The influence of conceptual (mis)match on collaborative referring in dialogue

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Abstract

When two dialogue partners need to refer to something, they jointly negotiate which referring expression should be used. If needed, the chosen referring expression is then reused throughout the interaction, which potentially has a direct, positive impact on subsequent communication. The purpose of this study was to determine if the way in which the partners view, or conceptualise, the referent under discussion, affects referring expression negotiation and subsequent communication. A matching task was preceded by an individual task during which participants were required to describe their conceptualisations of abstract tangram pictures. The results revealed that participants found it more difficult to converge on single referring expression during the matching task when they initially held different conceptualisations of the pictures. This had a negative impact on the remainder of the task. These findings are discussed in light of the shared *versus* mutual knowledge distinction, highlighting how the former directly contributes to the formation of the latter.

Keywords

Dialogue; common ground; referring expression; conceptual match; mutual knowledge

As two people interact, they usually converge on the same terms, or *referring expressions*, to talk about things. Such convergence has a positive influence on the interaction, because it enables dialogue partners to use fewer words and speech turns to reach mutual comprehension. The current study seeks to offer a better understanding of the factors which might affect the partners' ability to converge on referring expressions as they interact. It specifically focuses on whether or not shared conceptualisations – that is, similar ways of viewing the topic of the interaction –contribute to this process.

Introduction

When two people engage in dialogue, they have the opportunity to refer to things – that is, to use referring expressions to designate the people, animals, objects and entities under discussion. One remarkable feature of referential communication is that there are usually several different ways of referring to the same thing. For instance, the referring expression "the book", "this summer's bestseller" or "a novel" may all be used to refer to the same object. Thus, dialogue partners must make decisions as to which referring expressions should be used throughout the interaction (Brennan & Clark, 1996; Clark & Bangerter, 2004; Clark & Marshall, 1981; Gorman, Gegg-Harrison, Marsh, & Tanenhaus, 2013; Horton & Gerrig, 2005, 2016; Isaacs & Clark, 1987; Yoon & Brown-Schmidt, 2014).

Clark and colleagues have conducted a number of studies to determine how referential decisions are made (see Clark & Wilkes-Gibbs, 1986; Isaacs & Clark, 1987). These authors have found that such decisions are made jointly, as dialogue is above all a collaborative activity (Clark, 1992, 1996; Clark & Wilkes-Gibbs, 1986). Referring expressions are chosen through a process called *contribution* (Clark & Brennan, 1991; Clark & Schaefer, 1989; Clark & Wilkes-Gibbs, 1986), which can be illustrated with the following example.

(1) A: I read this, like, masterpiece book over the summer, and I loved it!

(2) B: I loved it too!

The contribution process is divided into two steps. During the first *presentation* step, one of the partners produces a referring expression which he or she thinks the other person is capable of understanding. For instance, in the example above, speaker A presents the referring expression "masterpiece book" in order to refer to a book. During the second *acceptance* step, the other partner indicates that the referring expression was understood well enough for current purposes. In the example above, speaker B achieves this by stating that she also loved the book, implying that she believes that she understands which book A is talking about.

Once presented and accepted, a referring expression is deemed part of the partners' common ground, which includes their mutual knowledge (i.e., the knowledge which they are aware of sharing; Clark, 1996; Clark & Marshall, 1981). In the example above, A and B's common ground would now include the knowledge that A and B both know which book is being referred to when the referring expression "masterpiece book" is used. What is more, dialogue partners may refer to the same referent (e.g., to the same book) more than once during the interaction. In such situations, they will favour the reuse of the same referring expression (e.g., "the masterpiece book" instead of "the book" or "the novel"), because the fact that it belongs to the common ground implies that they can reasonably assume that their partner is capable of understanding it correctly (Clark & Marshall, 1981; Clark & Wilkes-Gibbs, 1986; Fussell & Krauss, 1989; Gann & Barr, 2014; Nückles, Winter, Wittwer, Herbert, & Hübner, 2006; Vanlangendonck, Willems, Menenti, & Hagoort, 2016).

Dialogue partners must go through the two steps of the contribution process every time a referring expression is used or reused. However, this process becomes increasingly

efficient after the referring expression has been added to the common ground. Indeed, when a referring expression is produced for the first time, the dialogue partner producing it also usually produces hedges such as "like" (other examples could include "a kind of" or "it looks like") to indicate that it is only provisional at this stage and that it can be negotiated further (Brennan & Clark, 1996; Brennan & Ohaeri, 1999; Horton & Gerrig, 2002; Liu & Fox Tree, 2012). Dialogue partners also favour the production of indefinite referring expressions (e.g., "*a* masterpiece book" rather than "*the* masterpiece book") at this stage (Clark & Marshall, 1981). By contrast, once it is deemed part of the common ground, a referring expression is no longer provisional: dialogue partners may thus use fewer hedges (or no hedges) when presenting it again. They may also switch from an indefinite to a definite referring expression. For instance, in the book example, A and/or B might say "the masterpiece book" instead of "a, like, masterpiece book" if they need to refer to it again during the interaction. Furthermore, when a referring expression is presented for the first time, it may be accepted more or less implicitly. For instance, it may be accepted by moving on to the next speech turn (which is what B does in the book example), but also by repeating the reference presented (e.g., B could have said "a masterpiece book, absolutely") or by nodding one's head (Bangerter & Clark, 2003; Clark & Brennan, 1991; Clark & Krych, 2004; Fox Tree, 2010; Knutsen & Le Bigot, 2012; McInnes & Attwater, 2004). In addition, acceptance may take place immediately or several speech turns after the initial presentation, depending on whether or not the dialogue partner performing the acceptance is capable of understanding the referring expression immediately (which seems to be the case in the book example), or requires more information prior to accepting it (e.g., B could have said "which book?", initiating a series of speech turns in which A and B would have worked together towards establishing which book A was referring to). By contrast, a referring expression which already belongs to the common ground can be accepted more rapidly, as it is easier to

understand for both partners: indeed, any potential ambiguities would have been solved when it was discussed for the first time. In this sense, the reuse of referring expressions which belong to the common ground can be defined as collaborative, as it increases mutual comprehension while all the while making the interaction more efficient (Clark & Wilkes-Gibbs, 1986).

Although a lot of research has focused on how the initial contribution process affects subsequent referring expression reuse, very little research has examined the factors which might affect contribution in the first place, and hence modulate its influence on subsequent reuse. In particular, the way in which each participant "views", or conceptualises, the referent under discussion, is likely to affect the ease with which two dialogue partners reach an agreement regarding which referring expression should be used[1]. For instance, in the book example, the referring expression "masterpiece book" reflects a positive conceptualisation of the book under discussion. If A and B both share this conceptualisation, they might be more likely to converge on the use of the same referring expression than if B thought that the book was boring, for instance.

