Measures and mechanisms of common ground: backchannels, conversational repair, and interactive alignment in free and task-oriented social interactions

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Abstract

A crucial aspect of everyday conversational interactions is our ability to establish and maintain common ground. Understanding the relevant mechanisms involved in such social coordination remains an important challenge for cognitive science. While common ground is often discussed in very general terms, different contexts of interaction are likely to afford different coordination mechanisms. In this paper, we investigate the presence and relation of three mechanisms of social coordination – backchannels, interactive alignment and conversational repair – across free and task-oriented conversations. We find significant differences: task-oriented conversations involve higher presence of repair – restricted offers in particular – and backchannel, as well as a reduced level of lexical and syntactic alignment. We find that restricted repair is associated with lexical alignment and open repair with backchannels. Our findings highlight the need to explicitly assess several mechanisms at once and to investigate diverse social activities to understand their role and relations.

Keywords: Social coordination, common ground; conversational repair; interactive alignment; backchannel.

Introduction

A key question in cognitive science is how people coordinate knowledge and behavior in social interaction, a process sometimes referred to as grounding (Clark & Brennan, 1991; Dale, Fusaroli, Duran, & Richardson, 2013). Research over the past decades has highlighted processes like backchannels, conversational repair, and interactive alignment, but progress has been hampered by two challenges. First, these processes are rarely considered together, limiting our view of possible interrelations. Second, the study of such processes has been spread across disciplines and data types, limiting the possibilities for prediction and generalization (de Ruiter & Albert, 2017). Here we report on a principled comparison of backchannels, repair, and interactive alignment in two quite different types of contexts: free (FC) and task-oriented conversations (TOC). Engaging in conversation is a collaborative effort involving timely coordination at many levels. In their seminal 1991 article, Clark and Brennan (1991) suggest such coordination to be contingent on common ground, comprising mutual knowledge, beliefs and assumptions. The main mechanism for establishment and maintenance of common ground explored in their work is backchannels (Yngve, 1970). Backchannels are phatic signals such as head nods, eye blinks and vocal expressions of the type *uh-huh*, *yeah*, and *okay* (Bangerter & Clark, 2003; Schegloff, 1982). In this study, we are concerned with vocal backchannels only. Even if such signals are often quite subtle, research suggests that speakers are very sensitive to these kinds of cues as ways of providing and monitoring positive evidence of mutual understanding, and their interruption can have detrimental effects on communication (Clark & Krych, 2004).

A related phenomenon is conversational repair. While backchannels are mostly concerned with positive evidence of understanding, conversational repair refers to the interactional practices by which people signal and solve trouble in conversation (Schegloff, Jefferson, & Sacks, 1977). Here we focus on the most interactive form of repair: other-initiated repair, a highly frequent conversational sequence where one participant initiates the repair procedure by means of a request for clarification like *huh?* or *who?*, and the other completes it. Formats for other-initiated repair frequently show lexical and syntactic repetition (Jefferson, 1972; Sacks, 1992), with a recent cross-linguistic study of informal conversation finding that 48% of all repair initiating turns repeated part or whole of the prior turn (Dingemanse et al., 2015). Repair initiations can be ordered along a cline from weak (providing little indication of what or where the problem is, such as *huh?*) to strong (highlighting a specific element of a prior turn for clarification or confirmation, as in *who?*). While weak repair initiation is always possible, and so might be expected to be a default option, it has been suggested that the selection of repair formats follows a 'strongest initiator rule' (Clark & Schaefer, 1989), according to which people select the most specific repair format possible, given constraints like noise and joint attention.

While backchannels and conversational repair are often thought to be of a more explicit, inferential character, the theory of interactive alignment in conversation suggests common ground to be established through low-level automatic priming processes (Pickering & Garrod, 2004). It has been observed across many contexts and studies that interlocutors engaged in conversation often tend to adapt to each other's linguistic behaviors on many levels from prosody to syntax (Fusaroli & Tylén, 2016). If an interlocutor, for instance, uses the phrase "I'm sure" to express confidence, there is an enhanced probability that the conversational partner will use similar wording later in the conversation even if other expressions would work just as well in that context (Fusaroli et al., 2012). Alignment is thought to percolate between levels of linguistic representation. Lexical alignment can for instance facilitate the alignment of other levels (e.g. syntactic choices), eventually leading to alignment of situation models of the ongoing activity, that is, common ground (Pickering & Garrod, 2004). According to Pickering and Garrod, more explicit negotiation of common ground such as repair and backchannels are only recruited in cases of communication problems or misunderstandings. It should be noticed that a few alternative perspectives have been suggested: Brennan and Clark (1996) associate alignment with more explicit negotiations of shared conceptual representations, while others suggest a context-sensitive mechanism, which strategically selects for alignment or divergence according to the functional needs of the ongoing activity (Fusaroli, Raczaszek-Leonardi, & Tylén, 2014; Healey, Purver, & Howes, 2014). Common ground is often discussed as a unified concept foundational to conversation in general. However, different contexts of conversation are likely to afford different degrees of explication as well as different processes and mechanism for the establishment of common ground. Conversations among pilots and airport control towers thus require high levels of referential precision (Prinzo & Britton, 1993), while the average dinner conversation may be more concerned with maintenance of social relations (Dunbar, Marriott, & Duncan, 1997), to the point of ignoring referential misalignments (Galantucci & Roberts, 2014).

