“We’re running out of fuel”: When does miscommunication go unrepaired?

Abstract

We introduce a framework for studying repair initiation in the face of miscommunication. Our aim is to seed development of models that both predict when conversational repair is a likely communicative strategy, and explain why interlocutors would not engage in repair in the face of conversational difficulty. We identify three factors as critical to the predictability of repair: (i) the extent to which a misalignment is (un)recognised by participants (ignorance); (ii) the significance of misalignment relative to some cluster of goals (cost of misalignment); and (iii) the significance of engaging in repair relative to some cluster of goals (cost of repair). We offer a simple method for graphically depicting relevant aspects of communicative situations, and exemplify the framework with examples of non-repaired miscommunication before discussing its applicability to different empirical domains.

Keywords: conversational repair, miscommunication

1 Introduction

On January 25, 1990, after an hour of circling above JFK airport in a holding pattern, Avianca Flight 52 crashed on Long Island: the plane had run out of fuel. Accident investigators found that miscommunication was a proximal cause of the crash. Here is a portion of the (quite chilling) transcript of cockpit and radio transmissions from the flight:[1]

2124:04	JFK Radio:	Avianca zero five two, you are making a left turn, correct sir?
2124:06	Captain:	Tell them we are in emergency.
2124:06	Flight Engineer:	Two thousand feet.
2124:08	First Officer Radio:	That’s right to one eight zero on the heading, and, ah, we'll try once again. We’re running out of fuel.
2124:15	JFK Radio:	Okay.
2124:17	Captain:	What did he say?
2124:18	First Officer:	Maintain two thousand feet, one eight on the heading. I already advise him that we are going to attempt again, because we now can’t.
2124:21	JFK Radio:	American forty heavy, two two left, wind two zero zero at one niner, cleared to land. Wind shear reported, gain and loss of ten knots, seven hundred feet to the surface by a DC-9.
2124:22	Captain:	Advise him we are emergency!
2124:26	Captain:	Did you tell him?
2124:28	First Officer:	Yes sir. I already advised him.

Despite repeated reports that the plane was “running out of fuel”, air traffic control continued to give holding requests. The complete transcript reveals that, later in the interaction, JFK radio requested the plane to “climb and maintain three thousand” feet, to which the first officer responded with a peculiarly polite albeit resigned refusal: “Ah, negative sir. We-- we’re just

[1] Transcript obtained from Cockpit Voice Recorder Database, available online at: https://aviation-safety.net/investigation/cvr/transcripts/cvr_av052.php (accessed March 31, 2022)

running out of fuel". Following further holding instructions, the first officer radioed with ongoing attention to civility: "Avianca zero five two, we just, ah, lost two engines and, ah, we need priority, please".

Eventually, but after the cockpit voice recorder cut out, the crucial repair initiator was attempted from the JFK tower controller - "Avianca zero five two, you have, ah, you have enough fuel to make it to the airport?" They received no response.[2]

Work in Conversation Analysis and talk-in-interaction has long recognised that communicative troubles are inevitable, and hence efforts to overcome these are equally expected. As we know from Schegloff et al (1977), when troubles arise, speakers can initiate both self- and other-repair, for example by asking clarification questions, repeating parts of a trouble source, or disrupting the conversation with cut offs and negative backchannelling (see Purver et al. 2003 for an overview of clarification request forms and their functions). Speakers can also achieve both self- and other-repair, for example through clarifications or corrections. From a Conversation Analysis perspective, repair and repair initiation is taken as evidence for participants' orientation to communicative troubles. On this view, engaging in repair is a way of publicly displaying problems in understanding, and hence the absence of repair is taken as evidence that there is sufficient understanding between participants such that conversation can continue unhindered (Robinson 2014). However, as the Avianca Flight 52 example above reminds us, unnoticed and unrepaired miscommunication can have severe, real-world adverse consequences.

In this paper we address the phenomenon of *non*-repair, focussing on factors that influence when repair is not achieved. To this end, we contribute to discussions on repair from a cognitive perspective (e.g. Clark and Brennan 1991), adding what is not usually studied on a Conversation Analytic approach, namely the discursive and psychological motivations that interlocutors have for engaging - or of specific interest here, not engaging - in repair (see Albert & Ruiter 2018 on the methodological and practical benefits of combining CA research with a cognitive perspective). Previous work has considered the social benefits of engaging in repair: as Sanders (2017) says, people are motivated to repair misunderstandings in order to build common ground, even in the absence of shared background, and as Bernstein (2016) suggests, other-initiated repair efforts position a conversational partner as having something worth saying, and hence worth putting in the effort to understand. Other work has examined the psychological factors that may influence a speaker's choice of repair form, including processing demands, social appropriateness and attention to joint activity (Colman & Healey 2011). However, to our knowledge there is limited research into why people would *not* repair even in the face of known, or at least suspected, conversational misalignment.

Here we offer a framework for studying repair that enables the creation of models that predict when conversational repair would be more or less likely to arise in different situations. Specifically, our goal is to identify a set of features that distinguishes cases of miscommunication in a way that is determinate of whether repair would be an appropriate next communicative move. Assuming that miscommunication results in increased misalignment between speakers, we juxtapose three key factors that influence when a speaker may engage in a repair sequence as follows:

1. **Ignorance**: the extent to which participants are aware of a misalignment
2. **Cost of misalignment**: the significance of a misalignment relative to some cluster of goals
3. **Cost of repair**: the significance of engaging in repair relative to some cluster of goals

The **ignorance** factor targets the rather obvious assumption that a prerequisite to repair is awareness of misalignment. Irrespective of how detrimental a misalignment is with respect to

[2] The final moments of the ATC recording can be replayed online at https://www.youtube.com/watch?v=ie8kLg9Xvd8

communicative goals, interlocutors cannot repair a misalignment if they are ignorant of being so misaligned. But sometimes an interlocutor can be aware of a misalignment, yet choose not to repair it if there are other contributing factors that would deem a repair unnecessary or detrimental to the flow of communication. So, the **cost of misalignment** factor serves to acknowledge that whether speakers make use of their available repair strategies for resolving a misalignment will depend - in part - on how critical they deem it to be relative to their communicative goals. For example, a speaker may choose not to repair if they deem the hearer's display of misunderstanding in some way preferable to the speaker's initial intended meaning (a case of "what you said was better"), and in such cases, opting not to repair may be more beneficial to interactional outcomes that repairing, even if it means letting the misunderstanding slide. In other cases, a misalignment can be potentially catastrophic with regard to achieving communicative goals and hence repair would be highly desirable; however, as we will show, the **cost of repair** might lead one to avoid repair options, for example if production effort is more costly than its relative gain to other communicative goals.[3]

Overall, we demonstrate that the practice of not-repairing can be a complex issue motivated by the interplay of these three factors, ranging from a lack of production effort when the misalignment is not considered functionally significant, to a lack of awareness of a misalignment that would ordinarily trigger repair as functionally beneficial.