To provide a different example (based on the materials used in the current study), imagine that A and B are discussing the abstract tangram picture shown in Figure 1. If A and B both conceptualise this picture in the same way (e.g., as a hammer), whoever mentions it first will probably present the referring expression "a hammer", and the other partner may accept this referring expression immediately, because he or she does not need any additional information in order to understand this referential choice. At this stage, it is important to highlight that the match between A's conceptualisation and B's conceptualisation would only be incidental, as A and B would not have had the opportunity to discuss their conceptualisations prior to the contribution process. In Clark and colleagues' terminology

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[1] The notion of conceptualisation in the current study can be linked with literature on perspective-taking, and more specifically with the notion of "level 2 perspective-taking", which refers to how people "view" a scene (see Flavell, Everett, Croft, & Flavell, 1981).

(Clark, 1996; Clark & Marshall, 1978, 1981), the belief that the picture resembles a hammer would initially be *shared* by A and B, but would not count as a *mutual* belief prior to the contribution process, because A and B would not yet be aware that they share this belief. It would only become mutual after the contribution process, once the referring expression has been added to A and B's common ground.

Figure 1. Example of an abstract tangram picture.

Alternatively, if A and B conceptualise this picture in different ways (e.g., if A conceptualises it as a hammer and B conceptualises it as an axe) and that A mentions it first, he will probably present the referring expression "a hammer"; B might then not be able to accept this referring expression immediately, depending on whether she is capable of understanding this referential choice, or whether she requires additional information before accepting the referring expression. Divergences in conceptualisations could also affect subsequent referring expression reuse. For instance, if the same picture is referred to a second time by B later during the interaction, she might reuse the referring expression "the hammer", because it belongs to the common ground. However, because this referring expression does not match her own conceptualisation of the picture, she might choose to use the referring expression "an axe" instead of "the hammer", because the referring expression "an axe" matches her own conceptualisation (Knutsen & Le Bigot, 2016). In this case, the referring

expression "an axe" would have to be processed as a new referring expression by the dyad, causing them to go through a complete, lengthy contribution process again.

In sum, the fact that dialogue partners hold different conceptualisations of a referent might affect the initial contribution process and subsequent referring expression reuse; however, this possibility has not yet been tested experimentally[2]. The purpose of the current study is thus to examine how initial individual conceptualisations of referents affects the way in which dialogue partners repeatedly refer to them. This should contribute to a better understanding of how individual knowledge and representations held by dialogue partners shape the way in which people jointly reach mutual understanding.

Hypothesis, overview and rationale

The hypothesis tested in the current experiment is that when two dialogue partners (incidentally) share the same initial conceptualisation of the referent under discussion, the contribution process (i.e., presentation and acceptance; Clark & Schaefer, 1989) is more efficient than when they hold different conceptualisations. An experiment was conducted in which pairs of participants took turns at describing abstract tangram pictures to each other. In order to determine whether or not the participants initially shared the same conceptualisation of these pictures, the experiment started with an individual phase during which each participant was shown these pictures one by one on a computer screen. Each participant wrote a brief description of what they thought each picture represented. The two participants' answers were then compared to determine whether or not they initially shared the same conceptualisation of each picture. The participants then engaged in a matching game (Clark & Wilkes-Gibbs, 1986; Krauss & Weinheimer, 1966). One of the participants (the director) gave instructions to the other participant (the matcher) to enable the latter to arrange cards

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[2] Precisely, a similar research question was addressed in an experiment reported by Wilkes-Gibbs (1995). However, in that experiment, the participants were primed to conceptualise the stimuli used in a certain way, in contrast to the current study where the participants' own conceptualisations were taken into account.

representing abstract tangram pictures in a grid. The participants performed four trials, using the same pictures in each trial. In this kind of task, participants typically agree upon a referring expression during the first trial; they then reuse the same referring expression in subsequent trials. Reused referring expressions tend to be indefinite, and to include fewer hedges; what is more, because reused referring expressions require less explicit negotiation, participants produce less speech (i.e., fewer words in total, and fewer speech turns) in subsequent trials (Brennan & Ohaeri, 1999; Clark & Wilkes-Gibbs, 1986; Hupet & Chantraine, 1992; Hupet, Chantraine, & Nef, 1993; Hupet, Seron, & Chantraine, 1991; Isaacs & Clark, 1987).

The same phenomena should be observed in the current study. However, it was also expected that the participants would find it more difficult to agree upon a single referring expression when they initially held different conceptualisations of the pictures. As a consequence, the probability of producing an indefinite referring expression and/or hedges, as well as the number of words and speech turns produced, were expected remain higher across trials 2, 3 and 4 when the participants initially held different conceptualisations of the pictures.

Method

Participants

A total of 52 participants (11 male; average age 19.79 years, $SD = 3.23$) took part in the experiment in pairs for course credit or a small payment (£5). All were native English speakers. They signed an informed consent form at the beginning of the experiment and were fully debriefed afterwards.

Apparatus and materials

Apparatus. iMac desktop computers were used by the participants to complete the individual conceptualisation questionnaire during the pre-test. The interactions between the participants during the matching games were recorded using a digital voice recorder.

Stimuli used in the individual conceptualisation questionnaire. During the pre-test, the participants completed a Qualtrics questionnaire. On each page of this questionnaire, they were shown a tangram picture (which was either one of the 32 pictures which would then be used by the current pair in the matching games, or one of the 32 filler pictures, which would not be used by the current pair in the matching games, but which was used by another pair). Below each picture was a text box in which the participants could type their description of the picture. All pictures (target pictures and fillers) were shown in a random order.

Stimuli used in the matching games. A total of eight tangram pictures were selected randomly and used in each matching game. A set of grids and cards were prepared for each matching game. Each set included four A4 sheets of paper on which the eight pictures were arranged in a 4 x 2 grid. The same pictures were printed on all four sheets of paper, but in a different order each time. These grids were used by the directors. Each set also included eight small loose paper cards on which the same eight pictures had been printed. These cards were used by the matchers.

Each pair performed a total of four matching games during the experiment[3]. A different set of grids and cards were used in each game (different pictures were used in each set). Thus, each pair was exposed to 32 pictures in total during the matching game (four games x eight pictures). Three different groups of 32 tangram pictures were used in the

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[3] Most experiments involving matching tasks only require the participants to perform one matching game. However, data collected previously (Knutsen & Le Bigot, 2016) suggested that the number of cases in which the participants would share the same initial conceptualisation of the picture under discussion would be quite small compared to the number of cases in which the participants would hold different initial conceptualisations of this picture. We thus required the participants to take part in four matching games in order to increase the number of observations per participant and per dyad.

experiment for counterbalancing purposes; each pair of participants was only exposed to one of the three groups of pictures.