To establish a more refined framework for the investigation of common ground, we propose an integrative approach comparing backchannel, alignment and repair across diverse social activities. In particular, we focus on free spontaneously occurring interactions – traditionally favored by conversation analytic approaches – and a well-defined spatial navigation task to be jointly solved through conversation – traditionally favored by more cognitive and quantitative approaches. The investigation aims to determine how common ground is negotiated and maintained, and whether these processes are modulated by the social context. Moreover, we will investigate how the suggested mechanisms of common ground relate to each other: e.g. if repair and alignment are associated (Dingemanse et al., 2015), then measures of alignment will be tapping into both mechanisms.

We predict that (i) the different social contexts involve distinctive patterns in the dynamics and mechanisms of common ground, such that they allow an accurate classification of conversations as free or task-oriented. More specifically, (ii) baseline frequency of repair, interactive alignment, and backchannels may be higher in task-oriented interactions due to requirements for referential precision. (iii) The quality of the dynamics at work is also predicted to be different. Particularly, task-oriented conversations, aimed at coordinative precision and more tightly constrained by the lab context, will feature more restricted forms of repair. By contrast, free interactions, which often happen in more noisy environments and incorporate a wider range of activities, will involve more open forms of repair. (iv) The different indices of common ground are not independent from each other. For instance, we expect repair and alignment to be related because the repetition of linguistic forms across speakers is a key formal measure of both. The latter point underlines the importance of considering possible relations between repair and alignment when discussing measures and mechanisms of social coordination.

Methods

Free Social Conversations

We used 18 conversations from the DanTIN corpus (Steensig et al., 2013), 10 minutes per conversation, for a total of 4954 speech turns. Data collection was limited to spontaneous, naturally occurring conversations between families and friends. Participants often engaged in additional activities during these conversations (e.g., eating, or playing games). The average conversation involved 275 speech turns (SD=55 turns), with an average of 58 turns per interlocutor (SD=52). All conversations were in Danish. The corpus reflects the diversity of free social interactions, with seven conversations involving 2 participants, seven with 3, two with 4, two with 5 participants, and one with 7 participants. We are currently extending this corpus to be better able to model the effects of number of interlocutors and participation framework.

Task-oriented Conversations

We used the 44 task-oriented conversations that make up the DanPass corpus (Grønnum, 2009), totaling 9448 speech turns. The conversations were aimed at solving the Map Task (Anderson et al., 1991). The average length of each conversation was 7.4 minutes (SD=3), with an average 214 turns per conversation (SD=85), and 107 per interlocutor (SD=42). All conversations were in Danish and involved only 2 participants in separate booths. We are currently extending this corpus to include co-present interlocutors.

Backchannels

Backchannels were manually coded in 10% of the transcripts (2 free social and 5 task-oriented conversations). Based on this, an automatic procedure for coding backchannels was developed, based on turn length (< 4 words) and presence of the words "*ja*", "*nej*", "*okay*", "*nå*", "*jo*", "*mmhm*", "*jamen*", "*mmm*", and "*åh*". The system achieved substantial intercoder agreement with the manual coding (Kappa=0.62). As we are currently extending and validating the coding scheme, results based on the current version of this measure should be treated with caution.

Conversational Repair

A trained analyst identified sequences of other-initiated repair and classified them according to three cross-linguistically attested format types: *open request*, which signals a problem while leaving open what or where it is; *restricted request*, which restricts the problem space by requesting clarification of a specific element of the problematic turn; and *restricted offer*, which offers a candidate perception or understanding for confirmation (Dingemanse & Enfield, 2015). In addition, 10% of the transcripts (3 free social and 5 task-oriented conversations) were analyzed by a second coder. We obtained substantial intercoder reliability, corresponding to a Kappa of 0.67 for repairs in general, and 0.79 respectively for open and restricted repairs (the latter breaking down to 0.4 for restricted requests and 0.38 for restricted offers).

