be... [Only true / Either true or false]

In this game you are... [Helping the guesser click on winning cards / Playing against the guesser]

You can write... [Maximum 1 word / Maximum 3 words]