Task and procedure

The two participants sat at different tables in a quiet experimental room; the tables and chair were positioned so that the participants would face different walls of the room in order to prevent them from seeing each other's face or pictures during the experiment. The experiment started with a pre-test during which the participants were shown 64 tangram pictures one by one on a computer screen; their task was to come up with a short label for each of these pictures. The participants completed the pre-test at their own pace and could not communicate at this point. When they had both finished, they then moved on to the matching games.

Each of the four matching games involved four trials. At the beginning of each trial, the director was given an array of eight pictures, and the matcher was given the corresponding eight loose cards. The task of the director was to describe the arrangement of the cards in the array so that the matcher could place his or her cards in the same order. The two participants could talk as much as they liked to complete this task. After each trial, the experimenter told the participants how many mistakes they had made (if any), but did not tell them which cards had been misplaced. The participants then embarked on the following trial.

The participants switched roles (director and matcher) after each trial. What is more, the participant who played the role of the director in the first trial of the first matching game played the role of the matcher in the first trial of the second matching game, and so on. This was so that both participants had the opportunity to come up with referring expressions throughout the game.

The experiment lasted approximately one hour.

Data coding and experimental design

Initial conceptualisation sharedness. The participants' responses on the pre-test for target pictures were extracted from Qualtrics and compared to determine, for each picture, whether or not the two participants shared the same conceptualisation of this picture. If the participants' responses reflected the same object, person, animal and/or entity (e.g., if both participants described the same picture as "a dog"), the participants' responses were coded as reflecting the same conceptualisation. Alternatively, if the participants' responses reflected different objects, people, animals and/or entities (e.g., if the same picture was described as "a lamp" by one of the participants and "a boat" by the other participant), the participants' responses were coded as reflecting different conceptualisations. The data from five pairs (representing 19.23% of the entire dataset) were double-coded for initial conceptualisations and for all other variables involving the coding of conceptualisations described below. Both coders agreed in 83.47% of cases (Cronbach's alpha = 0.73, acceptable). All disagreements were solved through discussion and the remainder of the data were single-coded.

Number of words and speech turns produced. The participants' speech during the matching games was transcribed. All speech was included in the transcripts, including interruptions and fillers such as "erm". However, experimenter-oriented speech such as questions about the procedure was not transcribed. The number of words produced to describe each tangram picture in each trial was then computed in Excel. The number of speech turns was also computed; a speech turn started when one of the participants started talking and lasted for as long as the other participant did not produce any speech.

Hedges and indefinite references. The referring expression used by the director to describe each picture in each trial was then examined and coded for hedges and for whether or not it was an indefinite referring expression. A referring expression was coded as including

a hedge if the director produced an expression such as "kind of" (e.g., "okay *kind of* looks like a llama with a massive tail") or "like" (e.g., "the next one is *like* a boat as well") to describe the picture. A referring expression was coded as indefinite if the director used the indefinite article "a" (or "an") to describe the picture.

References to the participants' initial conceptualisations during the first trial. The first referring expression used by the director to describe each tangram figure during the first trial of each matching game was coded as to whether or not it reflected this participant's initial conceptualisation of the tangram figure, as identified in the pre-test. In some cases, the director produced more than one referring expression to describe the same picture during the first trial (e.g., "a hammer" and "a gun"). The second referring expression (and potentially any subsequent referring expressions) was not coded because these were often prompted by the other participant.

Reuse of referring expressions throughout trials 2, 3 and 4. The first referring expression used by the director to describe each tangram figure during trials 2, 3 and 4 was coded as to whether or not it was the same as the one used in the previous trial (i.e., as to whether or not the referring expression used in trial 2 reflected the same conceptualisation as in trial 1, and so on). Once again, only the first referring expression used to describe each tangram figure in each trial was taken into account.

A dialogue sample and a detailed coding example are provided in the Appendix.

Experimental design. Six dependent variables (DVs) were examined in this experiment: the probability of using a referring expression corresponding to one's initial conceptualisation in the first trial of the matching game, the probability of reusing the same conceptualisation as in the previous trial in trials 2, 3 and 4, the probability of these referring expressions including hedges, the probability of these referring expressions being indefinite,

the number of words produced per tangram figure in each trial and the number of speech turns produced per tangram figure in each trial.

The first independent variable (IV), which was categorical, was initial conceptualisation sharedness (same conceptualisation, different conceptualisations). The second IV, which was also categorical, was the trial number (serial position; 1, 2, 3, 4).

Another factor was also taken in account in this study. Some conceptualisations might have been a better match than others for the tangram figures used. For instance, some tangram figures might have been conceptualised in the same way by almost all participants, whereas other tangram figures might have been associated with more different conceptualisations by the participants. One consequence for the data analysis would be that the higher the consensus regarding a given tangram figure, the more likely participants would have been to share the same initial conceptualisation of this figure. This could affect the efficiency of the interaction not only in trial 1 (in which the participants might find it easier to agree upon a referring expression), but also potentially in subsequent trials. The data from the pre-test questionnaire (target trials and filler trials) was used to control for this potential confound. All conceptualisations used to describe each tangram figure in this questionnaire were listed, and the number of times each conceptualisation was used to describe each tangram figure was counted. This count, or *frequency in the dataset,* provided an estimate of how consensual any given conceptualisation was perceived to be for each tangram figure in the sample of participants used. This variable was included as a covariate in the statistical analyses in order to determine whether or not the effect of initial conceptualisation sharedness remained significant even when frequency in the corpus was controlled for. This variable was centred for the purpose of the analysis. An example is provided in the Appendix (for a similar rationale, see Knutsen, Ros, & Le Bigot, 2018).

Results

In total, the participants produced 10,253 speech turns, or 59,563 words, during the matching games. Because each pair described a total of 32 pictures (4 games x 8 pictures), the data from 832 (26 pairs x 32 pictures) pictures were initially collected. However, only the data from 669 trials (80.41% of the data) could be analysed. The data from the remaining trials were removed either because the pre-test description produced by one of the participants did not reflect a single conceptualisation (i.e., one of the participants did not respond, the description reflected two conceptualisations or the description reflected no specific conceptualisation [e.g., "a random shape"]) or because of audio recording issues during the matching phase. In total, the participants initially shared the same conceptualisation of the pictures in 196 trials (29.30% of all trials). Within each dyad, the participants shared the same conceptualisation for 7.84 tangram pictures ($SD = 3.45$) on average.

The data were analysed using generalised mixed models in SAS 9.4 (GLIMMIX procedure). Linear mixed models were used when the DV was continuous and logistic mixed models were used when the DV was binary (i.e., when the DV reflected a probability). Mixed models were used to account for the fact that participants were nested in dyads in this experiment. Indeed, each participant might have affected the behaviour of his or her partner during the matching games, violating the assumption of data independence. These mixed models included random intercepts to account for potential variability across dyads, participants and items (i.e., tangram pictures); they also included random slopes to account for the fact that dyads, participants and items potentially differed in their sensitivity to the IVs used in the design. All random effects were initially included in the models, accordingly with Barr, Levy, Scheepers, and Tily's (2013) recommendation. Whenever this caused the models to fail to converge, the random effects which caused the convergence issues were identified and the analyses were conducted again (Kiernan, Tao, & Gibbs, 2012). The identification of

problematic random effects is performed automatically in SAS and does not affect the

outcome of the analysis. The final random effects structure used in each analysis is reported

in Table 1.