Interactive Alignment

We calculated lexical and syntactic interactive alignment on a turn-by-turn basis. Each turn was lemmatized using the CST lemmatizer for Danish (Jongejan & Haltrup, 2005) and parts of speech tagged using DKIE (Derczynski, Field, & Bøgh, 2014). Lexical alignment was calculated as the cosine similarity between lemmatized words in adjacent speech turns uttered by different interlocutors. Syntactic alignment was calculated as the cosine similarity between 2-grams parts-of-speech in adjacent speech turns uttered by different interlocutors. To avoid possible lexical alignment confounds we regressed it out of syntactic alignment as in (Hopkins, Yuill, & Keller, 2016).

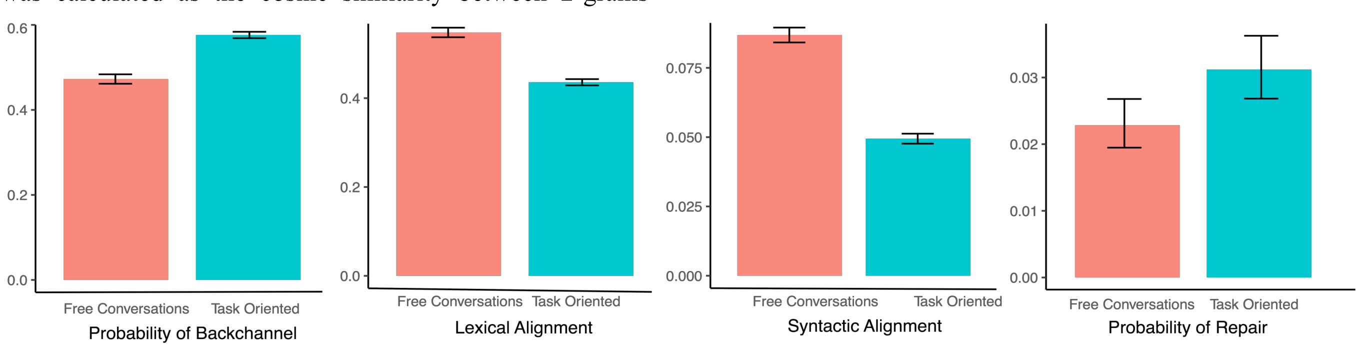
Data Analysis

To assess whether the free social vs. task-oriented nature of the conversations affected the development and maintenance of common ground, we employed mixed effects regression models to predict the presence of conversational repair (binomial variable), interactive alignment (continuous variable) and backchannels (binomial variable) on a turn-by-turn basis. We employed Task (binomial variable, FC vs. TOC), and Time within conversation (count variable, quantified as number of turns from the start) as fixed effects and conversation as random effects, including a random slope for Time. When the model did not converge, we removed first the random slope, then the fixed effect of Time. To determine whether the different social coordinative mechanisms are related to each other, we employed two mixed effects regressions. The first predicted the overall amount of repair initiations in a conversation (count variable) from the amount of backchannels and alignment, controlling for the offset of overall amount of conversational turns. The second predicted the presence of repair at a turn level (binomial variable) from the presence of backchannel and the level of alignment of that same turn. Finally, to establish how distinctive these mechanisms are, we produced a 5-fold cross-validated predictive regression assessing whether one could use the presence and amount of conversational repair, interactive alignment and backchannels to identify the nature of the conversation. All analyses were run using R 3.3.2, RStudio 1.0.136, lme4 1.1-12, irr 0.84 and tidyverse 1.1.0.

Results

Backchannels

Backchannels were highly frequent in the corpora (54% of the speech turns), and more so in TOC (58% of speech turns), than in FC (48% of speech turns): $\beta = 0.6$, $SE = 0.04$, $p < .001$ (see Figure 1). Backchannels also increased over time ($\beta = 0.07$, $SE = 0.03$, $p = .03$), but not differently in the two corpora ($\beta = -0.02$, $SE = 0.04$, $p = .57$).



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Conversational Repair

Conversational repair was highly frequent across both corpora, in line with previous findings in 12 other languages (Dingemanse et al., 2015). Repair initiations made up 3% of speech turns, with an average 45.59 seconds (SD = 54.8) and 34.03 speech turns (SD = 41.83) between successive repairs. Task Oriented Conversations showed a higher frequency of repair (β = 0.4, SE = 0.18, p = .0274) than Free Conversations, with 31.13 turns (51.13 seconds) between repair initiations in the former and 39.65 turns (61.3 seconds) between repair initiations in the latter; see Figure 1. Time was not a significant main effect (β = -0.0007, SE = 0.0006, p = .3), nor did it interact with Task (β = 0.0007, SE = 0.001, p = .6).

