People are Sensitive to Problems in Communication

People are Sensitive to Problems in Communication and Use Other-Initiated Repairs to Address Them

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24 **Abstract**

25 Recent research indicates that interpersonal communication is noisy, and that people
26 exhibit considerable insensitivity to problems in communication. Using a dyadic referential
27 communication task, the goal of which is accurate information transfer, the present study
28 examined the extent to which interlocutors are sensitive problems in communication and
29 use other-initiated repairs (OIRs) to address them. Participants were randomly assigned to
30 dyads (N = 88 participants, or 44 dyads) and attempted to communicate a series of recurring
31 abstract geometric shapes to a partner across a text-chat interface. Participants alternated
32 directing (describing shapes) and matching (interpreting shape descriptions) roles across
33 seventy-two trials of the task. Replicating prior research, over repeated social interactions
34 communication success improved and the shape descriptions became increasingly efficient
35 (indexed by the number of words used to communicate each shape). In addition,
36 confidence in having successfully communicated the different shapes increased over trials.
37 Importantly, matchers were less confident on trials in which communication was
38 unsuccessful, communication success was lower on trials that contained an OIR compared
39 to those that did not contain an OIR, and OIR trials were associated with lower Director
40 confidence. This pattern of results demonstrates that: 1) interlocutors exhibit (a degree of)
41 sensitivity to problems in communication, 2) appropriately use OIRs to address problems in
42 communication, and 3) OIRs signal problems in communication to their partner.

43 Introduction

44 It is widely believed that interlocutors are sensitive to problems in communication and use
45 an interactive repair mechanism to address them (Jefferson, 1987; Sacks, Schegloff, &
46 Jefferson, 1974; Schegloff, Jefferson, & Sacks, 1977; Sidnell, 2011). Conversational repair
47 encompasses a set of sequentially organized practices that interlocutors engage in to
48 address problems of speaking, hearing, or understanding (Sidnell, 2011). Repairs may be
49 self- or other-initiated (Kitzinger, 2013; Schegloff et al., 1977). Self-initiated repairs are
50 performed by the current speaker, who anticipates a problem in communication. Other-
51 initiated repairs (OIR) – from a generic ‘huh’, to a specific information request – are side-
52 sequences performed by a ‘listener’ to signal trouble and address breakdowns in
53 communication (Dingemanse et al., 2015; Schegloff, 2000; Schegloff et al., 1977). OIR is a
54 frequent feature of conversation - occurring every 84 seconds (Dingemanse et al., 2015) -
55 and similar repair mechanisms are seen across a range of different languages (Dingemanse
56 et al., 2015; Dingemanse & Enfield, 2015; Sicoli, 2016).

57 For instance, in the current task a participant described an abstract geometric shape
58 as “nun.” Their partner queried this label, by offering the alternative description, “is that
59 pray?”. This type of OIR seeks a confirmation of the offer, which in this case received a
60 disconfirming “no.” This is the most common type of OIR in conversation, as it is the most
61 specific in pin-pointing the trouble source. Other types of OIR, like the open request
62 “huh?”, are less explicit in identifying the source of the miscommunication. Despite the
63 ubiquity of OIRs during conversation, it is unclear if OIRs actually resolve problems in
64 communication, or if people are even sensitive to problems in communication in the first

place. The present study experimentally tests if interlocutors are sensitive to problems in communication and if they use OIRs to signal and address those problems.

Are Interlocutors Sensitive to Communication Problems?

Anecdotal evidence suggests that other-initiated repairs (OIRs) may not affect communication behavior. In Garrod and Anderson (1987) pairs of participants created spatial description schemes to collaboratively navigate through a computerized maze. Participants sometimes tried to repair communication breakdowns by explicitly negotiating alternative spatial description schemes. However, the new description schemes that were agreed on during interactive repair rarely survived, indicating that the repairs did not affect subsequent communication behavior. Similarly, explicitly negotiating a communication strategy did not improve performance in an experimental-semiotic task (Galantucci, 2009).

More fundamentally, experimental research suggests that interlocutors may not be sensitive to problems in communication in the first place. This was examined in a series of studies in which communicative incoherence was introduced into dyadic conversations. Communicating remotely via a text-chat interface, interacting pairs of participants' text-chat entries were surreptitiously swapped with those produced by another participant engaged in a separate and unrelated conversation (Galantucci & Roberts, 2014), or they were replaced with a pre-determined message that introduced conversational incoherence (Roberts, Langstein, & Galantucci, 2016). In each case, a majority of participants failed to notice the incoherent topic change. This insensitivity also held for face-to-face interactions in which an experimental confederate uttered a nonsensical phrase during the task (Galantucci, Roberts, & Langstein, 2018). These findings suggest that communication is noisy and error prone, and that people can be insensitive to problems. This insensitivity to

problems in communication is consistent with ‘change blindness’ studies, which demonstrate that people can be insensitive to major changes in their immediate environment (Simons & Rensink, 2005). For example, in a classic study, only half of the participants detected the surreptitious replacement of their conversation partner during a face-to-face interaction (Simons & Levin, 1998).