Table 1

Random Effects Structure Used in the Analyses

Analysis number	Random effects structure
#1	By-dyad and by-item random intercepts
#2	By-item random intercepts, by-dyad random slopes corresponding to initial conceptualisation sharedness and by-participant random slopes corresponding to trial number
#3	By-dyad and by-item random intercepts, by-participant and by-item random slopes corresponding to initial conceptualisation sharedness and by-participant random slopes corresponding to trial number
#4	By-dyad, by-participant and by-item random intercepts, by-dyad, by-participant and by-item random slopes corresponding to trial number and by-dyad random slopes corresponding to initial conceptualisation sharedness
#5	By-dyad and by-item random intercepts, by-dyad, by-participant and by-item random slopes corresponding to trial number, by-dyad and by-item random slopes corresponding to initial conceptualisation sharedness and by-dyad random slopes corresponding to participant role
#6	By-dyad, by-participant and by-item random intercepts, by-dyad, by-participant and by-item random slopes corresponding to trial number and by-dyad and by-item random slopes corresponding to initial conceptualisation sharedness

Because the number of pictures for which the participants initially shared the same

conceptualisation was different across dyads, the experimental design was unbalanced. The

Satterthwaite correction was applied to all analyses in order to account for this (Keselman,

Algina, Kowalchuk, & Wolfinger, 1999; Satterthwaite, 1946).

The interactions between the covariate (frequency in the dataset) and all other IVs and

interactions were not included in the model, as these always failed to reach statistical

significance.

Analysis 1: Effect of initial conceptualisation sharedness on referring expression production in trial 1

This analysis sought to confirm that initial conceptualisation sharedness did not affect which referring expression the directors used in trial 1. Indeed, at this point, directors did not know whether their partner shared the same conceptualisation as them of the picture under discussion, so their choice should not be affected by this variable. Instead, the directors' referring expression may depend mainly on frequency in the dataset, as directors might have avoided referring to their own conceptualisation if it was relatively rare (this would imply that the participants somehow "knew" which referring expressions were better suited than others to describe tangram figures in particular; experiments in this field suggest this may be the case; e.g., Rogers & Fay, 2016). The results are shown in Figure 2.
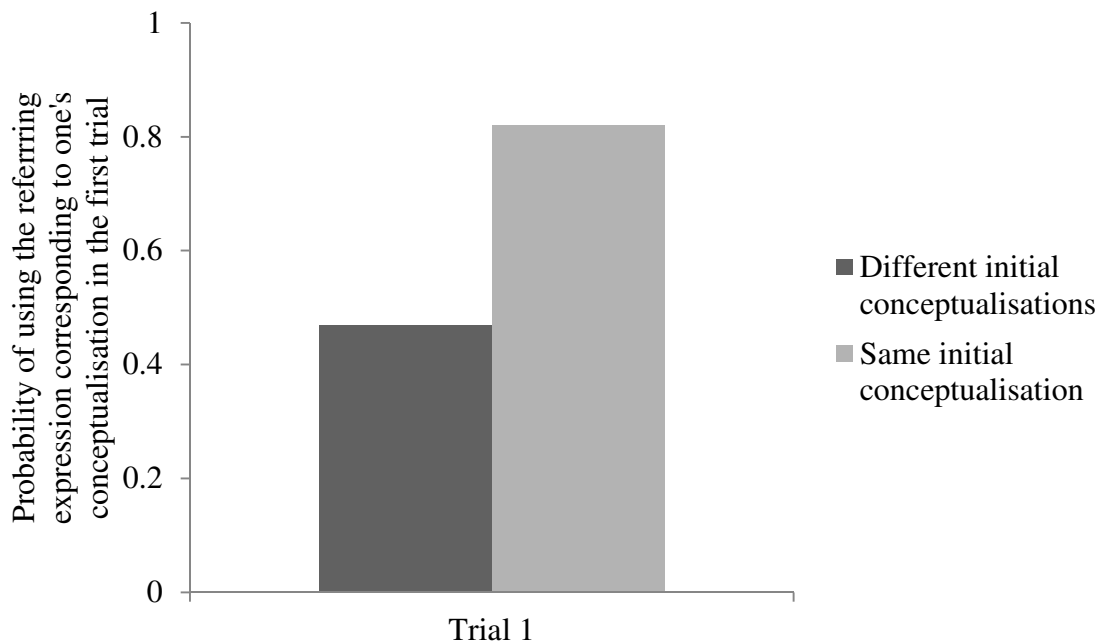

Figure 2. Probability of using the referring expression corresponding to one's own conceptualisation in trial 1 as a function of initial conceptualisation sharedness.

No significant effect of initial conceptualisation sharedness was found, $F(1, 666) = 0.40$, $p = .529$. However, there was a significant effect of frequency in the dataset, $F(1, 666)$

= 72.83, $p < .001$. The higher the frequency of a conceptualisation in the dataset, the more likely directors were to use a corresponding referring expression, $b = 0.14$.

Analysis 2: Effect of initial conceptualisation sharedness on referring expression production in trials 2, 3 and 4

The purpose of this analysis was to confirm that participants found it harder to converge on a single referring expression across trials when they initially had different conceptualisations of the picture under discussion. The results are shown in Figure 3.
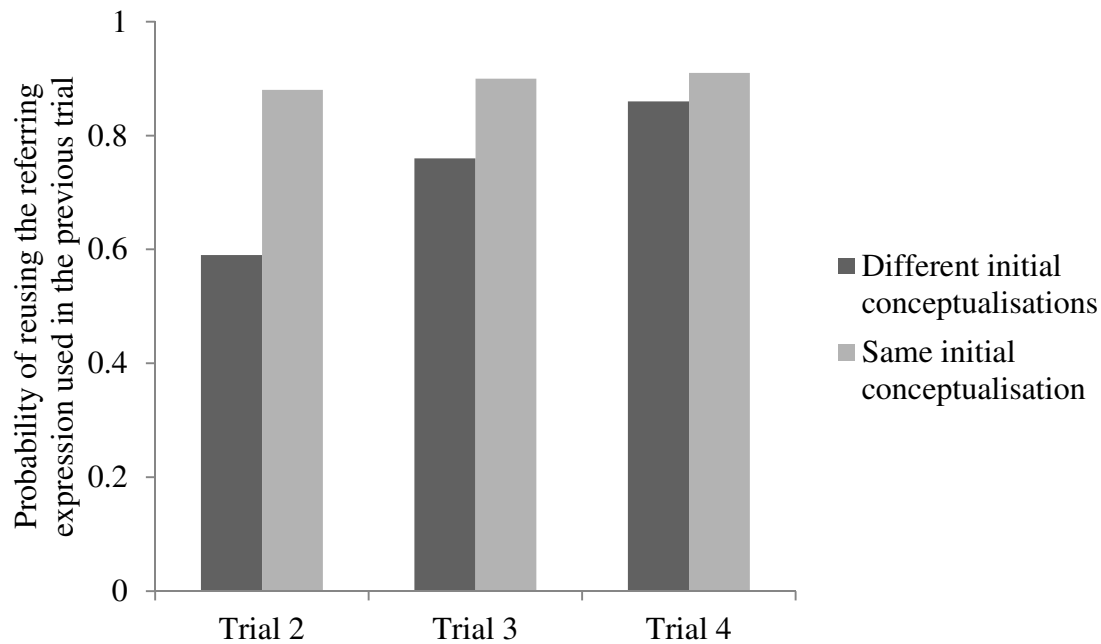

