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Coming to Terms: Quantifying the Benefits of Linguistic Coordination

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Abstract

Sharing a public language facilitates particularly efficient forms of joint perception and action by giving interlocutors refined tools for directing attention and aligning conceptual models and action. We hypothesized that interlocutors who flexibly align their linguistic practices and converge on a shared language will improve their cooperative performance on joint tasks. To test this prediction, we employed a novel experimental design, in which pairs of participants cooperated linguistically to solve a perceptual task. We found that dyad members generally showed a high propensity to adapt to each other's linguistic practices. However, although general linguistic alignment did not have a positive effect on performance, the alignment of particular task-relevant vocabularies strongly correlated with collective performance. In other words, the more dyad members selectively aligned linguistic tools fit for the task, the better they performed. Our work thus uncovers the interplay between social dynamics and sensitivity to task affordances in successful cooperation.

Keywords

language, social interaction, problem solving, cooperation, psycholinguistics

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It has been argued that, as a distinctive human trait, mimicry is involved in many aspects of human social interaction, such as coordination and learning, cultural evolution, and group cohesion (Chartrand & van Baaren, 2009; Mesoudi, 2009; Tomasello, 1999). Likewise, mimicry is a characteristic of human language: Interlocutors have been found to mutually adapt to each other's linguistic behaviors (Fusaroli & Tylén, 2012; Pickering & Garrod, 2004). Such linguistic alignment has been shown to facilitate the development and stabilization of linguistic vocabularies employed to achieve joint problem solving and coordination (Garrod & Anderson, 1987; Garrod & Doherty, 1994; Garrod & Pickering, 2009; Healey & Mills, 2006). Thus, it can be considered one of the mechanisms through which language comes to act as a device for social coordination (Clark, 1996; Tylén, Weed, Wallentin, Roepstorff, & Frith, 2010).

However, although previous research has emphasized the existence of linguistic alignment (Gries, 2005; Pickering & Ferreira, 2008) and its general role in social coordination (Pickering & Garrod, 2004), a more detailed understanding and articulation of the interplay of linguistic alignment and coordination mechanisms is still to be elaborated. In the experiment reported here, we presented an experimental paradigm that allowed for a quantification of linguistic alignment as well as its effects on social coordination, which made it possible to test hypotheses related to the dynamics of linguistic alignment and social coordination.

General Versus Selective Alignment

Previous studies have indicated that linguistic alignment is motivated by *structural priming*, that is, the automated repetition of linguistic forms across interlocutors (Pickering & Ferreira, 2008). Listening to a linguistic form is thought to activate the structures necessary to produce it. Thus, interlocutors engage in reciprocal and continuous priming that leads them to not only mirror each other's speech locally but gradually converge on a shared set of linguistic expressions, a common language (Pickering & Garrod, 2004). It has been

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argued that such reciprocal linguistic adaptability facilitates the alignment of a situation model, which is a multidimensional "representation of the situation under discussion" (Pickering & Garrod, 2004, p. 172; Zwaan & Radvansky, 1998). Through alignment of a multitude of linguistic parameters, interlocutors gradually adapt to each other's representation of a shared situation.

However, this conception of linguistic alignment has also been disputed (Mills & Healey, 2008). Ultimately, automated structural priming would predict spontaneous matching of all linguistic behaviors in all contexts (Healey, Howes, & Purver, 2010). This effect has not been systematically shown and—more crucially—the consequences of indiscriminate alignment seem undesirable for a number of reasons. Social interaction certainly involves alignment, but it also includes other types of more selective and complementary coordination (cf. the complementary structure of turn taking, for example; Matusov, 1996; Wilson & Wilson, 2005). Moreover, in nonverbal contexts, alignment has recently been shown to be selective and moderated, for instance, by attitudes, liking, affiliation goals, and social membership (Kavanagh, Suhler, Churchland, & Winkielman, 2011; Stel et al., 2010). We thus speculate that general and indiscriminate linguistic alignment following from low-level structural priming might not necessarily be beneficial to social coordination. Rather, the selective alignment of linguistic parameters that optimally meet the affordances of a particular contextual situation (e.g., a collective task) will facilitate coordination and thus lead to increased coordinative benefit. From such perspectives, the facilitative effect of linguistic alignment critically depends on sensitivity to the affordances of the task at hand.

Quantifying Linguistic Alignment and Its Effects

To further articulate, investigate, and test such hypotheses requires a precise quantification of linguistic alignment, its selectivity, and its effects. Previous studies have pointed to the coordinative benefits of linguistic and semiotic interactions, showing how the negotiation and development of a shared language facilitate joint task solving (Galantucci, 2005; Garrod, Fay, Lee, Oberlander, & MacLeod, 2007). However, to our knowledge, no study has yet investigated the quantitative connections between linguistic strategies, linguistic alignment, and the effects of such alignment on social coordination.