Before accepting that people tend to be insensitive to problems in communication, it is important to highlight several factors that may undermine this conclusion. First, it is well-established that social interaction improves communication success (Fay et al., 2018; Garrod, Fay, Lee, Oberlander, & MacLeod, 2007; Schober & Clark, 1989). Under the collaborative view of interpersonal communication (Clark, 1996) interlocutors use an interactive grounding process to negotiate shared reference that improves communication success. This account assumes that people are sensitive to problems in communication, although it is not directly tested. See Pickering & Garrod (2004) for a different view, that does not assume sensitivity to communication problems. Second, if temporary incoherence does not negatively impact the overall gist of the conversation then it may not be necessary to treat or even recall. Third, if the primary goal of conversation is social, then other-initiated repairs might be unnecessary, or may even be face-threatening (Schegloff et al., 1977). Fourth, self-reports of noticing communication problems can be inaccurate (due to insufficient recall, saliency, etc.), and we should instead focus on behavioral evidence – what people actually *do* in interaction during communication breakdowns. A stronger test of people’s sensitivity to problems in communication would include a task-oriented conversation, where the primary goal is accurate information transfer, and an analysis of what participants do *in-situ* when facing a perceived problem in communication.

Using a referential communication paradigm, we test interlocutors' sensitivity to problems in communication. Participants' goal was to accurately communicate a series of confusable abstract geometric shapes to a partner. If participants are sensitive to problems in communication, they will be less confident on trials in which communication was unsuccessful, and will be more likely to produce an other-initiated repair on these trials compared to successful communication trials. By contrast, if participants are insensitive to problems in communication there will be no difference in interlocutor confidence, or repair frequency, in trials that were successful or unsuccessful.

Method

The study received approval from the University of Western Australia Ethics Committee. Participants viewed an information sheet before giving written consent to take part in the study. The information sheet and consent form were both approved by the Ethics Committee. All methods were performed in accordance with the guidelines from the NHMRC/ARC/University Australia's National Statement on Ethical Conduct in Human Research.

Participants

A convenience sample of 88 undergraduate students from the University of Western Australia (mean age = 23.82 years, SD = 8.49; 59 female), organised into 44 dyads, participated in exchange for partial course credit.

Task and Procedure

The goal for each participant was to successfully communicate a series of confusable abstract geometric shapes to a partner using a text-chat interface. The shapes, known as tangrams, have been widely used to study referential human communication (Clark & Wilkes-Gibbs, 1986; Rogers, Fay, & Maybery, 2013; Tolins, Zeamer, & Fox Tree, 2017). The Director typed a message to communicate a shape displayed on their screen (sampled from a pool of 6 target shapes that were repeated over the task) and their partner, the Matcher, tried to guess which shape was being communicated from a randomly ordered list of 8 shapes (the 6 target shapes plus 2 distractor shapes). The shapes were randomly sampled from a set of 18 (see Fig. 1).

Fig. 1. The set of 18 geometric shapes, or tangrams. Eight shapes were randomly sampled from the pool of 18 for each dyad, and 6 of the sampled shapes were communicated 12 times each over 72 trials. The remaining 2 shapes served as distractors, and were never communicated by the dyad.

The task was administered using a text-chat interface that recorded all typed communication activity. All communication was done across networked desktop computers. Shape descriptions were typed using a standard keyboard. For each participant, a text-chat box filled the left half of their screen, where they could exchange messages with their partner. Each dyad member was allocated a different font color (light blue or yellow, displayed against a black background), to easily identify the author of each message. For the Director, a to-be-communicated shape was displayed to the right of the text-chat box, below a prompt asking them to describe the shape to their partner. For the Matcher, 8 shapes were displayed in a 2×4 grid to the right of the text-chat box, below a prompt asking them to select the shape being described by the Director. When the Matcher believed they had identified the Director's intended shape they selected the relevant shape from the interface by mouse click (see **Fig. 2**).

Fig. 2. The text-chat interface. The left panel shows the Director's interface and the right panel shows the Matcher's interface.

Following Matcher shape selection, the Director and Matcher each indicated how confident they were that the Matcher had selected the Director's intended shape. Confidence was rated on a Likert scale of 0-6, where 0 = Not at all confident and 6 = Extremely confident. When both confidence estimates had been entered, the current trial ended and the next trial was initiated. The text-chat box was cleared at the start of each trial. Each trial had a 30 second time limit, after which the trial ended without the Matcher selecting a shape, and both participants were notified that time had run out. Confidence estimates were not requested in this situation. Pilot testing indicated that 30 seconds was enough time to produce an other-initiated repair, but was not always enough time to complete the repair. This time limit was essential to ensure we had a sufficient sample of unresolved communication problems. Participants were given no explicit feedback with regard to their communication success. Having participants communicate remotely across networked computers meant they were unaware of their partner's identity.