Figure 3. Probability of reusing the referring expression used in the previous trial as a function of initial conceptualisation sharedness and trial number.

There was a significant effect of initial conceptualisation sharedness, $F(1, 77) = 5.59$, $p = .021$. Overall, directors were less likely to reuse the same referring expression as in the previous trial when the participants had different initial conceptualisations of the tangram figure under discussion, $OR = 0.51$, $CI_{.95} = 0.29, 0.90$. No significant effect of trial number

was found, $F(2, 4) = 6.83$, $p = .052$. However, there was a significant initial conceptualisation sharedness x trial number interaction, $F(2, 2000) = 5.03$, $p = .007$. Simple main effects tests revealed that the effect of initial conceptualisation sharedness was significant in trial 2 ($F(1, 160) = 14.25$, $p < .001$) but not in trial 3 ($F(1, 203) = 3.29$, $p = .071$) or in trial 4 ($F(1, 242) = 0.04$, $p = .843$). Finally, there was a significant effect of frequency in the dataset, $F(1, 1061) = 6.08$, $p = .014$. The probability of reusing the same referring expression as in the previous trial increased as frequency in the dataset also increased, $b = 0.02$.

Analysis 3: Effect of initial conceptualisation sharedness on the probability of producing hedges

The purpose of this analysis was to confirm that the number of hedges produced by directors decreased across trials, and that this was mainly the case when the participants initially shared the same conceptualisation of the picture under discussion. The results are shown in Figure 4.
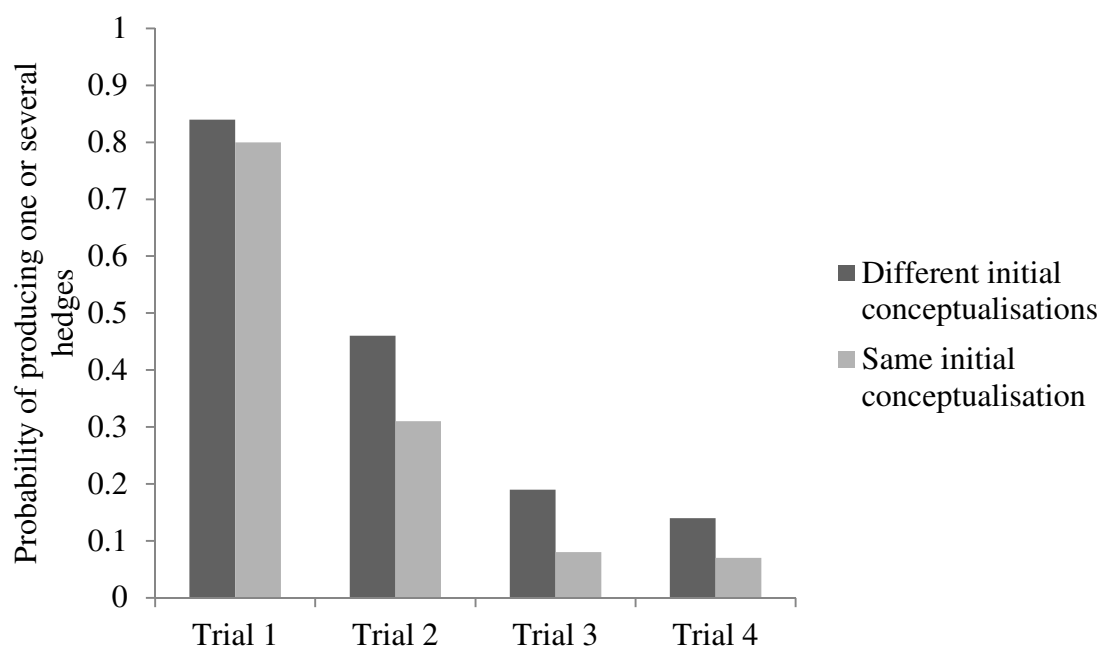
Figure 4. Probability of producing hedges as a function of initial conceptualisation sharedness and trial number.

There was a significant effect of initial conceptualisation sharedness, $F(1, 125) =$ 5.55, $p = .020$. Overall, directors were more likely to produce hedges when the participants had different initial conceptualisations of the tangram figure under discussion, $OR = 1.55$, $CI_{.95} = 1.07, 2.23$. There was also a significant effect of trial number, $F(3, 217) = 122.79$, $p <$ .001. Additional pairwise comparisons (Bonferroni-corrected) revealed that hedges were more likely to be produced in trial 1 than in trial 2 (*adjusted p* < .001) and in trial 2 than in trial 3 (*adjusted p* < .001); no significant difference was found between trials 3 and 4 (*adjusted p* = 1.00). There was no significant initial conceptualisation sharedness x trial number interaction, $F(3, 2667) = 1.42$, $p = .234$. There was a significant effect of frequency in the dataset, $F(1, 500) = 5.39$, $p = .021$. The higher the frequency of a conceptualisation in the dataset, the less likely directors were to use hedges when producing a referring expression corresponding to this conceptualisation, $b = - 0.02$.