We thus expanded on a recent experiment, in which we asked pairs of participants to make private and joint perceptual decisions in a psychophysical task (Bahrami et al., 2010). By comparing individual and collective task performance, we were able to create an objective index of coordinative performance (collective benefit). The experiment also presented strong task affordances: To gain collective benefit, dyad members had to share and compare their individual levels of confidence and make collective decisions in favor of the more confident participant on a trial-by-trial basis. Though not explicitly instructed to do so, participants had to establish linguistic tools for expressing confidence. This experimental design allowed us to investigate correlations between linguistic adaptability and collective benefit. Moreover, it made it possible to compare indiscriminate linguistic alignment with the selective alignment of a particularly task-relevant linguistic repertoire—expressions of graded confidence.

Reciprocal linguistic adaptability was operationalized using two complementary measurements. *Local linguistic alignment* designated the participants' propensity to flexibly and reciprocally adapt to each other's ways of talking. *Global linguistic convergence* designated the degree to which participants in a dyad converged on a limited functional set of shared expressions of confidence rather than indecisively drifted between multiple sets of expressions.

We predicted that the degree to which participants came to locally and globally share linguistic tools fit to the affordances of the task would correlate with the collective benefit in the joint task. We also predicted no such effect for general linguistic parameters not immediately relevant for the task (indiscriminate alignment).

Method

Thirty-two native speakers of Danish (14 male, 18 female; mean age = 25.2 years, *SD* = 6.9 years), all of whom provided written informed consent, participated in the experiment. The participants were paired into 16 dyads; the members of each dyad knew each other in advance. The participants in each dyad sat in front of separate screens at right angles to each other in a darkened room (see Fig. 1a). On each trial, they were sequentially shown two 85-ms-long visual displays containing six Gabor patches (see Fig. 1b). By pressing buttons, the participants had to individually indicate which of the displays contained a contrast oddball. As long as both participants gave corresponding answers, they would automatically proceed to the next trial. However, if their individual choices disagreed, they were prompted to freely discuss the situation with each other to reach a joint decision. There were no time or other constraints on the joint-decision dialogues. The same computer that presented the stimuli was used to record the task responses. The linguistic interactions were videotaped using a Sony HVR-A1 digital video camera.

Videos from the 16 dyads (~20 hr of recordings) were transcribed at the word level by five research assistants naive to the purpose of the study. The full transcript for each dyad covered an average of 92 joint decision trials (*SD* = 15.5) and contained 3,537 words (*SD* = 1,244). In all, there were approximately 1,470 joint decision trials and 56,600 words for the whole experimental corpus.

Analysis

Psychophysical performance

Psychometric functions were estimated for each interlocutor and for each dyad by plotting the proportion of trials in which