Participants completed the task in dyads (randomly allocated). Each dyad ($N = 44$ dyads) played 72 trials with the same partner. Each of 6 shapes was communicated 12 times across the 72 trials. For each dyad the same 6 target shapes and 2 distractor shapes were used across the task. The distractor shapes were never communicated. So, each target shape recurred 12 times over the course of the experiment. Each participant acted as the Director on half of the trials and the Matcher on the other half, with role allocation randomized across trials. Matchers could provide text feedback within a trial, allowing them to initiate repairs.

Repair Coding

Each trial was coded as including a repair(s) or not including a repair(s) (by author AM). Repair trials were those that included a Matcher response to a Director's description that indicated miscommunication or uncertainty, and which was intended to elicit a Director response. Also included in the initial repair coding were self-repairs in which a Director revised a previous description, as with correcting a typo. A random sample of trials (20%) were then coded as repair or not repair (by author BW). The two sets of ratings showed strong inter-coder agreement ($Kappa = .94, k = 2, N = 595$). Repairs were then coded as self-initiated ($N = 149$) or other-initiated ($N = 266$), and instances of other-initiated repair were coded following Dingemanse and Enfield's (2015) classification: open requests (no specification of a precise trouble source; $N = 35$), restricted requests (queries specific information with Wh- or option questions; $N = 59$), and restricted offers (a candidate understanding or suggested alternate description; $N = 172$) (by authors AM and BW). The two sets of ratings again showed strong inter-coder agreement ($Kappa = .94, k = 2, N = 410$). The ratings from author AM were used in the analyses.

Results

The data was analyzed using logistic and linear mixed effects modelling, with crossed random effects for dyads and for shapes. All analyses were performed and all figures were created in R (R Core Team, 2013). Statistical models were estimated using the `glmer()` and `lmer()` functions of `lme4` (Bates, Maechler, Bolker, & Walker, 2013). The maximal random effects structure justified by the experiment design was specified where possible (Barr, Levy,

Scheepers, & Tily, 2013). The data, R Script and text-chat dialogues are available on the Open Science Framework: <https://osf.io/53948/>

Section 1 provides a descriptive analysis of the types of other-initiated repairs (OIR) observed, as well as how the OIRs were addressed. Section 2 examines the change in Director and Matcher confidence, communication efficiency and communication success when participants repeatedly played the referential communication game. Section 3 tests if Matchers were sensitive to problems in communication, and if Matchers' use of OIRs signalled a communication problem to their conversational partner (i.e., the Director).

Section 1. Descriptive Analysis of Other-Initiated Repairs

Participants performed 266 other-initiated repairs (OIRs); 8.6% of trials involved an OIR (ten trials had more than one OIR). Restricted offers were the most frequent, and open requests the least frequent (see Table 1). Text-chat repairs reflect a similar distribution to that found in spoken conversation (Kendrick, 2015, on English OIRs). The similar distribution of OIRs across modalities may be attributed to: 1) participants' tendency to reproduce spoken communication in text-based communication (e.g., using "???" for prosodic cues); and 2) the ability to process the written signals as one would in spoken discourse. The frequency of restricted offers suggests that participants in our text-based task adhered to the preference for specificity seen in spoken repairs, by which an interlocutor should be specific with respect to the problem (Dingemanse & Enfield, 2015).

Table 1. Other-initiated repair types from the present text-chat experiment and spoken conversation in English (from Kendrick, 2015). Percentages are followed by counts of total OIR use (in brackets).

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	<i>Open Request</i>	<i>Restricted Request</i>	<i>Restricted Offer</i>
Text-Chat	13.2% (35)	22.2% (59)	64.6% (172)
Spoken (English)	23.4% (41)	34.3% (60)	42.3% (74)

Open requests, the least specific type of OIR, were infrequent despite being relatively quick to produce. This type of OIR often includes “Huh?” or “What?” in spoken English (Dingemanse, Torreira, & Enfield, 2013; Kendrick, 2015). The text-chat communication included modality-specific open requests such as (repeated) question marks or variations on “What?” (e.g., “wut”). Examples of open requests below (marked by the arrow) represent common uses and solutions to this repair initiation. In examples 1 and 2, open requests were followed by clarifications – albeit potentially ambiguous ones – that elaborated on prior descriptions, while the request in example 3 was not resolved (due to task time limitations). Open requests were addressed with clarifications in 55% of their occurrence, while the remainder went unaddressed.

(1) Open Request: Dyad 21, Iteration 4, Trial 22

Player 1: Diamond head

Player 1: Trunk is lopsided

-> Player 2: ?