Analysis 4: Effect of initial conceptualisation sharedness on the probability of producing an indefinite referring expression

The purpose of this analysis was to confirm that the number of indefinite referring expressions produced by directors decreased across trials, and that this was mainly the case when the participants initially shared the same conceptualisation of the picture under discussion. The results are shown in Figure 5.
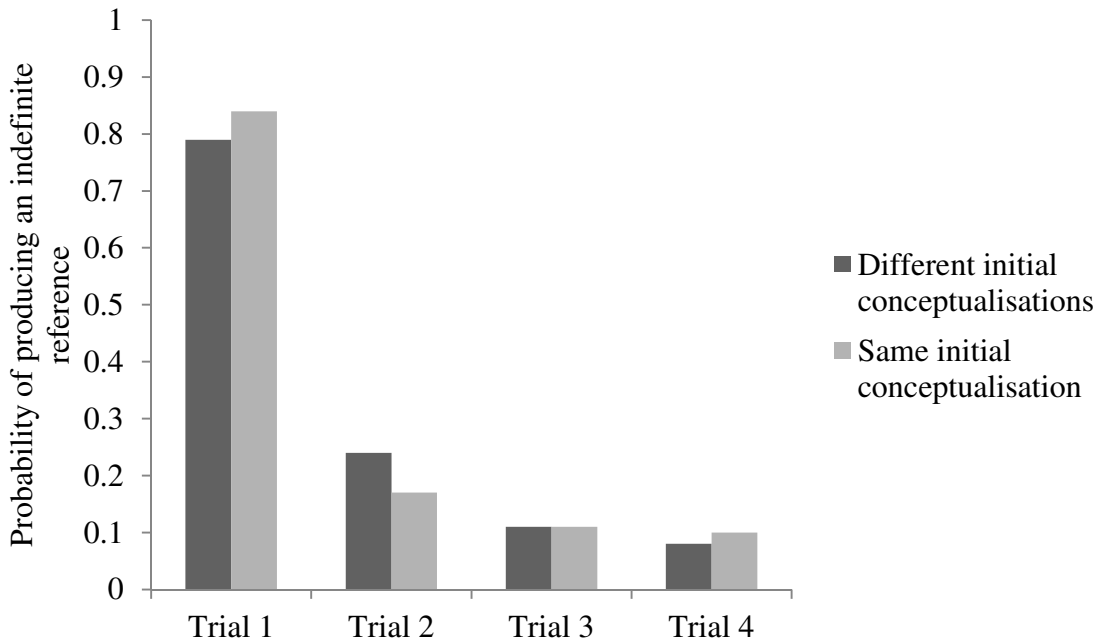
20

Figure 5. Probability of producing an indefinite referring expression as a function of initial conceptualisation sharedness and trial number.

There was no significant effect of initial conceptualisation sharedness, $F(1, 41) = 0.38$, $p = .540$. However, there was a significant effect of trial number, $F(3, 75) – 101.45$, $p < .001$. Additional pairwise comparisons (Bonferroni-corrected) revealed that indefinite referring expressions were more likely to be produced in trial 1 than in trial 2 (*adjusted p < .001*) and in trial 2 than in trial 3 (*adjusted p = .018*); no significant difference was found between trials 3 and 4 (*adjusted p = 1.00*). There was no significant initial conceptualisation sharedness x trial number interaction, $F(3, 1269) = 2.46$, $p = .062$. Finally, there was no significant effect of frequency in the dataset, $F(1, 452) = 0.44$, $p = .505$.

Analysis 5: Effect of initial conceptualisation sharedness on the number of words produced

The purpose of this analysis was to confirm that the number of words produced decreased across trials, and that this was mainly the case when the participants initially shared the same

conceptualisation of the picture under discussion. In addition, directors and matchers might

have been affected by this variable differently, so participant role was included as an

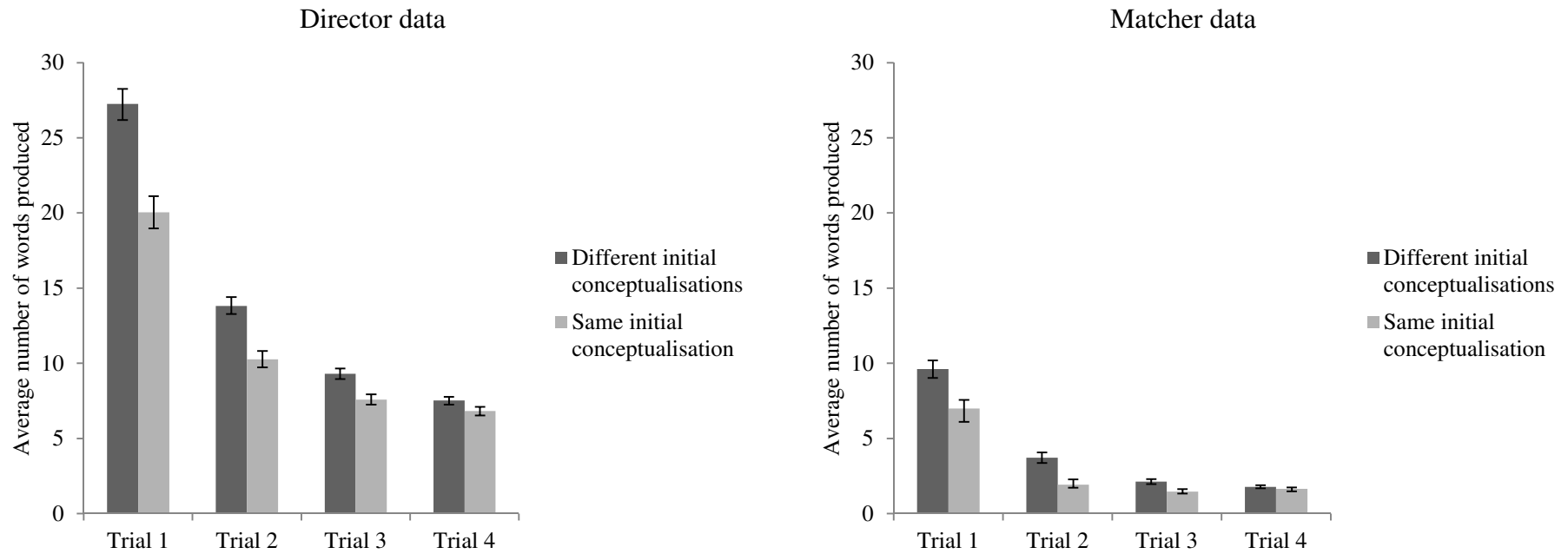additional IV in this analysis. The results are reported in Figure 6.

Figure 6. Average number of words produced by directors (left panel) and matchers (right panel) as a function of initial conceptualisation

sharedness and trial number. Bars represent the standard error.

There was no significant effect of initial conceptualisation sharedness, $F(1, 34) =$ 1.55, $p = .221$ or of participant role, $F(1, 2659) = 0.06$, $p = .805$. However, there was a significant effect of trial number, $F(3, 2123) = 9.27$, $p < .001$. Additional pairwise comparisons (Bonferroni corrected) revealed that more words were produced in trial 1 than in trial 2 (*adjusted p* = .003); no significant differences were found between trials 2 and 3 (*adjusted p* = 1.00) or between trials 3 and 4 (*adjusted p* = 1.00). There was also a significant initial conceptualisation sharedness x trial number interaction, $F(3, 2152) = 3.24$, $p = .021$. Simple main effects tests revealed that there was a significant effect of initial conceptualisation sharedness in trial 1 ($F(1, 181) = 7.87$, $p = .006$), but not in trial 2 ($F(1, 183) = 1.66$, $p = .199$), in trial 3 ($F(1, 181) = 0.01$, $p = .925$) or in trial 4 ($F(1, 183) = 0.54$, $p = .464$). No other interaction in the model was significant. Finally, there was no significant effect of frequency in the dataset, $F(1, 710) = 3.76$, $p = .053$.