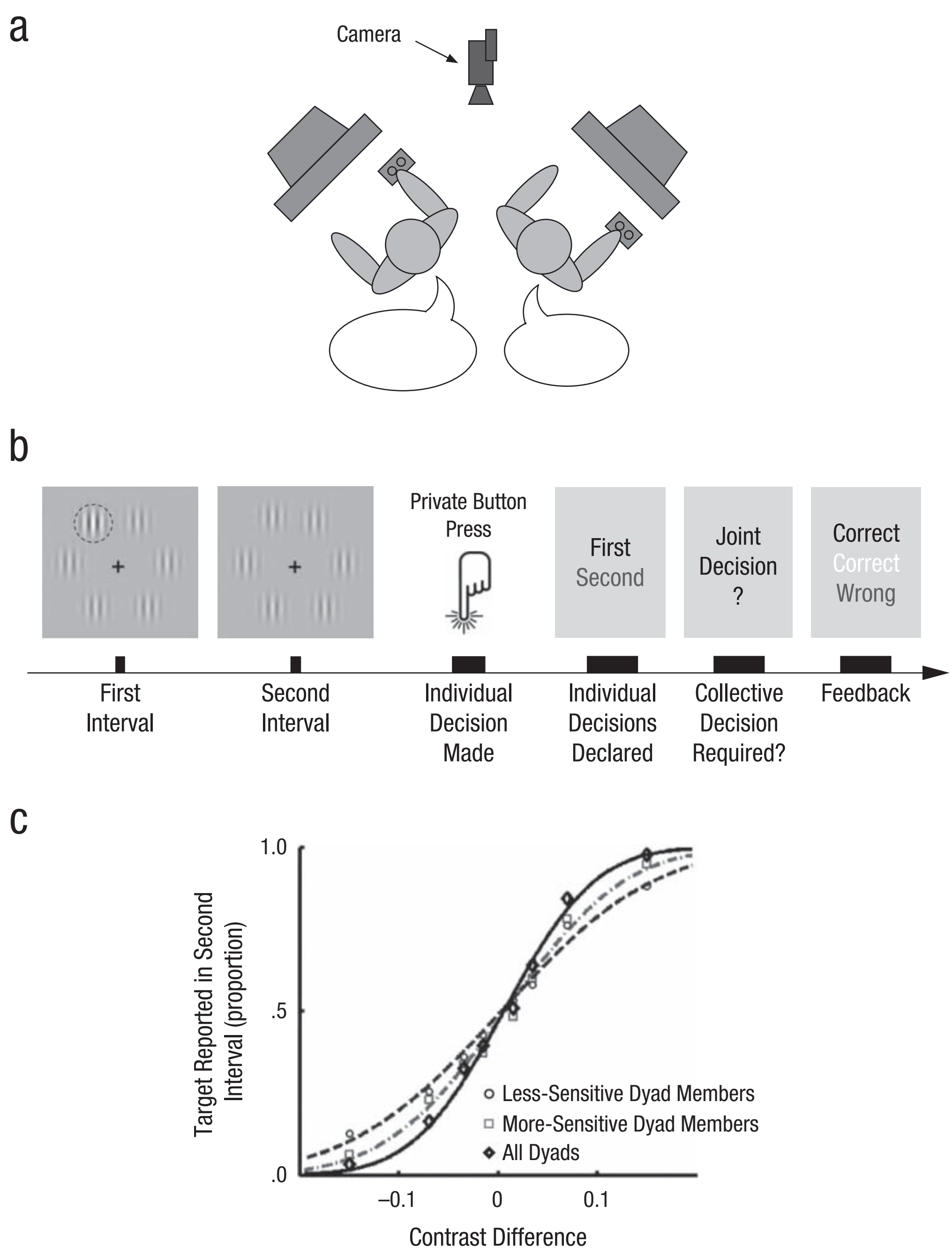

Fig. 1. Experimental setup (adapted by permission from Bahrami, et al., 2010), sample trial sequence, and psychometric results. Participants were assigned to dyads, and the members of each dyad sat at right angles to each other at separate screens (a). Each trial (b) started with two stimulus intervals, each of which contained six Gabor patches. A contrast oddball (here indicated by the dashed circle) appeared in one of these intervals, selected at random. Participants had to identify the interval in which the oddball appeared. They first indicated their individual decisions privately. If their decisions did not match, they were then prompted to negotiate a joint decision. Feedback was given at the end of each trial for each participant individually (at the top and bottom of the display) and for joint decisions (in the middle of the display). The graph in (c) shows the proportion of trials in which the target was reported to be in the second interval as a function of the contrast difference between the oddball and the Gabor patch at the same location in the first interval. The curves are the best fit to a cumulative Gaussian function.

the oddball was reported in the second interval as a function of the contrast difference between the oddball and the Gabor patch at the same location in the first interval (see Fig. 1c). Individual interlocutors' functions were calculated relying on the individual decisions that constituted the first part of each trial. Collective psychometric functions were calculated using all joint decisions (collapsed across trials on which interlocutors agreed and disagreed). The psychometric data were fit to a cumulative Gaussian function whose parameters were bias, b, and variance, σ^2, using a probit regression model created with the glmfit function in MATLAB (The Mathworks, Natick, MA). The cumulative Gaussian function, $P(\Delta c)$, was defined as follows:

$$P(\Delta c) = H\left(\frac{\Delta c + b}{\sigma}\right),$$

where Δc is the contrast difference between the second and first displays and $H(z)$ is the cumulative Normal function,

$$H(z) = \int_{-\infty}^{z} \frac{dt}{(2\pi)^{1/2}} \exp\left[\frac{-t^2}{2}\right].$$

Following standard practice, we calculated the psychometric functions, $P(\Delta c)$, for the probability of choosing the second interval. Thus, a positive bias indicated an increased probability of saying that the second interval had higher contrast. The estimated variance was related to the maximum slope of the psychometric curve, s, via the following function:

$$s = \frac{1}{(2\pi\sigma^2)^{1/2}}.$$

A large slope corresponded to highly sensitive performance. Using the slope measure, we quantified individuals' as well as the dyad's sensitivity and defined *collective benefit* as the ratio of the dyad's slope to that of the more sensitive dyad member. A collective benefit value above 1 would indicate successful cooperation, and values below 1 would indicate that collaboration was counterproductive and that the dyad performed worse than its more sensitive member working alone.