Note that we are not simply interested in instances in which there is a clear misalignment and participants choose not to repair. Rather, we anticipate that the insights we present here on repair will provide the starting point for a more comprehensive framework that can account for the global communicative strategies that participants adopt and the interactional factors that affect these. Interlocutors need to balance a host of competing needs and desires that can influence their choice of communicative style, information density, and audience design, all of which affect the probability of small or large misalignments. For example, someone might attempt a low-risk strategy (such as the adoption of a highly restricted vocabulary like that of Aviation English in an air traffic control situation) in which misalignments are very rare, or one may adopt a high-risk high-gain strategy, in which a lot of information is provided rapidly, without high consideration of audience design or grounding efforts that would ensure all parties are building from the same basic assumptions about the topics of conversation. The factors we consider regarding the likelihood of repair in what follows should thus be considered as just a small step towards making progress on this more ambitious project.

The structure of the paper is as follows. In Section 2, we illustrate the three factors as explanatory of the practice of non-repair by applying them to different scenarios in which miscommunication results in misalignment of varying severity to communicative outcomes. Specifically, the factors depicted provide a simple generalization about the types of situation in which repair is likely to be achieved and those in which, for better or worse, it is unlikely to take place. We offer simple graphical presentations that display relevant aspects of the speech situations, which we then combine in Section 3 to provide the beginnings of a framework that provides insights into the predictability of repair initiation depending on the relative strength of each of the factors. Section 4 extends the discussion beyond repair as a communicative strategy in the face of miscommunication, before Section 5 considers how the framework could be extended and applied in different domains, including as a helpful stage for future quantitative modelling.

2 When miscommunication goes unrepaired: A framework for studying repair

Our proposed framework for studying miscommunication contributes to the tradition of dialogic theory stemming from Clark (1996) that views conversation as a joint activity. That is, rather than

[3] It is worth briefly acknowledging that we don't assume that 'decisions' to repair or communicative 'strategies' are necessarily conscious (although they can be); rather, in what follows we simply aim to indicate some of the cognitive conditions that can influence how a conversation progresses.

putting the full responsibility of communication on speakers' utterances alone, hearers are viewed as active participants in the communicative enterprise, and are hence afforded an integral place in a theory of interpretation in dialogue. As part of their role to respond appropriately to others' communicative contributions (Allwood 1976), hearers engage in a process of grounding to regulate the ways in which speakers come to mutual understandings in the process of communication (Clark & Brennan 1991). The simplest way of displaying understanding is to provide a relevant next turn. But hearers can also explicitly signal understanding through positive feedback mechanisms such as nodding, backchannelling ('yes', 'mm-hm'), repetition or paraphrasing. On the other hand, when miscommunication occurs, hearers can display different degrees of recognition using negative feedback mechanisms, ranging from silence and confused looks through to more explicit repair initiation strategies such as clarificatory requests (Schegloff et al. 1977). An irrelevant or inappropriate next turn can also signal that miscommunication has occurred, without necessarily demonstrating the hearer's awareness of such. Following misalignment signals, a speaker then has an opportunity to repair the communicative trouble. It is the lack of such repair outcomes that we focus on below.

It is worth bearing in mind that the study of non-repair as a communicative strategy presents an obvious methodological challenge, especially in the absence of misalignment cues from hearers, and we do not purport to present an exhaustive and systematic empirical foundation for our model. Instead, we illustrate our proposal with examples for which there is observable evidence that miscommunication has occurred, such as from post-hoc self-reporting by interlocutors or from speculative analysis by other scholars, that exemplify a range of possibilities that we suggest a model of miscommunication should predict. This is not to say that repair or repair initiation is not present in our examples in any form, but that in each example there is some kind of misalignment between the interlocutors that is not resolved through an appropriate repair strategy.

2.1 Unnoticed miscommunication: High ignorance

Here we start with the first two features as a broad-brush way of distinguishing cases of miscommunication. To repeat, they are: (1) **ignorance**: the extent to which a misalignment is (un)recognised by participants; and (2) **cost of misalignment**: the significance of misalignment relative to some cluster of goals.

To illustrate these, we start with our catastrophic example of the Avianca Flight 52 disaster. The complete transcript and final accident report (National Transportation Safety Board 1991) indicate there were multiple misalignments stemming from different sources before the eventual crash of the flight. Some crucial misalignments resulted from non-communication, for example the fact that the air traffic controllers failed to communicate that there was wind shear at low altitude contributing to a failed landing approach. Other misalignments more clearly resulted from (linguistic) miscommunication, such as that between the first officer and the JFK air traffic controller, only the former of whom believed there was a critical emergency. The transcript is also suggestive of a more subtle misalignment between the first officer and the captain, because while they both believed the first officer had reported a problem, they differed as to what they took reporting an emergency to consist of and hence the severity of the situation.

For simplicity, we focus here on the misalignment between the first officer and the air traffic controller at JFK airport stemming at least partially from the following exchange:

(1)	2124:08	First Officer Radio:	That's right to one eight zero on the heading, and, ah, we'll try once again. We're running out of fuel.
	2124:15	JFK Radio:	Okay.

Although in a rather obvious sense (since all those in the cockpit perished) the first officer paid a higher price for the miscommunication than the air traffic controller did, we can assume that both

parties shared the overall goal of maintaining flight safety, and both would have considered the cost of the misalignment to be very high. One must question, then, why Avianca Flight 52 wasn't given priority for landing. Subsequent flight analysis has suggested that although the messages from the cockpit appeared to signify an emergency situation for a plane, one of the major causes of the crash was the fact that they did not conform to standardised international disaster protocol. These protocols require an emergency to be declared using standardised wording: either 'pan pan' in case of an urgent problem that is not immediately life threatening, or 'mayday' (from French 'venez m'aider') in case of an urgent drop-everything-and-save-us situation. Since the flight crew did not use the emergency protocol, the air traffic controller inferred from the "running out of fuel" messages that there was no life-threatening emergency, and therefore that, although Flight 52 was low on fuel, it was not so low to prioritise over all other air traffic control movements, and so did not adequately communicate the critical nature of the situation to the air traffic control team. Thus it was due to a suboptimal reporting strategy on the part of the first officer that ignorance of the critical misalignment ensued, and hence repair was not an available next move for the air traffic control team.

We can presume that the first officer was in a similar state of ignorance of the misalignment. Although he showed increasing agitation that priority was not being given to their situation, his failure to use the standard aviation disaster protocol is indicative of a lack of awareness that his mode of reporting the fuel situation would be responsible for a misalignment regarding the state of emergency, and hence a lack of awareness that air traffic control would have misunderstood the situation.

We illustrate this Avianca Flight 52 situation on a two-dimensional chart in which the two factors, ignorance and cost of misalignment, are placed on separate axes. To be clear, we do not claim that the diagram sheds any light on the problems surrounding the Avianca Flight 52 conversation. It is rather a starting point in generalising away from what is obviously an extreme case.