Player 1: Cant see his legs

(2) Open Request: Dyad 15, Iteration 9, Trial 50

Player 2: lean

-> Player 1: what???

Player 1: lean hahah

Player 2: gravity

260

261 (3) Open Request: Dyad 8, Iteration 11, Trial 61

262 Player 2: leaning preacher lookig folk

263 -> Player 1: wut

264

265

266 Restricted requests, where a Matcher asked a specific question about the Director's

267 description, were used in just less than a quarter of OIRs. Restricted requests specify the

268 trouble source more explicitly than open requests, and as such appeared more frequently

269 (satisfying the preference for specificity in OIR). Below are representative examples of how

270 restricted requests were performed (marked by arrows), and the solutions given. Restricted

271 requests asked about specific information, by providing an "or" option about a specific

272 feature as in (4), or by querying information about a specific feature as in (5) and (6). The

273 former strategy was used in 56% of restricted requests, while specific queries made up the

274 remainder of occurrences. The time limitations of the task appeared to impact the

275 strategies for making restricted requests in that they tended to be short queries about

276 particular features using "or" or "any" constructions. Sixty-one percent of responses to

277 restricted requests were clarifications in direct response to the restricted request, while

278 nearly 30% went unattended.

279

280 (4) Restricted Request: Dyad 22, Iteration 7, Trial 41

281 Player 2: praying

282 Player 2: nealing down

283 Player 2: dimond head

284 -> Player 1: facing left or right

285 Player 2: looking right

286

287 (5) Restricted Request: Dyad 15, Iteration 5, Trial 30

288 Player 2: dog

289 -> Player 1: what is the dog?

290 Player 2: faces left

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291 Player 2: has a tail

292 Player 2: and a square head

293 Player 2: odd dog

294

295 (6) Restricted Request: Dyad 25, Iteration 2, Trial 10

296 Player 1: this legit looks like a chess piece

297 Player 1: like a diagonal square on top

298 -> Player 2: any arms?

299 Player 1: and one leg

300 Player 1: one arm left

301

302

303 The most frequent OIR strategy was the restricted offer, which gives an
304 interpretation of the Director's description in a suggestive manner. Offers typically ended
305 with a question mark (82% of all occurrences), indicating they were not other-corrections
306 (Jefferson, 1987) but an attempt to understand a potentially problematic description.
307 Offers are candidate understandings, which may take the prototypical "you mean X?" form,
308 as in (9) below. As such, offers were usually followed by the Director's confirmation of the
309 offer or a correction of the offer (7-9, offers marked by arrows). Offers were met with
310 either correction if the interpretation did not match the Director's intended meaning, as in
311 (7), or confirmation if the offer was an accurate interpretation (49%), as in (8) and (9).
312 Corrections could be as simple (and potentially uninformative) as "no", although these
313 occurred infrequently (6%), as negative responses typically included corrected versions
314 (14%). The remaining offers went unaddressed, either due to time limitations or
315 simultaneously fulfilled requests. Text-based interaction does not allow for immediate
316 public production of descriptions or repairs – that is, it takes time to type responses, and we
317 do not know what the other is typing in the moment. Therefore, it was not uncommon that
318 while the Matcher was typing a repair initiation, the Director was typing the to-be-queried
319 description simultaneously. While this modality difference is interesting, it falls beyond the

320 scope of the present study, but it does at least provide an explanation for *some* of the
321 unattended repair initiations.

322 (7) Restricted Offer: Dyad 1, Iteration 5, Trial 27

323 Player 1: dancing left kick right

324 -> Player 2: no head guy?

325 Player 1: head

326

327 (8) Restricted Offer: Dyad 2, Iteration 11, Trial 63

328 Player 2: diamond head

329 -> Player 1: looks like they're kneeling?

330 -> Player 1: like Z shape?

331 Player 2: no

332 Player 2: yea

333

334 (9) Restricted Offer: Dyad 18, Iteration 7, Trial 37

335 Player 2: person running to the right, arms raised, looking up

336 -> Player 1: you mean kevin?

337 Player 2: wait kevin?

338 Player 2: yep

339 Player 1: YES

340

341

342 The presence and rate of other-initiated repairs in the present study suggests that
343 participants noticed and attended to problems in communication by (1) initiating a repair,
344 and (2) responding to the repair initiation. We consider the effect of OIRs as a whole, that
345 is, collapsed across the different OIR types. The reasons for this are two-fold: first, not all
346 OIR strategies provided sufficient data for separate analyses; second, all OIR strategies
347 demonstrated the recognition of a problem in communication, even if they treated the
348 problem differently.