Linguistic performance

The transcripts from each dyad were coded independently by two linguists for expressions that indicated some level of confidence (Peterson & Pitz, 1988), such as "I'm not sure," "I'm blank," or "I think I saw something . . ." Subsequently, expressions were grouped into types. For example, expressions such as "I'm not sure," "I'm almost sure," and "I'm absolutely sure" were grouped as tokens of the type "sure." Expressions such as "I think I saw . . .," "I did not see anything . . .," and "I saw something" were grouped as tokens of the type "to see." All expressions using numeric values were grouped as tokens of the type "number." In all, 35 such types of confidence expressions—some used more productively than others—were identified in the corpus.

The transcripts from each dyad and the complete list of confidence-expression types were then entered in an automated search procedure (programmed and run in MATLAB) to map distributive patterns and token frequencies for each type. This procedure allowed us to quantify indices of local linguistic alignment (both indiscriminately and selectively for confidence expressions) and global linguistic convergence (for confidence expressions) for each dyad.

Local linguistic alignment was calculated using the following expression to determine the transition probability that a given lexical expression of a participant would be a repetition of an expression used by the other participant in the previous interaction trial:

$$P(s(X)_n | s(Y)_{n-1}),$$

where s is a linguistic expression, X and Y can be either of the interlocutors, and n is the interaction (for similar statistical operationalizations of local linguistic alignment, see also Garrod & Doherty, 1994). For discriminate alignment only, expressions of confidence entered the analysis (s = expression of confidence); for indiscriminate alignment, the function was applied on all lexical items in a dyad's transcript (s = any word).

Global linguistic convergence of confidence expressions was measured for each dyad by sorting and normalizing token distributions of each confidence-expression type. The convergence index was operationalized as the proportion of the most frequent confidence-expression type in relation to the overall sum of confidence tokens of the dyad:

$$C^{\%} = \frac{\text{Type}_{\text{max}}}{\text{Type}_{\text{all}}}.$$

We employed one-way analyses of variance (ANOVAs) to check whether alignment of given types as opposed to others would have an effect on global linguistic convergence and on collective benefit. Finally, effects of the number of items (granularity) on the most frequent linguistic confidence scale were calculated using a correlational analysis. All correlational analyses, ANOVAs, and t tests were executed in MATLAB.

Results

Linguistic expressions of confidence

Dyads displayed varied and, at first sight, rather unstructured ways of expressing their individual confidence. Table 1 presents a transcript excerpt from a representative trial. A number of interesting observations can be made from this short transcript. Interlocutors readily picked up and reused each other's confidence expressions, often in slightly modified forms (as in the case of "saw-see" and "wild guess"). This process was largely implicit: Participants rarely reflected on their practices or explicitly negotiated scales of confidence (for similar observations, see e.g., Galantucci, 2009). Moreover, they rarely employed preexisting and precise conceptual models, such as numerical scales, to express confidence, although that might seem an obvious strategy (Hamm, 1991). Rather, shared conceptual scales for comparing confidence were manifested in modifications of everyday expressions, such as "to be sure,"

Table 1. Example Transcript of a Joint-Decision Dialogue

Interlocutor	Time	Speech
A	0:02:42.1	vi tager din for jeg *så intet* ["We'll go with yours because I *saw nothing*."]
B	0:02:43.7	jeg *så* heller *ikke noget* - jeg *så* . . . ["I *didn't see anything* either – I *saw* . . ."]
A	0:02:46.2	*jeg satsede* ["I *took a wild guess*."]
B	0:02:47.2	sådan! ["Way to go!"]
A	0:02:47.3	sådan! ["Way to go!"]
B	0:02:48.5	det var også *et sats* det jeg lavede der ["Mine was also just *a wild guess* there."]

Note: The experiment was conducted in Danish; English translations are given in brackets. Expressions indicating the speakers' level of confidence are italicized.

"to think," or "to see." For instance, this list of expressions—obtained from a different transcript than the one shown in Table 1—furnishes a scale from "very certain" to "very uncertain" by modifications of the expression type "to be sure": "completely sure," "very very sure," "quite sure," "almost sure," "demi-sure," "somehow sure," "not so wildly sure," "not that sure," "a bit unsure," "unsure," "quite unsure," "very unsure," "indeed I am not sure at all," "completely unsure," and "utterly unsure." Dyads were generally found to evolve quite fine-grained scales, with an average of 18 items (SD = 7.5).