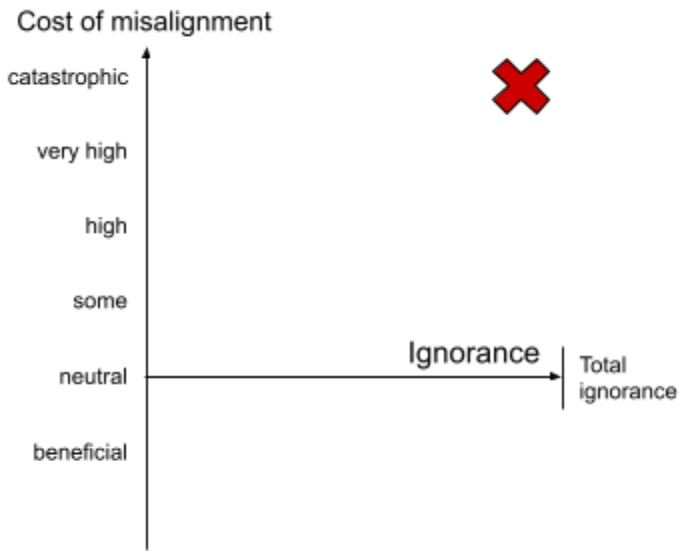

Figure 1: Ignorance and cost of misalignment between first officer and air traffic control of Avianca Flight 52

Given the tragic outcome of the flight, we plot the cost of this sustained misalignment at the extreme 'catastrophic' end of the scale.[4] At the same time, we place the misalignment at the far end of the ignorance scale, on the assumption that it was not recognised by either party. We thus take these two factors as explanatory for the lack of repair in this situation; we discuss in Section 3 how this chart (and those to follow in the remainder of this section) may be combined to provide the beginnings of a predictive model of repair as a communicative strategy following miscommunication.

Note that to label non-repair as a 'strategy' in high ignorance cases may seem odd: if speakers are unaware of being misaligned, they are unable to repair. The purpose of including such cases in our framework is to consider the situational and psychological factors that influence speakers' overarching communicative strategies that, in turn, lead to higher or lower levels of misalignment. Viewed in this context, ignorance of misalignment is a state that can arise due to a suboptimal prior communicative strategy, that, in turn, influences a speaker's future communicative strategy.

Indeed this is what we see in the Avianca Flight 52 case: it was due to the non-standard reporting of the fuel levels that the interlocutors came to be unaware of their misalignment vis-à-vis the state of emergency, which resulted in a lack of repair. But note that we are not concerned with what conversational strategies *should* have been adopted given the participants' state of ignorance about the misalignment. Rather, the example serves as a springboard for considering what conversational strategies should have been adopted to *avoid* such a misalignment arising in the first place. For example, it might be argued that in a high stakes environment, a sensible communicative strategy would be to assume a default of possible miscommunication, even without direct evidence of misalignment. In fact, following this particular flight, the USA National Transport Safety Board (1990) recommended that air traffic control should be vigilant to flight communications, especially those that might declare an emergency, even when non standard phraseology is used: in other words, to assume miscommunication as a possibility.[5]

2.2 Other motivations for not repairing: High cost of repair

The Avianca Flight 52 case exemplifies rather bluntly the fact that awareness of a misalignment (that is, having low ignorance) is a prerequisite for repair, explaining why repair was not immediately forthcoming as a communicative strategy for any of the relevant parties. We now move to cases in which speakers may be aware of a misalignment, and yet deliberately concede it even when repair is an open strategy for them. The question is, then, what kinds of competing factors may be at play such that an interlocutor would choose not to repair?

An example adapted from Clark (1997), concerning an interaction between himself and a server in a cafe, can help address this question:

(2)
Server:	And what would you like to drink?
Customer:	Hot tea, please. Uh, English breakfast.
Server:	That was Earl Grey?
Customer:	Right.

Here, the server's repair initiation, "that was Earl Grey?" reveals a misrecognition of the customer's ostensibly determinate intention to request English breakfast tea—a clarification which may have been required due to a lapse in the server's attention when the customer made

[4] Note that our labels for 'cost of misalignment' are for illustrative purposes only and are not intended to represent interlocutors' own descriptions of the relative costs of different kinds of misalignments.
[5] We return to a more detailed discussion of 'ignorance' in Section 4.

their initial request, or perhaps due to the server's lack of awareness that Earl Grey is a different kind of tea to English breakfast tea. Whatever the reason for the server's clarification question, it simultaneously demonstrates to the customer that a miscommunication has occurred, while also revealing the source of trouble being the precise type of tea desired by the customer. At this point, the customer has an opportunity to repair the miscommunication by correcting the server, such as by repeating their request for English breakfast tea as initially requested. However, this is not what happens: the customer concedes the miscommunication by grounding the server's alternative proposal, responding, "right".

We assume that the customer placed at least some value on receiving their initial order of English Breakfast tea, and so we raise the question of what kinds of motivations he would have for not correcting the server. His later acceptance of the proposed Earl Grey would suggest either that:

(a) he placed little weight on the exact type of tea he received;
(b) while getting English Breakfast tea would have been preferable to receiving Earl Grey, this marginal difference in desire was outweighed by the costs of engaging in repair, stemming either from the time and energy required for the repair, or, relatedly, politeness considerations involving potential damage to the customer's and/or server's public face; or
(c) the customer decided that he preferred to receive Earl Grey to English Breakfast tea, rendering the miscommunication to have net positive utility for him.

We can also speculate as to the priorities of the server regarding the interaction. Assuming that they didn't register the customer's request as to what type of tea was desired, we might doubt the server's level of attention and hence degree of interest in accurately taking down the order, although their clarification question, "that was Earl Grey?", does indicate at least some concern for meeting their customer's desires.

Of course, it is impossible to objectively evaluate the significance of the miscommunication in a situation for which there is little independent evidence of the goals and preferences of the interlocutors themselves. But for the sake of illustration, we hypothesise the following: both participants had the following goals: establishing the customer's preferred order, avoiding challenges to their own or the other's public face, and avoiding lengthy interaction. Let us suppose furthermore that the customer did in fact prefer his initial choice of English Breakfast to Earl Grey, as in option (b) above. We thus plot the ignorance and cost of misalignment of both participants with respect to these goals as in Figure 2.

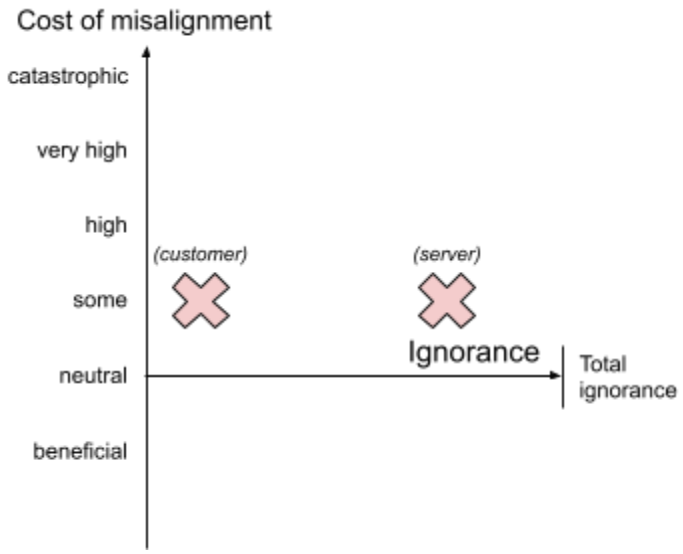

Figure 2: Ignorance and cost of misalignment between customer and server regarding tea order

We assume that the misalignment was detrimental to the customer's goal of receiving his preferred tea, and similarly detrimental to the server's goal of getting the customer's order right. In this case, we have a situation in which the resulting misalignment regarding the customer's initial order had some cost with regard to each participant's respective communicative goals.