349

350 **Section 2. Change in Communication Efficiency, Interlocutor Confidence and Dyad**
351 **Accuracy over Repeated Social Interactions**

Section 2 examines the change in Director and Matcher confidence (rated on a Likert scale ranging from 0-6), communication efficiency (the number of words used to communicate each shape), and communication success (shapes correctly identified by the Matchers) over repeated interactions (Iterations 1-12, i.e., from the first time the shape was communicated to the twelfth and final time it was communicated in each dyad). Each analysis excluded trials in which the participants ran out of time.

First, we present a typical dyadic interaction that involves OIR over multiple trials for the same shape (Fig. 3). In Trial 5, the Director (Player 2) initially described the Tangram with a directional description. The Matcher (Player 1) initiated a repair via the restricted offer “Standing?” The Director responded with the clarification “bowing man”, adding “with triangle bum”. Later, in Trial 23, the Matcher – now Player 2 – used the previously repaired description to offer, “begging with butt?” and received a confirmation preceded by an alternate offer, “triangle bum.” Later again, in Trial 56, the prior descriptions that arose from the repair sequences were used effectively, without the need for repair. Over repeated interactions and repair sequences the shape description was dramatically abbreviated, to “TB”, making communication more efficient.

Tangram	Iteration 1, Trial 5	Iteration 4, Trial 23	Iteration 10, Trial 56
Player 2: LF = left facing	Player 1: tray man	Player 1: Triangle Butt
	Player 2: So LF	Player 1: LF	Player 1: TB
	Player 1: yeah	Player 2: Begging with	Player 2: TB
	Player 1: standing?	butt?	
	Player 2: bowing man with a triangle bum	Player 1: triangle bum Player 1: yeah	

Fig. 3. Descriptions and repair sequences for a tangram by Dyad 30.

The confidence data was analyzed using a linear mixed effects model. Iteration (1-12, centered) was entered as a fixed effect. The random effects structure included by-Dyad and by-Shape random intercepts, as well as by-Dyad and by-Shape random slopes for Iteration. Over iterations, Director confidence increased ($\beta = 0.18$, $SE = 0.02$, $t = 10.86$, $p < .001$; see Fig. 4A) and Matcher confidence increased ($\beta = 0.16$, $SE = 0.02$, $t = 10.27$, $p < .001$; see Fig. 4B). Next, we analyzed the change in communication efficiency (same model). Over iterations fewer words were used to communicate each shape, making communication increasingly efficient ($\beta = -0.60$, $SE = 0.06$, $t = -10.34$, $p < .001$; see Fig. 4C). The communication success data was analyzed using a logistic mixed effects model (same model structure). Over iterations communication success improved ($\beta = 0.26$, $SE = 0.04$, $z = 6.21$, $p < .001$) (see Fig. 4D).

Over repeated interactions communication became increasingly efficient and accurate. This replicates a well-established pattern in the literature (e.g., Clark & Wilkes-Gibbs, 1986; Garrod et al., 2007; Krauss & Weinheimer, 1964). In addition, Director and Matcher confidence increased over repeated social interactions.

Fig. 4. Change in mean (A) Director and (B) Matcher confidence, (C) communication efficiency (number of words used to describe each shape), and (D) communication success (expressed as a percentage) over Iterations 1-12 and plotted for each dyad. In each panel the solid red line is the linear model fit and the light red shaded area is the bootstrapped 95% confidence interval. The dot points reflect the overall mean at each Iteration. The dashed horizontal red line (Panel D) indicates chance communication success of 12.5%. Chance performance would increase to 16.67% if participants realized the distractor items were never communicated. A small amount of noise was added to the communication success scores to reduce over plotting (Panel D).

Section 3. Are Matchers Sensitive to Problems in Communication?

Matcher sensitivity to problems in communication was assessed in two ways: at the perceptual level (using confidence estimates) and at the behavioral level (using other-initiated repairs). If Matchers are sensitive to problems in communication, they will be less confident on trials in which communication was unsuccessful compared to trials in which communication was successful (Hypothesis 1), and trials that contain an OIR will be less successful compared to trials that do not contain an OIR (Hypothesis 2). If OIRs signal communication problems to the Director, Directors will be less confident on trials that contain an OIR compared to trials that did not contain an OIR (Hypothesis 3).

To test Hypothesis 1 we identified all unsuccessful trials (excluding trials where participants ran out of time) and then selected a comparison group of matched successful trials. For each unsuccessful trial we randomly selected a successful trial from another dyad from the same trial number (i.e., 1-72). Because matcher confidence and communication success changed over trials (see **Fig. 4**), it was crucial to match unsuccessful and successful trials by trial number. The Matcher confidence data was analyzed using a linear mixed effects model. Trial Type (Successful, Unsuccessful) was entered as a fixed effect (centred). The random effects structure included by-Matcher and by-Shape random intercepts, as well as by-Matcher and by-Shape random slopes for Trial Type. Matchers were sensitive to problems in communication; their confidence was lower on trials in which communication was unsuccessful compared to trials in which communication was successful, supporting Hypothesis 1 ($\beta = -0.96$, $SE = 0.16$, $t = -6.00$, $p < .001$; see **Fig. 5A**).