Analysis 6: Effect of initial conceptualisation sharedness on the number of speech turns produced

The purpose of this analysis was to confirm that the number of speech turns produced decreased across trials, and that this was mainly the case when the participants initially shared the same conceptualisation of the picture under discussion. Because, for each picture, the number of speech turns produced by the director and the matcher was usually the same (or one of the participants produced one more speech turn than the other participant), the number of speech turns produced by the dyad was examined in this analysis, rather than the number of speech turns produced by each participant individually; thus, participant role was

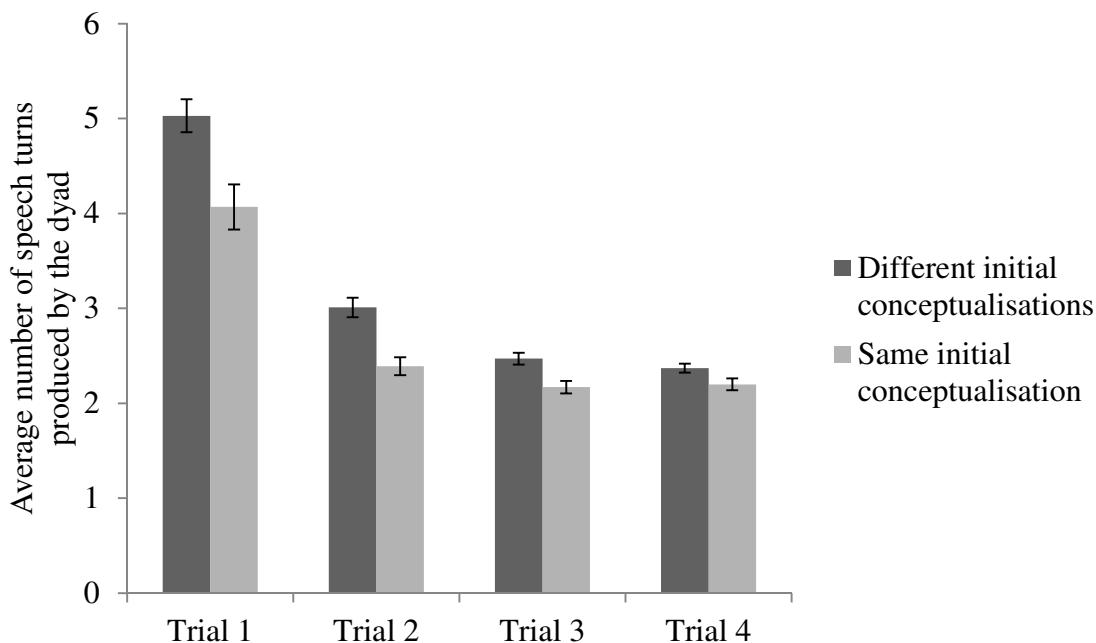not taken into account. The results are shown in Figure 7.

Figure 7. Average number of speech turns produced by the dyad as a function of initial conceptualisation sharedness and trial number. Bars represent the standard error.

There was no significant effect of initial conceptualisation sharedness, $F(1, 37) = 1.43$, $p = .239$. However, there was a main effect of trial number, $F(3, 81) = 30.47$, $p < .001$. Additional pairwise comparisons revealed that more speech turns were produced in trial 1 than in trial 2 (*adjusted p* < .001); no significant difference was found between trials 2 and 3 (*adjusted p* = 1.00) or between trials 3 and 4 (*adjusted p* = 1.00). There was no significant initial conceptualisation sharedness x trial number interaction, $F(3, 1998) = 1.87$, $p = .133$. There was also no significant effect of frequency in the dataset, $F(1, 480) = 2.53$, $p = .113$.

Discussion

When two people refer to something for the first time, they must negotiate a suitable referring expression they both agree to use (Clark & Wilkes-Gibbs, 1986). Once chosen, it is added to their common ground (Clark & Schaefer, 1989), causing both partners to reuse it again later

during the interaction (Brennan & Clark, 1996). This has a direct impact on subsequent communication, enabling dialogue partners to use fewer indefinite referring expressions and hedges (Brennan & Clark, 1996; Brennan & Ohaeri, 1999; Clark & Marshall, 1981; Horton & Gerrig, 2002; Liu & Fox Tree, 2012) as well as fewer words and speech turns (Clark & Wilkes-Gibbs, 1986; Hupet & Chantraine, 1992; Hupet et al., 1993, 1991). The purpose of this study was to examine how initial conceptualisation sharedness affects referring expression convergence as well as speech production during the remainder of the interaction.

In line with previous research on common ground construction and reuse, directors used fewer hedges and indefinite referring expressions across trials, and the participants produced fewer words and speech turns across trials (see Clark & Wilkes-Gibbs, 1986). Moreover, initial conceptualisation sharedness also affected dialogue. Although initial conceptualisation sharedness had no reliable influence on the way in which the directors referred to the pictures in trial 1, the participants found it more difficult to converge on a single referring expression when they conceptualised these pictures in different ways. Indeed, conceptual divergence made the participants less likely to use the same referring expression in trials 1 and 2. Initial conceptualisation sharedness also had a direct impact on the type of referring expression produced and the efficiency of the interaction. The participants holding different initial conceptualisations led directors to use more hedges across all trials. Both directors and matchers produced more words to describe the pictures in trial 1 when they had different initial conceptualisations. The participants also produced more speech turns in all trials when they conceptualised the pictures in different ways.

Finally, although not central in the current study, frequency in the dataset also affected some aspects of the interaction (and in particular their first choice of a referring expression in trial 1), suggesting that the participants had a sense of whether or not their own conceptualisations of the pictures were more or less common in the sample of participants

used. This could be due to all participants belonging to the same population (i.e., undergraduate psychology students). Additional research needs to be conducted to examine this possibility further.

This pattern of results offers partial support for the hypothesis outlined in the introduction. Some aspects of the interaction – namely hedge production and the number of speech turns produced – were affected by initial conceptualisation sharedness *during the entire task*, as predicted. The results regarding hedge production suggest that the participants remained hesitant as to the status of the referring expression(s) considered within their common ground when their initial conceptualisations were different (Brennan & Clark, 1996). As for the number of speech turns produced, the results suggest that lack of initial conceptualisation sharedness made it more difficult for the participants to adopt a minimal procedural routine in which the director presented a referring expression in a single speech turn and the matcher accepted it in the following speech turn (Clark & Schaefer, 1989). However, other aspects of the interaction – namely the probability of reusing the same referring expression as in the previous trial and the number of words produced – were affected by initial conceptualisation sharedness *in the short term only.* (i.e., the effects were only significant in trial 1 and/or in trial 2). Regarding referring expression reuse, this implies that when the participant who was the director in trial 2 switched to a referring expression which reflected his or her own conceptualisation (rather than the other participant's conceptualisation, or to a completely new referring expression); the two participants then reused this referring expression in subsequent trials, rather than switching back to the one considered in trial 1. Regarding the number of words produced, the results imply that in trial 1, the participants needed extra words to make sure that they understood each other correctly, and/or to discuss their different conceptualisations explicitly. However, they did not seem to resort to this kind of extra negotiation in subsequent trials.