There is, however, a greater asymmetry between customer and server with respect to recognition of the misalignment. The customer clearly had very high awareness of the problem, as is evident both from the transcript, and from his (Clark's) later recollection of the situation (Clark 1997). On the other hand, while the server's repair initiation indicates some awareness of a misalignment, their proposal of Earl Grey also suggests a degree of confidence that their view of the customer's preferences aligned with the customer's own view, and hence that their level of ignorance of the misalignment was somewhat higher than the customer's. We represent this asymmetry with separate coordinates for each participant.

Now, given that the customer *was* aware of the miscommunication, we must ask: why did he take the Earl Grey? While repairing the miscommunication would have been beneficial with respect to the single goal of receiving his initial choice of tea, as hinted at above, we conjecture that the customer's motivations for not correcting the server involved not only the cost of misalignment, but also the third factor in our proposed model, the **cost of repair**: the significance of engaging in repair relative to some cluster of goals.

We identify six possible costs of initiating a repair, falling into two classes: inefficiencies, and politeness problems. By *inefficiencies* we mean the fact that a repair would require:

(i) extra time, and
(ii) extra production effort.

As regards *politeness problems*, repair could potentially threaten:

(iii) the customer's positive face in admitting responsibility for a miscommunication,
(iv) the server's positive face in drawing attention to their failure to recover the customer's intended order,
(v) the server's positive face in rejecting the server's proposal, and

(vi) the customer's positive face through appearing rude, only to be mitigated through posturing in the form of apology or hedging, causing further threat to the customer's negative face.

Given what actually happened, we can suppose that at least some of these costs of repair were contributing factors in the decision not to repair, and hence to accept the server's alternative proposed tea, as indeed hinted by Clark himself, the customer in this example:

> I initially intended to be taken as meaning one thing, but I changed my mind. Speakers may accept a misconstrual because they deem it too trivial, disrupting, or embarrassing to correct. (Clark 1997: 589)

In a multi-factor model of the appropriateness of communicative strategies following miscommunication, it would be ideal to represent this third dimension of the cost of repair on a three-dimensional chart alongside the first two factors of ignorance and cost of misalignment. However, given that repair is only actionable when ignorance is sufficiently low, we discard ignorance for now and introduce here a separate two-dimensional chart juxtaposing the cost of the resulting misalignment with the cost of repair (Figure 3).

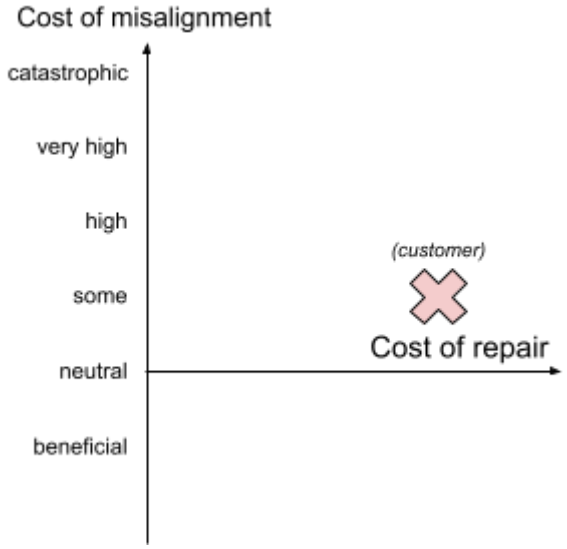

Figure 3: Cost of repair vs cost of misalignment for customer regarding tea order

This chart illustrates the cost of repair as being higher than the cost of the misalignment itself, which leads to the non-repairing next turn. Of course the customer could have had other motivations for not repairing: it is possible that the cost of the misalignment was actually negative - i.e. on the 'beneficial' end of our scale - if, for example, he thought that the alternative tea on offer, Earl Grey, was preferable to his initial choice. In any case, what this example serves to illustrate is that non-repair as a communicative strategy can be a more complex issue than simply whether the overarching rhetorical goal has been satisfied, as there may be competing factors at play such as - in this case - a desire for a particular tea versus the effort of correcting the server.

Non-repair in this tea situation is predominantly due to face-saving concerns. An example from Corti and Gillespie (2016) highlights how inefficiencies can instead provide the driving force for a non-repair. Their study looked at repair behaviour of human interactant when chatting with both human and non-human agents. In the following extract, the interactant has been informed that their interlocutor (Cleverbot) produces utterances from a computer generated chat bot.

(3) Interactant: So what's your family life like?
Cleverbot: I don't have one.
Interactant: That might explain quite a bit then.
Cleverbot: Might?
Interactant: So are you running away from something by being a student in London?

In response to the interactant suggesting that Cleverbot not having a family "might explain quite a bit", Cleverbot produces a repair initiation through its clarification question "might?". However, rather than explain and respond to Cleverbot's question, the interactant chooses to change the direction of the conversation, opting to forgo the invitation to repair their previous turn.

In general, the study found that people were more likely to initiate repair when talking with a human agent than when (knowingly) talking with an artificial agent. They suggest that if people do not assume their conversational partner to be highly intersubjective with an ability to form perspectives on the other's point of view, they will not put in the effort to build common ground through repair and other grounding strategies. In terms of our framework, when a conversational partner is deemed to lack intersubjectivity, the cost of repair will be considered too high relative to the potential gains from engaging in repair, and hence repair is unlikely to occur.

Note that a high cost of repair when inefficiencies are a relevant concern are not limited to 'don't care' situations; as Corti and Gillespie (2016) point out, analogous non-repair strategies may occur when communicating with interlocutors with speech or language difficulties, where a high cost of repair relative to the low cost of misalignment leads speakers to treat trouble source turns as unproblematic and hence to let miscommunications slide (see e.g. Goodwin 2003, Skelt 2012).

2.3 Misalignment as the default state: Low cost of misalignment

It is worth bearing in mind that all communicative acts produce at least partial misalignments between interlocutors with regard to the full import of the speaker's intended meaning. This can be because speaker intentions are not always determinate in content (Sperber and Wilson 2015), or, by the same token, because speakers' intentions can be - sometimes by design - more or less clearly inferable by a hearer. Given that such misalignments are inevitable, we expect interlocutors to consider their costs sufficiently low and hence to result in a low rate of repair and repair initiation to avoid constant disruption to the flow of conversation. Of course it does matter whether hearers interpret speakers' utterances in a way that the speaker would accept having communicated; it is not that any interpretation will do (Haugh 2013; Sanders 1987). However, if the hearer recovers a message that is *compatible* with what the speaker intended (Elder 2019), such misalignments are 'benign', and any repair work would be likely unnecessary as long as the interlocutors were satisfied that the cost of the misalignment was low enough that there was no trouble in understanding.

An example using co-constructed utterances can help illustrate this point:

(4) Daughter: Oh here dad, a good way to get those corners out
Dad: is to stick yer finger inside.
Daughter: Well, that's one way. (Lerner 1991)

As discussed by Gregoromichelaki et al. (2011), in (4) there is little guarantee that the daughter expected or planned to complete her initial utterance in the way that the dad continued - either in terms of form or content - and hence it is likely that the dad's response resulted in a micro-misalignment with regard to some aspect of her initial utterance. Indeed, we can infer from the daughter's 'well'-prefaced response that she had an alternative planned suggestion for how to

"get those corners out", and hence had some awareness of a misalignment. However, given that she accepted the dad's proposal, we can presume that any misalignment - irrespective of her degree of recognition - was not functionally significant to the goal of getting the corners out, and hence was not worth repairing. We represent this interaction on the ignorance/cost of misalignment chart in Figure 4.