To test Hypothesis 2 we identified all OIR trials (including trials where participants ran out of time) and then selected a comparison group of matched trials that did not contain an OIR. For each OIR trial we randomly selected a trial that did not contain an OIR from another dyad from the same trial number (i.e., 1-72). The communication success data

was analyzed using a logistic mixed effects model (same model structure). Trial Type (No OIR, OIR) was entered as a fixed effect (centred). Communication success was lower on trials that contained an OIR compared to trials that did not contain an OIR, supporting Hypothesis 2 ($\beta = -0.91$, $SE = 0.32$, $z = -2.84$, $p = .004$; see Fig. 5B).

To test Hypothesis 3 we identified all OIR trials (excluding trials where participants ran out of time) and then selected a comparison group of matched trials that did not contain an OIR. The Director confidence data was analyzed using a linear mixed effects model. Trial Type (No OIR, OIR) was entered as a fixed effect (centred). The random effects structure included by-Director and by-Shape random intercepts, as well as by-Director random slopes for Trial Type (including a by-Director random slope for Shape led to model over-fitting). Director confidence was lower on OIR trials compared to no OIR trials, suggesting that OIRs signalled a communication problem to the Director, supporting Hypothesis 3 ($\beta = -0.63$, $SE = 0.18$, $t = -3.57$, $p = .001$; see Fig. 5C).

Fig. 5. Mean (A) Matcher confidence (0-6) of communication success in successful and unsuccessful communication trials, (B) communication success in trials without an OIR (No OIR) and with an OIR (OIR) and (C) Director confidence (0-6) in trials without an OIR and

with an OIR. Error bars are the bootstrapped 95% confidence intervals and the dot points indicate the mean score per participant/dyad.

Discussion

Other-initiated repairs (OIRs) are a frequent and universal feature of human communication (Dingemanse et al., 2015; Dingemanse & Enfield, 2015). OIRs are widely thought to signal trouble and address problems in communication (Schegloff, 2000; Sidnell, 2011). However, recent research casts doubt on this, arguing instead that communication is noisy and error prone, and that interlocutors exhibit considerable insensitivity to problems in communication (Galantucci & Roberts, 2014; Galantucci et al., 2018; Roberts et al., 2016; see also the literature on change blindness; Simons & Rensink, 2005). Using a referential communication task, the goal of which is accurate information transfer, we show that matchers were less confident on trials where communication was unsuccessful, and that communication success was lower on trials that contained an OIR compared to those that did not contain an OIR. This pattern of results demonstrates that interlocutors exhibit (a degree of) sensitivity to problems in communication and use OIRs to address them. In addition, that OIRs were present in unsuccessful trials supports the idea that repair does not necessarily resolve communication problems, but is a signal to them. This is supported by the finding that OIR trials were associated with lower Director confidence compared to trials without an OIR, indicating that Matchers' OIRs signalled problems in communication to their partner.

Because language is ambiguous (Altmann, 1998) and because ambiguity resolution is guided by egocentric processing biases (Keysar, 2007), communication will inevitably be

noisy and error prone. For this reason, sensitivity to problems in communication will be imperfect. This has been empirically demonstrated using a task in which speakers try to communicate one of two meanings of ambiguous statements to a listener and then estimate their communication effectiveness (Fay, Page, Serfaty, Tai, & Winkler, 2008; Keysar & Henly, 2002). Consistent with an egocentric processing bias, speakers systematically overestimated their communication effectiveness, predicting the listener would understand their intended meaning more often than they actually did. Signal detection analysis indicated that, in addition to this egocentric response bias, speakers exhibited a degree of sensitivity, being able to discriminate successful trials from unsuccessful communication trials. This pattern of results is consistent with the Matcher sensitivity results returned by the present study.

The consequences of miscommunication will vary depending on the context. In the present study the goal of communication was accurate information transfer, whereas in other studies the goal is predominantly social in nature (cf. Galantucci & Roberts, 2014 (though Study 1 here is an exception); Roberts et al., 2016). Doing reference is a ubiquitous aspect of everyday interpersonal communication (Clark & Bangerter, 2004; Krauss & Fussell, 1996; Sacks & Schegloff, 1979). Indeed, it is one in which we often find repair sequences as we query our references through recipient-designed descriptions or try-marking (Clark & Wilkes-Gibbs, 1986; Sacks & Schegloff, 1979). Problems in referential communication then might be more actionable than temporary incoherence or non-sense phrase insertion in less consequential interactions. We can observe that participants are sensitive to problems in referential communication by the ways in which they react to inadequate signals *in-situ*. Rather than relying on self-reports in post-tests, we can look at the actions participants

perform – such as initiating a repair - as evidence of noticing communication problems and acting upon them.