It is interesting that dyads did not converge on the same lexicalizations of confidence scales. We observed at least four dominant ways of expressing degrees of confidence on which different dyads converged, elaborating on expressions such as "to be sure," "to see," "to think," and "to know"—together with a few less articulated attempts, such as "to guess," "to believe," and "to shoot." Additionally, even dyads that evolved scales based on the same expression types displayed little overlap in the expression tokens they used. For example, across the five dyads that developed a scale based on "to be sure," no single confidence expression was used by all of them, only 15% were used by more than two dyads, and 72% were unique to a single dyad. Analogous distributions were found for the other dominant expression types.

Adaptability of expressions of confidence (local alignment and global convergence)

In general, dyads reciprocally adapted to each other's expressions of confidence on a trial-by-trial basis (local linguistic alignment). When a participant used an expression of confidence there was, across dyads, an average transition probability of .16 (SD = .05) that the same expression type had been used by the partner in the preceding trial.

Most dyads also converged on a limited functional set of confidence expressions across trials (global linguistic convergence; M = 34%, SD = 10%) rather than indecisively drifting between local alignments on different types. High-convergence dyads had the most frequent type of confidence expression accounting for around 50% of the overall tokens; however, in the case of low-convergence dyads—indecisively attempting multiple types of expressions—that number amounted to around 20% (see Fig. 2 for examples of distribution of tokens across the expression types).

In each dyad, the degree of local linguistic alignment was strongly correlated with the degree of global linguistic convergence, $r(14) = .85$, $p < .00001$ (see Fig. 3a). This indicates that dyads with a high level of local alignment of confidence expressions also tended to develop very stable and consistent ways to express and assess their levels of confidence.

Indiscriminate linguistic alignment

Taking into account the full lexical repertoire rather than just expressions of confidence, we found that dyads displayed a high degree of local linguistic alignment, with an average transition probability of .5997 (SD = .1967). This means that, in general, interlocutors frequently adapted to each other's expressions.

Collective benefit

In terms of task performance, dyads gained a significant collective benefit in the perceptual decision-making task, compared with the results of the better-performing member of each dyad working alone, $M = 1.18$, $SD = 0.25$, $t(15) = 2.84$, $p = .01$. However, not all dyads did equally well: Three out of 16 dyads did not exceed their respective best member's individual performance (i.e., did not gain a collective benefit). This variation in collective benefit suggests that not all dyads communicated optimally about their confidence.

Linguistic alignment and collective benefit

In support of our hypothesis, our findings showed that local linguistic alignment of confidence expressions significantly correlated with collective benefit, $r(14) = .51$, $p < .05$ (see Fig. 3b). That is, the more the dyad members aligned on task-relevant confidence expressions, the higher the benefit they achieved from cooperation. It is interesting, however, that this