Open repair was much more frequent (38.5% of repair) in free social interactions, than in task oriented interactions (4% of repair): β = -2.82, SE = 0.39, p < .001. Open repair tended to decrease in frequency as conversations proceed (β = -0.005, SE = 0.003, p = .0607), with no interaction with interaction type (β = 0.007, SE = 0.004, p = .1275). Restricted request repair was not significantly different between corpora (FC: 17%, TOC: 22%): β = 0.4, SE = 0.34, p = .23). There was a marginal tendency for restricted request repair to increase over time (β = 0.003, SE = 0.0016, p = .0804), with no interaction with interaction type (β = 0.002, SE = 0.004, p = .5), but the model did not converge with these factors. Restricted offer repairs were more frequent in TOC (74% of repair) than in FC (45% of repair): β = 1.97, SE = 0.48, p < .001. There was no significant main effect of time (β = 0.003, SE = 0.0024, p = .185), but a significant interaction with interaction type (β = -0.006, SE = 0.003, p = .0415) indicating a decrease in the TOC over time, but not in FC (see Figure 2).

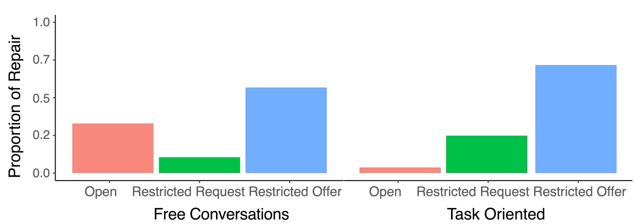

Figure 2: Distribution of repair types in the two corpora.

Interactive alignment

As illustrated by Figure 1, syntactic and lexical alignment is significantly lower in TOC than FC (lexical: β = -0.14, SE = 0.15, p < .001; syntactic: β = -0.04, SE = 0.009, p < .001). Alignment significantly decreases over time for lexical (β = -0.0002, SE = 0.00001, p < .001), but not syntactic (β = -0.00005, SE = 0.00004, p = .8), and the decrease significantly interacts with Task, being smaller in TOC (lexical: β = 0.0001, SE = 0.00007, p = .008; syntactic: β = 0.007, SE = 0.00005, p < .001). These patterns hold when varying distance between speech turns (alignment over longer stretches of conversation, up to 5 turns of distance); increasing the unit of analysis (up to 4-grams of lexical or syntactic units); or controlling for increased alignment in repair turns.

Relations between repair, alignment and backchannels

The general level of conversational repair in a conversation was positively associated with the level of backchannel (β = 0.01, SE = 0.003, p < .001) and syntactic alignment (β = 0.44, SE = 0.18, p = .014) and negatively associated with lexical alignment (β = -0.46, SE = 0.19, p = .014). At a turn level, conversational repair was associated with increased lexical alignment (β = 0.98, SE = 0.19, p < .001), a result driven by the two restricted repair formats. A follow-up explorative analysis indicates that in TOC, alignment is indeed much higher for turns containing repair initiations than for other turns (Lexical: 0.168 vs. 0.102; Syntactic 0.091 vs. 0.048), but not so in FC (Lexical: 0.113 vs. 0.112; Syntactic: 0.074 vs. 0.087). Interactions between the different indexes did not significantly improve the likelihood of the model.

Social coordinative mechanisms as discriminative patterns

Employing a combination of repair, interactive alignment and backchannels information, we were able to classify the transcripts according to their interaction type with an accuracy of 83.82% (95% CIs: 77.46%–88.97%), a sensitivity of 84.71% and a specificity of 82.95%, over chance accuracy of 51.46%. General levels of repair in a conversation alone gave an accuracy of 61.4% (95% CIs: 53.7%–68.74%). Interactive alignment gave an accuracy of 80.7% (95% CIs: 73.98%-86.33%). Backchannel gave an accuracy of 63.16% (95% CIs: 55.46%-70.39%).

Discussion

In this study, we compared different ways in which common ground may be established and maintained across both task-oriented and free conversations. We predicted that (i) we would find distinctive patterns of repair, backchannels and alignment. In particular, (ii) task-oriented conversation should show higher rates of repair, backchannels and alignment; (iii) task-oriented conversation should show lower rates of open requests for clarification; (iv) repair and alignment should be correlated because of the high frequency of repetition in restricted repair formats.