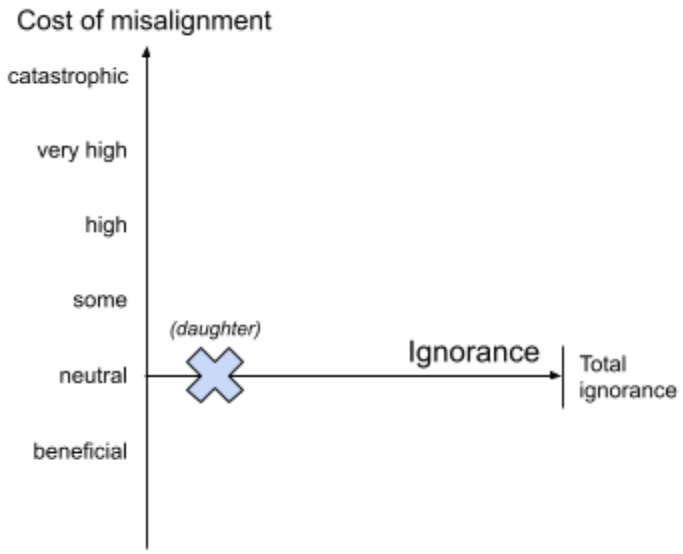

Figure 4: Ignorance and cost of misalignment for daughter with regard to 'getting the corners out'

With regard to the cost of repair, we conjecture that in this particular instance, the trade-off between repairing and accepting the misalignment tipped in favour of not repairing. However, unlike in the cafe situation in (2), this is not to say that there was necessarily a high cost of repair for the daughter in (4). In fact, we imagine that - in this same scenario - the cost of repair was quite low given the close interpersonal relationship between the speakers evidenced by the dad's interruption and the daughter's use of "well", as well as the informal style of speech that is indicative of a low time-sensitive interaction. We plot this as in Figure 5.

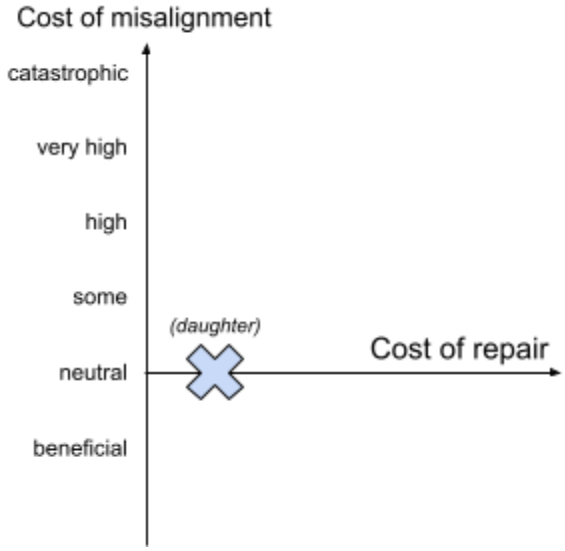

Figure 5: Cost of repair vs cost of misalignment for daughter with regard to 'getting the corners out'

We conjecture that the low cost of repair coupled with the low cost of misalignment would not render a repair completely out of the question, and an equally natural and expected response could have included a repair, e.g. saying, "well that's not what I was going to say, but your way works too". Such a communicative move would put the misalignment on record, while also allowing the alternative proposal to take precedence. Rather, what the low cost of repair does is reduce the *predictability* of repair as an appropriate conversational move, as both a repair and non-repair option would be equally viable. We return to this idea in Section 3 below.

Finally, we suggest that the cost of misalignment can be so low that the misalignment is, in fact, beneficial to communication if it helps the interlocutors develop their joint attitudes within the conversation, and in such cases repair would not be expected. The following extract is taken from Bjørndahl et al (2015: 501) who examined footage of people solving LEGO construction tasks (original language Danish, English translation given in italics).

(5)	1	S3	Jeg tænker noget med nogle broer
			I'm thinking something with some bridges
	2	S2	Ja
	3	S5	Ja
	4	S1	(Reaches for the pile of LEGO blocks)
	5	S4	Jamn hvor er de [to buer der]
			Yeah, so where are those two arches
	6		[(Makes a pointing gesture two times in the air)]

The unspecified referent of 'something' of participant S3 leaves open what the proposal amounts to, both in terms of how the construction should proceed and the number of bridges to be built. As Bjørndahl et al note, while underdetermination often invites repair, whether that is self-initiated or other-initiated, in this example the other participants respond with affiliative messages of acceptance, and efforts to collaboratively act on the proposal of the building activity.

The possible benefit of the misalignment in this example is suggestive of the hypothesis that in many communicative environments it can actually be desirable that utterance content remains to some extent ambiguous, or at least underdetermined. Other examples include poetry, literature, political speeches, teasing and mock impoliteness, all the way to 'pub talk', academic discussion and other situations where micro-misalignments can be part of an exploratory process in which interlocutors come to shared understandings through a process of joint action. And while such ambiguities are most prominently seen in cases of vague, metaphorical and poetic language, they can arguably occur to different extents in *all* utterances (Recanati 2010). This is because linguistic forms can underdetermine utterance content, requiring hearers to engage in inferential work to recover the speaker's intended meaning: inferential work which is often subconscious and automatic. We thus expect interlocutors to have high tolerance for such micro-misalignments in virtue of the fact that they constitute a ubiquitous and a natural part of the communicative process, and presumably often fail to reach the level of conscious awareness.

3 Putting it together: The interplay of factors affecting likelihood of repair

The previous section illustrated a range of situations in which a misalignment is not properly repaired at the time of the exchange, and showed how our three factors, ignorance, cost of misalignment and cost of repair, jointly affect the likelihood of repair being an appropriate next conversational move. The examples differ according to the degree of ignorance the interlocutors have with respect to the misalignment, where a low level of ignorance renders a misalignment unrepairable: communicative conflict is not resolvable if one does not know one is in a conflict. They also differ according to the cost of misalignment, with higher costs making the

misalignments strong candidates for repair (as long as ignorance is sufficiently low). But we have also seen how low ignorance and some cost can still lead to non-repairing scenarios, such as for the customer in the cafe situation, for example if the cost of repair outweighs any negative effects of the misalignment itself.

Overall, then, these examples demonstrate that miscommunication is a graded phenomenon both in terms of the degree to which interlocutors may be misaligned, but more importantly, with respect to how important a misalignment can be with respect to achieving communicative goals. While catastrophic miscommunication is certainly to be avoided where possible, and where unavoidable repaired as far as possible, we have seen that in some situations non-repair may be considered a desirable rhetorical strategy, either because the misalignment is not relevant, is detrimental to other communicative goals, or because other competing goals outweigh the relative benefit of repairing.

We use this limited data to hypothesise how our three factors combine to function as a predictor of repair as a communicative strategy following a miscommunication. Figure 6 represents the likelihood of repair depending on levels of cost of misalignment and ignorance of misalignment, assuming a neutral - that is, low - cost of repair (we will return to what this means shortly). The further towards the top left of the chart from the dotted curve a given misalignment lies, the more likely repair is to occur; the further towards the bottom right of the chart, the less likely repair is to occur. Crucially, the closer towards the dotted curve a given misalignment is, the more equivocal - that is, less predictable - it is whether repair would occur or not.