In the present study, communication problems appeared to be corrected through a combination of repair and interactive alignment (Pickering & Garrod, 2004). For instance, Tangram 9 was initially described as “left facing” (Dyad 30, Trial 5; see **Fig. 3**). The Matcher signalled a potential misunderstanding by adding the restricted offer “standing?”, to which the Director added the (corrected) clarification “bowing man”. Later, the Matcher (the Director on Trial 5), queried the description for the same shape, “tray man”, adding the restricted offer “begging with butt?”, to which the current Director responded “triangle bum” (Trial 23). By trial 56 the dyad had aligned on the description “triangle butt”, abbreviated to “TB” later in the trial. Here, OIRs signalled a potential communication problem, which was resolved by incrementally aligning their shape descriptions over trials. This observation, that OIRs signalled miscommunication and triggered a re-alignment process, is consistent with the results of an experiment showing that interactive alignment may be the primary means through which interlocutors negotiate mutual understanding (Fay, Walker, Swoboda, & Garrod, 2018).

Conclusion

It is widely believed that people are sensitive to problems in communication and use other-initiated repairs (OIRs) to address them (Jefferson, 1987; Sacks et al., 1974; Schegloff et al., 1977; Sidnell, 2011). This view is challenged by recent studies indicating that interlocutors exhibit considerable insensitivity to incoherency in conversation (Galantucci & Roberts, 2014; Galantucci et al., 2018; Roberts et al., 2016), a finding consistent with change

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508 blindness studies (Simons & Rensink, 2005). Following De Ruiter and Albert (2017), we
509 adopted a mixed method approach that combined the experimental method with in-depth
510 qualitative text analysis to examine interlocutor sensitivity to problems in communication.
511 Participants were less confident on trials in which communication was unsuccessful, and
512 were more likely to use an OIR on these trials compared to trials in which communication
513 was successful. We conclude that interlocutors exhibit (a degree of) sensitivity to problems
514 in communication, and use OIRs to signal and address them.

References

- Altmann, G. T. M. (1998). Ambiguity in sentence processing. *Trends in Cognitive Sciences*, 2(4), 146–152.
- Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, 68(3), 255–278. <https://doi.org/10.1016/j.jml.2012.11.001>
- Bates, D., Maechler, M., Bolker, B., & Walker, S. (2013). lme4: Linear mixed-effects models using Eigen and S4. *R Package Version*, 1(4).
- Clark, H. H. (1996). *Using language*. Cambridge: Cambridge University Press.
- Clark, H. H., & Bangerter, A. (2004). Changing Ideas about Reference. In *Experimental Pragmatics* (pp. 25–49). Palgrave Macmillan, London. https://doi.org/10.1057/9780230524125_2
- Clark, H. H., & Wilkes-Gibbs, D. (1986). Referring as a collaborative process. *Cognition*, 22, 1–39.
- De Ruiter, J. P., & Albert, S. (2017). An appeal for a methodological fusion of conversation analysis and experimental psychology. *Research on Language and Social Interaction*, 50(1), 90–107.
- Dingemanse, M., & Enfield, N. J. (2015). Other-initiated repair across languages: towards a typology of conversational structures. *Open Linguistics*, 1(1).
- Dingemanse, M., Roberts, S. G., Baranova, J., Blythe, J., Drew, P., Floyd, S., ... others. (2015). Universal principles in the repair of communication problems. *PloS One*, 10(9), e0136100.

- 537 Dingemanse, M., Torreira, F., & Enfield, N. J. (2013). Is “Huh?” a universal word?
538 Conversational infrastructure and the convergent evolution of linguistic items. *PLoS*
539 *One*, 8(11), e78273.
- 540 Fay, N., Ellison, T. M., Tylén, K., Fusaroli, R., Walker, B., & Garrod, S. (2018). Applying the
541 cultural ratchet to a social artefact: The cumulative cultural evolution of a language
542 game. *Evolution and Human Behavior*, 39(3), 300–309.
543 <https://doi.org/10.1016/j.evolhumbehav.2018.02.002>
- 544 Fay, N., Page, A. C., Serfaty, C., Tai, V., & Winkler, C. (2008). Speaker Overestimation of
545 Communication Effectiveness and Fear of Negative Evaluation: Being realistic is
546 unrealistic. *Psychonomic Bulletin & Review*, 15(6), 1160–1165.
- 547 Fay, N., Walker, B., Swoboda, N., & Garrod, S. (2018). How to Create Shared Symbols.
548 *Cognitive Science*. <https://doi.org/10.1111/cogs.12600>
- 549 Galantucci, B. (2009). Experimental semiotics: A new approach for studying communication
550 as a form of joint action. *Topics in Cognitive Science*, 1(2), 393–410.
- 551 Galantucci, B., & Roberts, G. (2014). Do We Notice when Communication Goes Awry? An
552 Investigation of People’s Sensitivity to Coherence in Spontaneous Conversation.
553 *PLOS ONE*, 9(7), e103182. <https://doi.org/10.1371/journal.pone.0103182>
- 554 Galantucci, B., Roberts, G., & Langstein, B. (2018). Content deafness: When coherent talk
555 just doesn’t matter. *Language & Communication*, 1–6.
556 <https://doi.org/10.1016/j.langcom.2018.01.001>
- 557 Garrod, S., & Anderson, A. (1987). Saying what you mean in dialogue: A study in conceptual
558 and semantic co-ordination. *Cognition*, 27(2), 181–218.