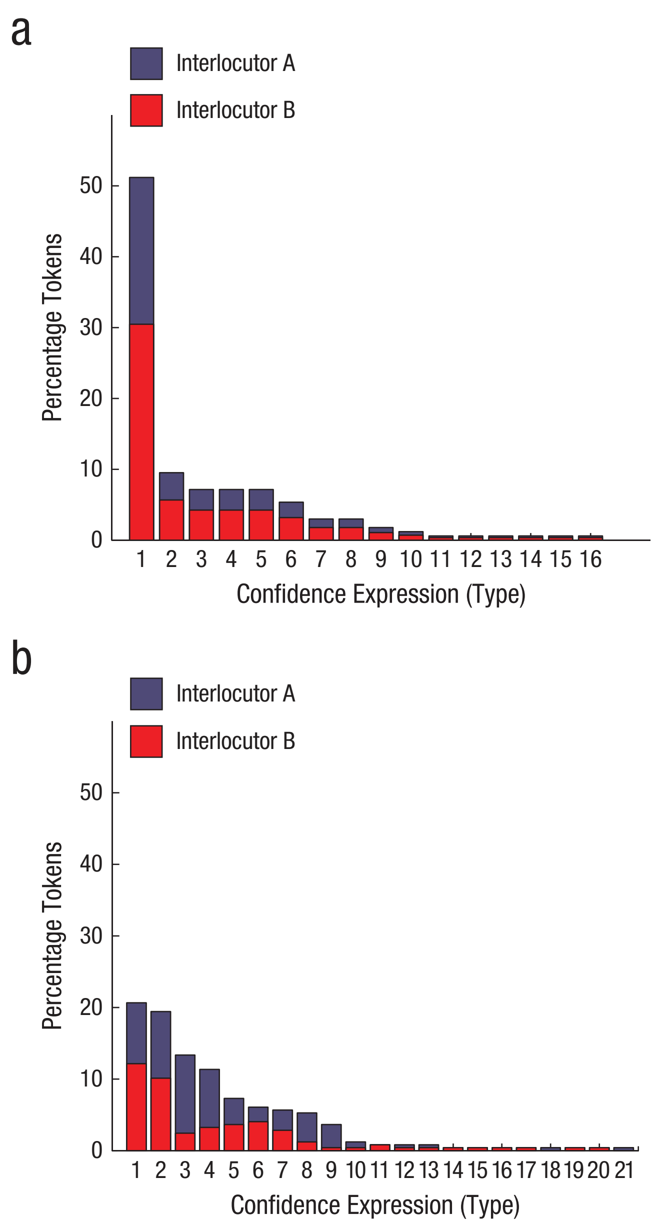

Fig. 2. Example distributions of the percentage of token words used in different types of confidence expressions. Results are shown for (a) a dyad that had a high level of convergence and (b) a dyad that had a low level of convergence. For each dyad, the types of confidence expressions are numbered in order from the most frequently used to the least frequently used. In both graphs, the height of each bar indicates the total percentage of tokens used, and the shading shows how that total was divided between the two interlocutors in the dyad.

was not the case when taking into account the full lexical repertoire. Indiscriminate local linguistic alignment inversely correlated with collective benefit, $r(14) = -.63$, $p < .0005$ (see Fig. 3c). It thus seems that not every local alignment was beneficial for collective task solving and—in fact—unselective alignment was associated with low or even negative collective benefit.

Also as predicted, the degree of global linguistic convergence of confidence expressions significantly correlated with collective benefit, $r(14) = .67$, $p < .005$ (see Fig. 3d). This correlation indicates that the more consistently a dyad used a particular set of linguistic expressions of graded confidence, the higher the collective benefit it achieved. Although there was a greater correlation between global linguistic convergence and collective benefit, $r(14) = .67$, than between local linguistic alignment and collective benefit, $r(14) = .51$, it should be noted that the two linguistic parameters were not independent. Therefore, a multiple correlation including both the local and global linguistic parameters did not increase the correlation coefficient relative to global linguistic convergence.

Influence of lexicalization patterns

To test whether any of the confidence-expression types employed by the dyads had specific effects on task performance, we compared the four most frequent types (i.e., those shared by two or more dyads). One-way ANOVAs revealed that the expression types did not significantly differ in their effects on convergence, $F(3, 12) = 2.51$, n.s., or collective benefit, $F(3, 12) = 0.65$, n.s. Additionally we tested for correlations between the number of items on confidence scales (scale granularity) and collective benefit. Again, no significant correlations were found, $r(14) = .0$, n.s.

Discussion

Carving language for social interaction

We found that members of dyads that showed a high propensity to mutually adapt to each other's linguistic expressions of confidence also gained a higher collective benefit in the psychophysical task. Significant correlations were found for local linguistic alignment—the transition probability that a dyad member would pick up and reuse confidence expressions used by their partner in the previous trial. These correlations were even stronger for global linguistic convergence—the propensity of dyads to stabilize particular sets of expressions constituting scales for sharing and comparing confidence. It is interesting, however, that only the selective alignment of confidence expressions showed this positive effect. In contrast, indiscriminate alignment of all lexical items inversely correlated with collective benefit in the task.

It has been repeatedly argued that language can be considered a tool for social coordination (Clark, 1996; Wittgenstein, 1953/1968). Although this view might seem trivial, it creates a number of important questions. In particular, under which conditions does language come to serve as an efficient tool for coordination? Our findings point to at least two crucial factors that influence the socially coordinative benefit of language. First, the linguistic tools must be fit to the affordances of the task. Second, the linguistic tools have to be shared by interlocutors.