We found full support for (i): knowing the amount of repair, backchannels and alignment present in a conversation enables accurate (> 80%) discrimination between task-oriented and free conversations. We also found partial support for (ii): higher rates of backchannels and repair in TOC but not alignment; full support for (iii): lower rates of open requests, making restricted offers the most frequent in task-oriented interaction; partial support for (iv): lexical, but not syntactic alignment, is correlated with repair, an effect driven particularly by restricted repair formats. As such, our preliminary findings shed new light on the relations between backchannels, conversational repair and interactive alignment as measures of social coordination. If further confirmed with a more controlled dataset, they might also help clarify the relations between informal and task-oriented interactions.

Four findings stand out. First, FC and TOC present clear differences in the mechanisms employed to negotiate and maintain common ground. As solving the MapTask requires the construction of a shared representation of the space to navigate and its landmarks, we observe more explicit negotiation (repair) and confirmation of common ground. In line with our previous work, we also find that alignment seems less crucial in TOC. This could be a consequence of a division of labor leading to complementary rather than repeated lexical and syntactic structure among individuals solving a task (Fusaroli, et al., 2012; Fusaroli & Tylén, 2016). The higher alignment in FC might also indicate the prevalence of less explicit mechanisms to negotiate common ground, less likely to lead to face-loss (Bjørndahl, Fusaroli, Østergaard, & Tylén, 2015; Brown & Levinson, 1978). However, as a previous study reports an opposite result with TOC showing higher alignment than FC, ongoing work is implementing more conservative and comparable techniques, such as the use of surrogate pair (composed of interlocutors from different conversations) baselines (Healey, Purver, & Howes, 2010; Hopkins, et al., 2016). Analogously, further investigation of the temporal decrease of alignment is warranted.

Second, repair in task-oriented interaction is strongly skewed towards restricted formats and particularly the restricted offer format. This provides novel support for the 'strongest initiator rule' (Clark & Schaefer 1989), according to which participants initiate repair using the strongest repair initiator possible given the circumstances. Prior work based on informal interaction found that noise and parallel involvements increased the likelihood of open repair (Dingemanse & Enfield, 2015; Dingemanse et al., 2015), essentially by making it comparatively harder to initiate repair using restricted formats, which require having heard and understood as least part of the problematic source turn. Here we replicate this finding in an informal corpus of Danish interaction, and add a direct comparison with task-oriented interaction. The task-oriented condition takes away some common causes of perceptual and attentional difficulties, which should push people towards using more specific repair formats. This prediction is indeed met: in task-oriented interaction, the most specific ('strongest') repair initiation format is also the most commonly used.

Third, repair and alignment are intertwined. For instance, consider the following example, in which the restricted request consists in the repetition of all the words of the previous sentence, albeit in a slightly different order:

A: *Vi var i Ikea* [We were at Ikea]
B: *Var I i Ikea, dig og ?* [You were at Ikea, you and ?]
A: *mmh*

While alignment has often been cast as an implicit, automated background process, and repair as its explicit, and much rarer, "friend in need," our parallel investigation of repair and alignment reveals that widely used formal measures of alignment also pick up many restricted repair sequences. This is no surprise —after all, the crucial role of repetition in repair sequences has long been known— but it does point to the need for a reappraisal of the relationship between repair and alignment. Our findings suggest that the evidential base for a large part of the alignment literature may include many explicit repair sequences, belying the common assumption that alignment is an automated, low-level process.

Fourth, the combination of backchannels, repair and alignment allows us to classify interaction type with a high degree of accuracy. While these results still need to be generalized to a wider range of social activities and contexts, they open up new avenues for the possibility of classifying discourse data and contributing to the growing field of computer-assisted studies of dialog structure.

Although very encouraging, our findings should be viewed as preliminary. The two corpora differ in several aspects: the presence of a task: interlocutors' physical co-presence (in FC but not TOC), number of interlocutors involved in the conversations (2 in TOC, 2 or more in FC), and familiarity (possibly higher in FC). All these aspects are likely to affect conversational dynamics. We are currently extending the corpora to include full variation along these dimensions and account for them in the statistical analyses.

Conclusions

A comparative assessment of three mechanisms for the negotiation of common ground – backchannels, conversational repair and interactive alignment – highlights important differences in free and task-oriented conversations, plausibly related to situational features and task demands. Our results point to interactions between these mechanisms, e.g. with restricted repair feeding lexical alignment, which suggests future research should further disentangle their reciprocal role. As a theory-driven quantitative comparative study of conversations, our approach shows how insights from conversation analysis, cognitive science and natural language processing can be combined to contribute to a cumulative science of human interaction.

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