- 559 Garrod, S., Fay, N., Lee, J., Oberlander, J., & MacLeod, T. (2007). Foundations of
560 Representation: Where Might Graphical Symbol Systems Come From? *Cognitive*
561 *Science*, 31(6), 961–987.
- 562 Jefferson, G. (1987). On exposed and embedded correction in conversation. *Talk and Social*
563 *Organization*, 86–100.
- 564 Kendrick, K. H. (2015). Other-initiated repair in English. *Open Linguistics*, 1(1).
- 565 Keysar, B. (2007). Communication and miscommunication: The role of egocentric processes.
566 *Intercultural Pragmatics*, 4(1), 71–84.
- 567 Keysar, B., & Henly, A. S. (2002). Speakers' overestimation of their effectiveness.
568 *Psychological Science*, 13(3), 207–212.
- 569 Kitzinger, C. (2013). Repair. *The Handbook of Conversation Analysis*, 229–256.
- 570 Krauss, R. M., & Fussell, S. R. (1996). Social Psychological Models of Interpersonal
571 Communication. In E. T. Higgins & A. W. Kruglanski (Eds.), *Social Psychology:*
572 *Handbook of basic principles* (pp. 655–701). New York: Guilford Press.
- 573 Krauss, R. M., & Weinheimer, S. (1964). Changes in the length of reference phrases as a
574 function of social interaction: A preliminary study. *Psychonomic Science*, 1, 113–114.
- 575 Pickering, M. J., & Garrod, S. (2004). Toward a mechanistic psychology of dialogue.
576 *Behavioral and Brain Sciences*, 27(2), 169–226.
- 577 R Core Team. (2013). *R: A Language and Environment for Statistical Computing*. Vienna,
578 Austria: R Foundation for Statistical Computing. Retrieved from [http://www.R-](http://www.R-project.org/)
579 [project.org/](http://www.R-project.org/)
- 580 Roberts, G., Langstein, B., & Galantucci, B. (2016). (In) sensitivity to incoherence in human
581 communication. *Language & Communication*, 47, 15–22.

- 582 Rogers, S. L., Fay, N., & Maybery, M. (2013). Audience Design through Social Interaction
583 during Group Discussion. *PLoS ONE*, 8(2), e57211.
- 584 Sacks, H., & Schegloff, E. A. (1979). Two preferences in the organization of reference to
585 persons in conversation and their interaction. In *Everyday Language: Studies in*
586 *Ethnomethodology* (pp. 15–21). New York: Irvington Publishers Inc.
- 587 Sacks, H., Schegloff, E. A., & Jefferson, G. A. (1974). A simplest systematics for the
588 organisation of turn taking in conversation. *Language*, 50(696–735).
- 589 Schegloff, E. A. (2000). When others initiate repair. *Applied Linguistics*, 21(2), 205–243.
- 590 Schegloff, E. A., Jefferson, G., & Sacks, H. (1977). The Preference for Self-Correction in the
591 Organization of Repair in Conversation. *Language*, 53(2), 361–382.
592 <https://doi.org/10.2307/413107>
- 593 Schober, M. F., & Clark, H. H. (1989). Understanding by Addressees and Overhearers.
594 *Cognitive Psychology*, 21(2), 211–232. (ISI:A1989U236200004).
- 595 Sicoli, M. A. (2016). Repair organization in Chinantec whistled speech. *Language*, 92(2), 411–
596 432.
- 597 Sidnell, J. (2011). *Conversation analysis: An introduction* (Vol. 45). John Wiley & Sons.
- 598 Simons, D. J., & Levin, D. T. (1998). Failure to detect changes to people during a real-world
599 interaction. *Psychonomic Bulletin & Review*, 5(4), 644–649.
600 <https://doi.org/10.3758/BF03208840>
- 601 Simons, D. J., & Rensink, R. A. (2005). Change blindness: past, present, and future. *Trends in*
602 *Cognitive Sciences*, 9(1), 16–20. <https://doi.org/10.1016/j.tics.2004.11.006>
- 603 Tolins, J., Zeamer, C., & Fox Tree, J. E. (2017). Overhearing dialogues and monologues: How
604 does entrainment lead to more comprehensible referring expressions? *Discourse*
605 *Processes*, 1–21.