27

These findings have important theoretical implications, as they offer a new, more precise insight into the distinction between *shared* and *mutual* knowledge (Clark, 1996; Clark & Marshall, 1981). Indeed, the current study provides strong evidence that merely *sharing* the same conceptualisation of a referent directly contributes to the contribution process (in the short and/or the long term), even if the dialogue partners are not initially aware of the conceptualisation overlap; recall that it is this contribution process which enables dialogue partners to build *mutual* knowledge (Clark & Schaefer, 1989). Thus, both shared *and* mutual knowledge play an important role in collaborative dialogue, as the former has a direct impact on how dialogue partners build and resort to the former throughout the interaction. What is more, dialogue partners are able to overcome at least some of the issues raised by the lack of initial conceptualisation sharedness as they progress in the interaction, as illustrated by the fact that some of the effects reported here were only visible in the first trial or in the first two trials.

These results raise a number of theoretical questions, among which the question of whether the dialogue between the two participants might have changed the way in which they conceptualised the pictures under discussion as they interacted. If participant A conceptualised a picture as a hammer, but heard participant B refer to it as a gun, would A then start conceptualising this picture as a gun? Answering "no" to this question would imply that participants do not need to align their conceptualisations of the referent under discussion in order to agree upon referring expressions; shared referring expressions would only be adopted provisionally in order to make communication more successful (for a similar suggestion, see Brennan & Clark, 1996). Alternatively, answering "yes" to the question of whether dialogue can change people's conceptualisations would be more in line with Pickering and Garrod's (2004; see also Pickering & Garrod, 2013) interactive alignment model, according to which lexical convergence causes the partners' mental models to also

convergence. In other words, according to this model, conceptualisations of the topic under discussion become increasingly similar as they come to using the same words to refer to things. Distinguishing between these two approaches on this topic will require additional research in which the longer-term impact of dialogic lexical convergence on individual conceptualisations will be examined.

To summarise and conclude, this paper sought to shed light on how individual conceptualisations of referents affect how dialogue partners talk about these referents. The findings highlight that lack of initial conceptual sharedness may impair collaboration, enriching the shared/mutual knowledge distinction. Future research will focus on whether adopting someone else's referring expressions to reach mutual understanding in this kind of situation had a reliable influence on one's own conceptualisations.

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Compliance with ethical standards

Funding

Conflict of interest

Dominique Knutsen and Ludovic Le Bigot declare that they have no conflict of interest.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

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Appendix – Dialogue sample and spreadsheet extract

Table A1

List of Referring Expressions Considered by the Participants to Refer to Two of the Tangram

Figures used and Frequency in the Dataset

Picture	Referring expression	Frequency in the dataset
Set 1, Item 1	Snake	23
	Goose	6
	Path or road	1
	Tree trunk	1
	S	1
Set 1, Item 8	Boat	26
	Person sitting	6
	Cat	2
	Squirrel	2

Table A2

Sample of the Grid Used to Code for Initial Conceptual Sharedness and Frequency in the Dataset

Pair	Picture code	A's conceptualisation	Frequency in the dataset of A's conceptualisation	B's conceptualisation	Frequency in the dataset of B's conceptualisation	Initial conceptualisation sharedness
1	Set 1 – Item 1	Goose	6	Snake	23	No
1	Set 1 – Item 8	Boat	26	Boat	26	Yes

Table A3

Dialogue Sample

Pair	Item	Trial	Participant	Utterance content
1	Set 1 – Item 1	1	A (Director)	erm the fifth one it looks like a goose but goose is looking up in the right direction
1	Set 1 – Item 1	1	B (Matcher)	sorry could you repeat that
1	Set 1 – Item 1	1	A (Director)	for the fifth one
1	Set 1 – Item 1	1	B (Matcher)	mhm
1	Set 1 – Item 1	1	A (Director)	it looks like a goose but it is facing in the right direction
1	Set 1 – Item 1	1	B (Matcher)	oh yeah
1	Set 1 – Item 1	2	B (Director)	and then the fourth one is like the game snake with a triangle at the bottom it's like a right angle triangle
1	Set 1 – Item 1	2	A (Matcher)	mhm
1	Set 1 – Item 1	2	B (Director)	it's got a right angle triangle at the bottom
1	Set 1 – Item 1	2	A (Matcher)	okay
1	Set 1 – Item 1	3	A (Director)	the seventh one looks like a goose again
1	Set 1 – Item 1	3	B (Matcher)	mhm

1	Set 1 – Item 1	4	B (Director)	then the next one is like a snake with a right hand triangle on the tip pointed
1	Set 1 – Item 1	4	A (Matcher)	mhm
1	Set 1 – Item 8	1	B (Director)	and then the next one is kind of like a kind of like a boat but it has a square on the top it's got like a D
1	Set 1 – Item 8	1	A (Matcher)	mhm
1	Set 1 – Item 8	2	A (Director)	the next one kind of looks like a boat and then boat is like a
1	Set 1 – Item 8	2	B (Matcher)	mhm
1	Set 1 – Item 8	3	B (Director)	and the next one is like a boat
1	Set 1 – Item 8	3	A (Matcher)	mhm
1	Set 1 – Item 8	4	A (Director)	a boat
1	Set 1 – Item 8	4	B (Matcher)	mhm

Table A4

Sample of the Grid Used to Code for all DVs Used in the Experiment

Pair	Picture code	Trial	Referring expression used by director	Reflected one's initial conceptualisation? (Trial 1 only)	Reuse of same referring expression as previously	Number of words (Director)	Number of words (Matcher)	Number of speech turns (dyad)	Hedges	Use of an indefinite referring expression
1	Set 1 –	1	Goose	Yes	NA	35	8	6	Yes	Yes

	Item 1									
1	Set 1 – Item 1	2	Snake	NA	No	31	2	4	Yes	No
1	Set 1 – Item 1	3	Goose	NA	No	8	1	2	Yes	Yes
1	Set 1 – Item 1	4	Snake	NA	No	16	1	2	Yes	Yes
1	Set1 – Item 8	1	Boat	Yes	NA	28	1	2	Yes	Yes
1	Set 1 – Item 8	2	Boat	NA	Yes	15	1	2	Yes	Yes
1	Set 1 – Item 8	3	Boat	NA	Yes	8	1	2	Yes	Yes
1	Set 1 – Item 8	4	Boat	NA	Yes	2	1	2	No	Yes