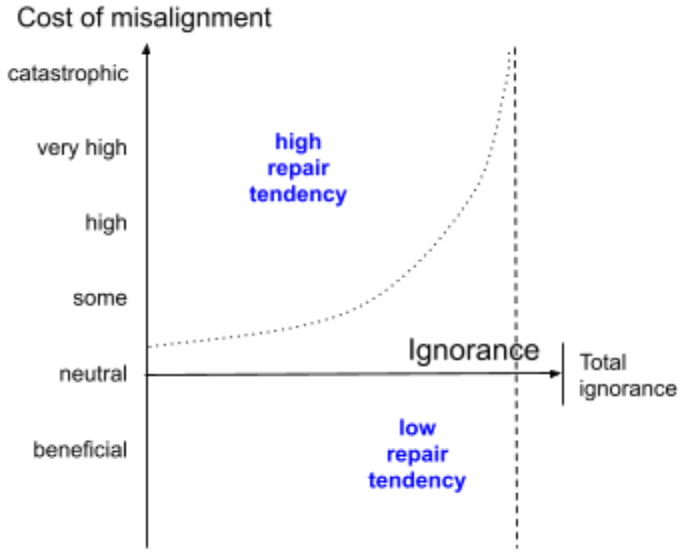

Figure 6: Effect of ignorance and cost of misalignment on likelihood of repair, assuming a neutral cost of repair

There are some key features to note in this representational chart. First, as discussed, low ignorance is at least a prerequisite for engaging in repair as our catastrophic case (1) has shown. This means that there will be a cut-off point on the ignorance scale, over which any instance of misalignment will be unrecognised by participants and therefore unrepairable. We represent this point with a dotted asymptote towards the right-hand edge of the ignorance scale, where irrespective of the cost of misalignment, repair is not an expected available communicative strategy.

Next, intuitively, for any instance of misalignment that falls below the zero 'neutral' cost line is beneficial to interactional goals, repair is also an unlikely strategy. As hinted above, the dotted curve separating the 'high repair tendency' area from the 'low repair tendency' area represents

the tipping point at which the decision to repair can go either way, with repair being increasingly likely towards the top left of the chart and increasingly unlikely towards the bottom right of the chart. The closer individual instances of misalignment are to the dotted curve, the less predictable it will be whether repair takes place.

There are two further points to note regarding this dotted curve. First, at the right hand side, the curve indicating the tipping point for repair extends all the way to the ignorance cut-off point: this is because we expect that when the cost of misalignment is highly significant (as it was for Avianca Flight 52), any degree of awareness, however small, should lead to repair.

The second point relates to what we term the 'neutral' cost of repair. We assume that a 'neutral' cost of repair will be some *non-zero* value. This is because repair always takes at least some time, and always takes some production effort. If the cost of repair were zero - that is, if there were no cost of repair - the left hand end of the dotted curve on Figure 6 would go through the zero 'neutral' point on the cost of misalignment scale. In this situation, ignorance would be low and cost of misalignment would be indifferent, and hence the move to engage in repair could go either way. But given that we assume a neutral cost of repair to be non-zero, in this chart, the dotted curve passes *above* the zero point on the cost of misalignment scale. What this means for the predictability of repair is that if the cost of repair is neutral at some small positive non-zero value, whenever the cost of misalignment is sufficiently low - say, at the neutral point and below - a no-repair communicative strategy is more likely than a repair strategy.

The next thing to consider is what would happen if there were a different - high or low - cost of repair. On the one hand, if the cost of repair increases - for example, if there is a greater risk to time, effort, face, etc., when one engages in repair - then the high repair tendency area will shrink towards the top left corner of our chart, and the low repair tendency area will increase, as in Figure 7.

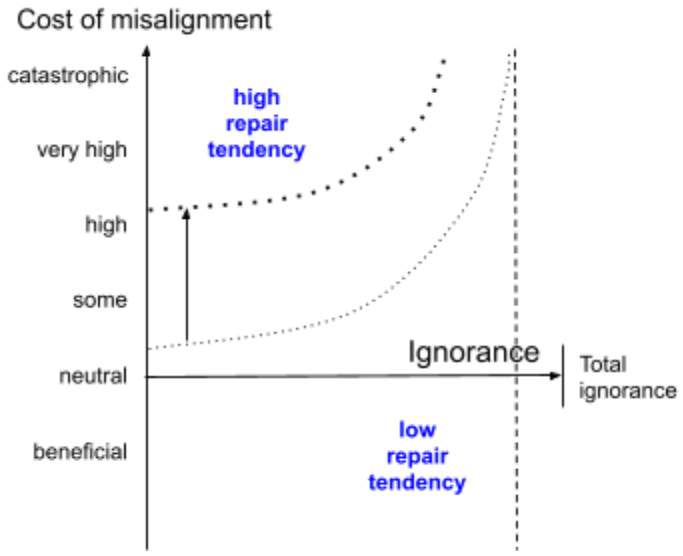

Figure 7: Effect of ignorance and cost of misalignment on likelihood of repair when cost of repair increases

This is one way to look at the cafe situation in (2): the cost of repair - say due to embarrassment or degree of effort - was high enough compared to the cost of misalignment that it was deemed preferable not to repair, and to accept the alternative tea.

But, assuming sufficiently low ignorance, even when the cost of misalignment is potentially catastrophically high, then a very high cost of repair could still prevent repair from being actionable. This has been seen in other prominent flight crash cases such as that of the JAL Cargo Flight 8054, when Japanese flight crew failed to question or correct the captain's inaccurate flight

control inputs, resulting in the flight crashing shortly after take-off. This lack of communication from the junior crew has been attributed to power-distance norms in Japanese culture, adherence to which involved silence as the preferred communicative strategy of the subordinate crew over correcting that captain that would cause significant threat to the captain's face, even at the expense of the crash (Strauch 2010).

On the other hand, when the cost of repair decreases, we expect the likelihood of repair to increase overall. The dotted curve will move towards the bottom right of the chart, increasing the high repair tendency area, as in Figure 8.

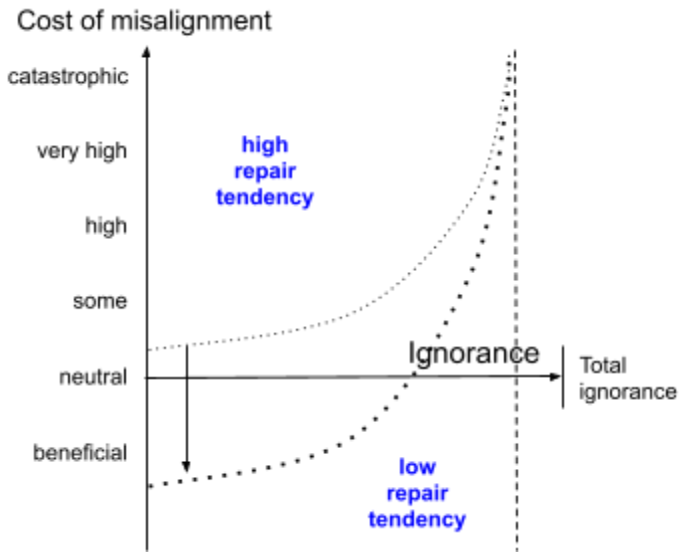

Figure 8: Effect of ignorance and cost of misalignment on likelihood of repair when cost of repair decreases

Note that when the cost of misalignment is low, the likelihood of repair will increase even when the cost of misalignment is low. As we described in the dad-daughter case in (4), in a situation that is not time critical, it may be natural to acknowledge a misunderstanding with "oh, I actually meant X, but what you said was better!" without any threat to face or achievement of conversational goals.