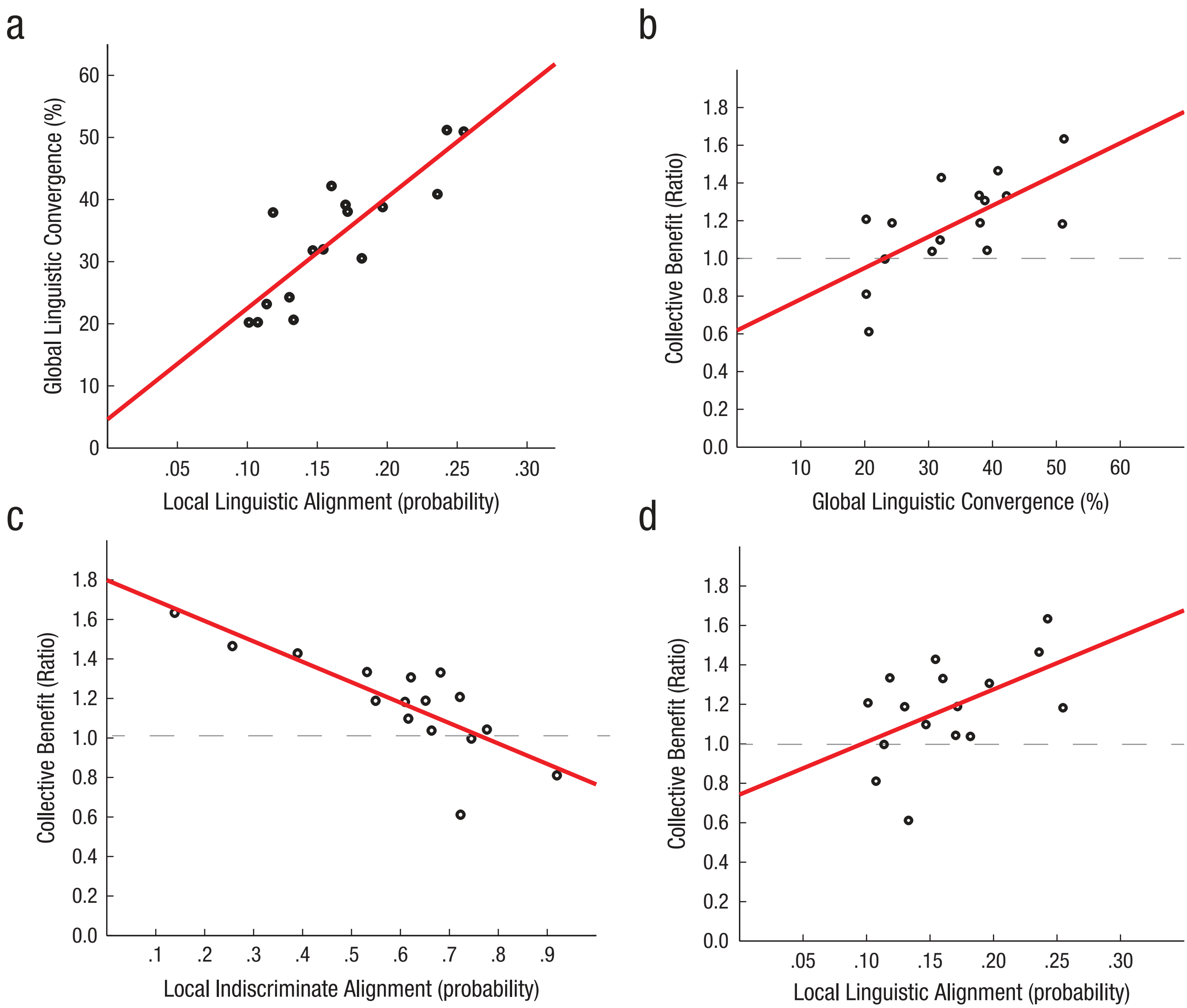

Fig. 3. Scatter plots (with best-fitting regression lines) showing the relation between key variables of the experiment. The graph in (a) shows global linguistic convergence as a function of local linguistic alignment. The other three graphs show collective benefit (calculated as the ratio between dyad performance and the performance of the better dyad member working alone) as a function of (b) global linguistic convergence, (c) local indiscriminate alignment, and (d) local linguistic alignment. The dashed lines in (b) through (d) indicate the threshold for collective benefit.

As regards the first factor, human language is an extremely rich and articulated semiotic resource. Still, from time to time, people encounter situations for which they do not have ready-made, conventional, and entrenched linguistic routines. This was the case in our experiment, in which successful performance critically depended on participants' ability to accurately compare their individual levels of confidence and go with the decision of the more-confident participant. That is, the particular task environment afforded for rather finely graded conceptual scales of confidence along with lexical means of navigating them. Sensitivity to this inherent and implicit task affordance turned out to be critical for collective performance.

As regards the idea that linguistic tools have to be shared by interlocutors, merely creating a linguistic tool fit to the task is not sufficient for optimal benefit. As noted, the lexical repertoires developed by dyads who performed well and dyads who performed poorly were in fact structurally not very different (i.e., the number of items on each dyad's confidence scale was similar) just as the specific lexical manifestations (i.e., each dyad's choice of confidence-expression types) of the scale seemed to play a minor role. For language to have a beneficial, socially coordinative effect, it has to be shared. Indeed, to jointly solve a task, interlocutors have to align their individual conceptual representations of the situation and of the task (Hutchins, 1995; Tomasello, Carpenter, Call, Behne, & Moll, 2005). Such conceptual alignment is established through public linguistic practices and resources, for instance, at the lexical level (Pickering & Garrod, 2004). Besides, once a shared conceptual model of the situation is established, interlocutors need linguistic means to continuously navigate the model (e.g., a scale).