So the final question with respect to this chart is: can there be a negative cost of repair, such that the act of repair itself is beneficial to interactional outcomes? We argue that there can be. A speaker may find it important to correct another speaker's contribution, for example to place emphasis on the hierarchical nature of a relationship and to demonstrate the speaker's position of authority. Or a speaker might draw attention to a misunderstanding in order to demonstrate speaker authenticity, for example by a therapist to a client in counselling to signal their genuineness as a person (e.g. Rogers 1951). Or simply in a low stakes situation such as a casual meet up between friends, there may be both low time pressures and low threat to face, and engaging in repair and repair initiation could be beneficial for demonstrating engagement with conversational partners. That is, if a hearer didn't catch what the speaker said, it can be useful for the hearer to ask for repetition in order to demonstrate their interest in the other person, to follow along with what the speaker is saying, and hence to help maintain or even enhance their interpersonal relationship. Such instances of repair would not be considered time wasting or a threat to face. Indeed, when the primary communicative goal is the social interaction itself, it is likely that there will be a tight correlation between the value of the content of the conversation and the cost of repair: as misunderstandings can have a high cost to the overall goal of

understanding and following along with the conversation, repair is an expected part of the interaction.

4 When predictability of repair is low: Finding another way out

The three factors we have identified constitute a first indication of the factors that can account for when and why speakers may engage in repair, and moreover, why they may *not* engage in repair, even in the presence of communicative difficulty. So far, we have put absence of repair down to (i) ignorance of a misalignment (as in the Avianca Flight 52 example), (ii) high cost of repair (the cafe situation; human and Cleverbot), or (iii) indifferent, or even negative (beneficial), cost of misalignment (dad and daughter; LEGO building situation).

But while we have presented our multi-factor model as capturing a categorical division between repairing and not repairing a misalignment, repair is just one kind of communicative act that speakers can employ in cases of miscommunication. The dotted curve separating the high versus low repair tendency areas in Figures 6-8 is supposed to represent exactly this: it indicates the points at which repair is least predictable due to other competing factors being at play. That is, along this dotted curve, we do not purport to predict whether repair will occur or not, nor is it our aim to do so. This is because when a miscommunication occurs, there are various different strategies that one can take, some of which can involve different kinds of repair, others of which involve non-repair acts. In this section, we pursue one more option that can explain absence of repair, namely: increasing alignment not by targeting the misalignment directly, but by finding another communicative strategy that will resolve the problem.

Let us motivate the problem with a final example. In (6) we see an interaction in which the speakers are ostensibly aware that they are misaligned due to the responses of the other seeming odd in some way, but are not clear on how exactly they are misaligned, resulting in attempts to 'get on the same page' through repair initiators but without successful resolution.

(6) [A customer aims to telephone a retail store to buy a new television, but mistakenly calls an operator at a repair centre]

Operator:	Seventeen inch?
Customer:	Okay.
	(pause)
Operator:	Well is it a portable? (Varonis & Gass 1985: 332-333)

Given that the operator works in a repair centre, we might expect that a viable completion of their initial subsentential utterance "seventeen inch?" to be asking a question about a television that the customer owns and that needs restoring, communicating the question "do you have a seventeen inch television?", which the customer would be expected to confirm or disconfirm. However, the customer's positive feedback "okay" would not be a typical response if the customer was answering a question about the size of their existing television, evidencing that the customer has not satisfactorily understood the operator's intended question. The pause that follows indicates that the operator has some awareness that something is not quite right with the interaction: perhaps that their previous utterance was not interpreted as expected, which could further suggest that there is a more serious misalignment in the operator's and customer's respective beliefs about what is in the common ground. But despite awareness of some kind of problem, the operator's follow-up question, "is it a portable?", hints that the operator has not fully understood the purpose of the customer's response, and hence that the operator is not sure what the underlying problem is.

After several turns involving multiple misalignments, the customer eventually asks for a new television directly, to which the operator clarifies, “oh, you wanna know...how much a new television is?”:

Customer:	(long pause) New television please. (clears throat)
Operator:	Oh, you wanna know (long pause) how much a new television is?
Customer:	Yeah, I wan’ buy one please.
Operator:	(pause) Do we wanna buy one?
Customer:	uh huh

Here we see the operator request clarification of the customer’s just prior utterance that they want to know how much a new television is, which the customer subsequently grounds by confirming they want to buy a new television. We might expect that this exchange would resolve the previous confusion due to their mismatch in common ground over the nature of the business being called. But instead, the operator attempts further clarification by testing a revised interpretation, asking “do we wanna buy one?”. Varonis and Gass (1985: 339) here suggest that the conflict in new information for the operator - namely that the customer wants to buy a new television - with what the operator assumes is in the common ground would involve too great a change in their beliefs, which leads the operator to pose a new hypothesis of what might have been communicated that is more congruent with their current beliefs. Unfortunately, the customer confirms the operator’s revised understanding (“uh huh”) thus sustaining the misalignment, which then leads to further back-and-forth based on the new assumption that the customer wants to sell a television, rather than to buy one.

While the off-kilter responses in this conversation provide the evidence that the interlocutors are misaligned in some way, the lack of resolution can be attributed to their being unaware of the reason they are misaligned. The problem is that they do not realise they are engaging in different communicative purposes: they are engaging in what Sanders (2015) terms different ‘activity intentions’. The issue is that despite the operator being aware there is some problem, evidenced by their multiple clarification questions of the customer’s previous turns, they are unclear on the source of the micro-misalignments that become apparent from the mismatches in communicative intentions. That is, although communicative intentions are responsible for some of the instances of miscommunication, these mismatches in understanding are not the root cause of the offending misalignment; rather, the problems in recovering communicative intentions serve to highlight an underlying mismatch in beliefs about the common ground, which continues to elude them. The result is that at no point during the interaction do either customer or operator offer clarification of the crucial information that is lacking in the common ground, namely the principal operations of the business being called, and hence we would not expect repair of the relevant issue to be forthcoming, at least until it became apparent to one of the interlocutors that this was the source of their misalignment.

This scenario highlights an important feature of misalignment: while misalignments between interlocutors can arise directly as a result of miscommunication - that is, mishaps in linguistic communication - misalignments can also be due to different kinds of differences in beliefs. Specifically, there is a difference between (i) inconsistencies in what speakers believe to be in the common ground, that may or may not be due to miscommunication, and (ii) *absence* of beliefs/attitudes/knowledge, that is, holes in the common ground. When speakers face a potential inconsistency, in other words, when one person is aware that there may be a mismatch in beliefs (as opposed to absence of information), they can target the misalignment directly via a repair strategy as we have been discussing, employing corrections and clarifications as needed. But much of the time what speakers are doing when they communicate is patching recognizable holes in common ground: speakers ask questions to find out more about what has previously been said

or to find out about the other person, among the many other reasons for engaging in communication, and this can also be a viable strategy in the face of misalignment.

Consider the following analogy. Imagine that we're out for a hike and we're looking for somewhere to stop for lunch. The map suggests that over the next hill we should be able to see a small church next to a pub where we could eat. We see no such thing. What do we do? Well, we could 'repair' by retracing our steps and trying a different route to find the church and, crucially, pub. Alternatively, we could 'clarify' our situation by examining the map in more detail to see if we are where we thought we were. Or alternatively we could carry on walking as per the original plan, hoping that the pub will come into view, or perhaps that we'll find somewhere else suitable for lunch instead. The latter strategy does not directly aim to 'repair' the mismatch between our expectations and apparent current situation, but this is not because of high utility or high ignorance; it is simply a different way of attempting to resolve the issue.

The hiking metaphor can help our analysis of (6). In the TV repair situation the misalignment presumably has some cost for both parties: it is obviously detrimental to the customer's goal of buying a television, and to the operator's goal of resolving the customer's queries. The question that remains is where we are on the ignorance scale. Both the operator and the customer do appear at different points to realise that something is not quite right, evidenced by their clarifications, questions and pauses (also evidencing that there is a low cost of repair for the interlocutors), but they fail to repair what we assume is the critical problem in the communication, namely the mismatch in beliefs about the operations of the centre being called. We thus assume that neither interlocutor has managed to diagnose the problem, and hence repair of the critical problem is not an open strategy to them.

This partial awareness of a misalignment presents a tactical issue for the interlocutors: they know they are not aligned in some important way, but the lack of understanding of the offending mismatch results in confusion over the best approach moving forward. What they can do is work with the information available to them: while they have high ignorance of their mismatched background assumptions, they have high awareness of the local misalignments that are presented from individual unexpected turns. This situation is therefore rather like our map-reading-lunch scenario described above: they know there is a problem insofar the conversation isn't proceeding as expected, but instead of resolving mismatches in common ground (a strategy unavailable to them due to lack of awareness), they work with the information they do have, hoping to come to an understanding of what is wrong. This is the tactic that the operator employs, asking clarificatory questions in order to seek new information and to patch holes in the common ground. But the scenario differs from the map-reading-lunch scenario insofar as the critical misalignment is due to a mismatch in perceived common ground. In this sense, the misalignment isn't something that came out of the conversation itself, and so it is not possible to 'backtrack' and figure out what went wrong. As such, all the communicative moves they make are building on the assumed common ground, which unfortunately leads to more confusion as those turns themselves yield further misalignment.

This TV repair example highlights that ignorance of misalignment is not simply a yes-no thing, where high ignorance results in no repair. Rather, ignorance involves both the fact that there is a misalignment, and the nature of that misalignment. Knowing the former is a prerequisite for knowing the latter, but knowing the latter is often crucial for ignorance to be actionable. In the case of Avianca Flight 52, the air traffic control team didn't seem to know they were misaligned with the flight crew, and hence didn't know how they were misaligned nor how to resolve the misalignment. In the cafe situation, the customer knew both that they were misaligned and how they were misaligned, and hence repair was an actionable strategy if they wanted to adopt it. But in the TV repair case, the interlocutors seem to know *that* they were misaligned, but not *how* they were misaligned, and hence they didn't have an actionable repair strategy.

5 Conclusion

We have identified three factors - ignorance, cost of misalignment, and cost of repair - that influence the likelihood of repair following miscommunication. Our hope is that our approach might seed further research into how various factors interact to inform conversational strategy in situations of conversational misalignment, what the boundaries of our account are, and that our approach will inspire empirically driven modelling of conversational misalignment strategies.

For example, an issue we have not discussed is the extent to which agents have shared goals and a mutual desire to coordinate. The interactions we have considered, with the possible exception of the chatbot conversation in (3), can be construed as cooperative in a relatively straightforward sense. There is much discussion in the literature on situations in which speakers purposefully form misalignments with their conversational partners by purposefully implicating something false (Haugh 2013), deliberately co-construct utterances in a devious way (Gregoromichelaki et al. 2011), recast another's utterance meaning for humorous purposes (Dynel 2016), manipulate another's utterance meaning for their own divergent purposes (Elder 2020), or even purposefully display failure to understand what is said (Dotson 2012). There is no reason to assume that the factors determining the probability of repair will operate in the same way in each of these contexts, or that any of these contexts will be similar in relevant respects to the situations that we have focused on.

In another vein, we hope that our framework will offer a pathway to a richer understanding of conversational misalignment strategies in general. A natural path forwards might begin by developing empirical methodologies involving experimental designs inspired by the framework we have proposed. Such designs might involve dialogue tasks, perhaps akin to the chatbot task discussed above (Corti and Gillespie 2016), in which factors of ignorance, repair cost, and misalignment cost are systematically varied, and the frequency of repair initiation and/or repair outcomes measured as a dependent variable. Variations of such tasks might be applied in multiple areas of applied linguistics that would contribute to existing discussions on repair, such as: clinical applications due to atypical psychology, hearing loss, or speech difficulty (e.g. Goodwin 2003, Skelt 2012); child language acquisition (e.g. Morgenstern et al 2013, Clark 2020); and second language learning and/or intercultural communication, including issues of culturally-informed expectations of behaviour (e.g. Bolden 2014, Bernstein 2016). For example, a spoken dialogue situation in which ambient noise was systematically varied would constitute a direct manipulation of (some aspects of) ignorance, and at the same time would have a natural interpretation in terms of hearing loss and speech difficulty. All of these domains involve asymmetric abilities (and hence costs) for speaking, for understanding, and for repair, and also complex social costs when consistent misunderstanding or mistaken speech becomes evident, due to loss of face and loss of rapport. Similarly, the study of conversational misalignment strategies could both support analysis of human needs and system failings in Human-Computer Interaction (HCI) systems, and could suggest factors that HCI systems should take into account in deciding whether computer repair is needed, and identify types of misalignment in the absence or presence of human-initiated repair.

More generally, we have not explicitly considered the ways in which different media and modes of communication affect both the nature of different kinds of misalignments, or the types of repair available. For example, if we have failed to adequately explain something in this paper, then readers will have entirely different, and more limited options for redress, than they would if we were presenting the work in real time at a conference. These options and the accompanying social pressures would again be different in a seminar or semi-formal workshop, and different again if we were informally discussing the ideas with colleagues in a cafe. Communicative situations vary enormously, and repair initiation must be studied separately in each situation type. The range of dyadic - not to mention multi-party - interactions is vast, with structural differences between parent-child interactions, romantic trysts, poetry readings, route instruction dialogues,

meetings between coauthors, appointment-setting dialogues, and other task-based dialogues ranging from playing Monopoly to landing a plane. A miserly repair and clarification strategy and calm affect may be warranted when you are hanging about in a tea shop, but the situation is patently different if you're a co-pilot hanging over New York without fuel.

So, different situations each have their own profile in terms of the types of misalignment that are possible, the utility of different types of information, costs of misalignments, and the costs of repair. Having said this, we think that it would be an impractical if not impossible task to provide a single model that can predict repair in all domains. Rather, we hope that the framework we have introduced in this paper can offer a general way of thinking about when and why repair occurs, and so provide an approach that might spur further systematic investigation of the factors underlying repair across interactional domains, as well as contribute to a more general project on how different communicative strategies may lead to misalignments of different strengths.

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