In our experiment, participants readily adapted to each other's verbal expressions of confidence. This was observed at the local level. Frequently, participants repeated each other's expressions in adjacent speech turns or trials (e.g., A: "We'll go with yours, because *I did not see anything*" // B: "*I did not see anything* either"). In principle, such locally adaptive behaviors can proceed with the continuous introduction of ever-new lexical items. That would be the case if participants used different types of expression in every single trial but mirrored each other in doing so. But more often, global patterns emerged from participants' local alignment in terms of stabilizing sets of recurring lexical items (as in the case of expressions containing "sure," as reported in Results). Local linguistic alignment was thus strongly correlated with global linguistic convergence. The repetitions of a given type propagated beyond the scope of one or two trials to form lineage patterns that were continuously reinforced and gradually outcompeted other types. It is interesting that although local linguistic alignment alone correlated with collective benefit in the perceptual task, the stabilization of shared global linguistic structures had a much stronger correlation.

These findings suggest that shared linguistic practices and repertoires evolve and stabilize through selective processes of reciprocal local alignment. As practices are established, they come to constitute an effective tool for guiding and constraining coordination and decision making toward improved collective performance (Fusaroli & Tylén, 2012). As a consequence, participants who more flexibly adapted to each other's linguistic practices and converged on a shared language for comparing levels of confidence gained significantly greater benefit from their cooperation.

How is collective benefit reached?

Previous studies (Pickering & Garrod, 2004) have suggested that linguistic alignment leads to the alignment of situation models. A situation model is a multidimensional representation profiling relevant aspects of a situation under discussion (Zwaan & Radvansky, 1998). Sharing such models enables interacting individuals to share attention, coordinate actions, and distribute roles in joint activities (Tylén et al., 2010), ultimately outperforming any of the individuals on their own (Bahrami et al., 2010). Although, as predicted by the structural priming model, participants in the present experiment were found to spontaneously align their linguistic behavior, this did not automatically lead to increased collective benefit. On the contrary, general indiscriminate alignment was even found to have a strong negative effect. We suggest that dyads whose members aligned on broad unspecialized linguistic repertoires did not necessarily converge on operational situation models allowing them to optimize their coordination on the joint task. In contrast, we observed that the most effective dyads, by means of their sensitivity to the implicit task affordances, selectively aligned on linguistic tools fit to the purpose. By jointly carving out and stabilizing linguistic scales of graded confidence, these interlocutors were able to more reliably compare their levels of confidence, which in turn improved their performance in the joint-decision task.

Quantifying linguistic alignment and collective benefit

Observations on the "fitness" and "sharedness" of symbolic systems have previously been noted in empirical literature on linguistic and semiotic meaning making (Fay, Garrod, & Roberts, 2008; Galantucci & Garrod, 2010; Garrod & Doherty, 1994; Garrod et al., 2007). Like the present study, these studies point to the dynamic character of linguistic interaction and suggest its beneficial role in social coordination and joint problem solving. However, the experimental paradigm used here introduces an important additional dimension. We constructed an experimental environment that elicited ecological and natural verbal dialogue, but we also recorded precise and objective performance measures through an extensive series of trials. This procedure made it possible to directly quantify two dynamically linked processes. First, the implicit local linguistic alignment permitted interlocutors to develop stable shared lexical repertoires, which fit the needs of the situation. Second, these linguistic structures facilitated, constrained, and optimized nonlinguistic coordination in the joint-decision task. The correlations found in this study and the methods we developed pave the way for direct experimental manipulations of linguistic alignment and task performance, and further articulate their causal relation.

Conclusions

We used a cooperative, experimental task to quantify the coordinative benefit of language in joint perceptual decision making. We found that the degree to which dyads aligned their linguistic practices and converged on shared task-relevant vocabularies through repeated trials significantly correlated with their task performance. Although our findings support the notion of language as a social coordination device in general, these results also suggest a more nuanced picture. Rather than a simple, built-in fail-safe tool, language is an acquired activity for which skill is necessary: Only through progressive reciprocal alignment and continuous, attentional sensitivity to the task environment can linguistic tools be created to optimize coordinative dynamics and thereby joint performance. Linguistic interactions pervade most, if not all, human social life. It will thus prove crucial to further pursue linguistically mediated coordinative dynamics in a wide variety of contexts in order to understand human social and cultural cognition and evolution.

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