A Kaleidoscope of Languages: When and How Non-Native English Speakers Shift between English and Their Native Language during Multilingual Teamwork

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ABSTRACT

Multilingual teams often include subgroups of members who share a native language different from the team's common language. Linguistic choices by members of these subgroups can have implications for information exchange at the team level. We reported a field study of language use in 3 multilingual teams, each of which consisted of some native English speakers (NS) and some non-native English speakers (NNS) who shared a native language with at least one other team member. We found that NNS often shifted between English and their native language. The way language shift happened differed for formal meetings, informal conversations, and instant messaging. Language variation was often associated with shifts in content, participants, and communication medium. Further analysis indicated that language shift had both benefits and costs for team communication, depending on the context in which it happened. Based on these findings, we outline suggestions for designing multilingual collaboration systems.

Author Keywords

Language shift; multilingual communication; diverse team; computer-supported cooperative work (CSCW).

ACM Classification Keywords

H.5.3. Group and Organization Interface: Computer-supported cooperative work.

INTRODUCTION

Multilingual teams in which people speaking different native languages work together are common in modern organizations [22]. Despite the promise of multilingual teams for integrating diverse expertise on a global scale, this potential is often hindered by problems regarding the use of a common language (e.g., English) to communicate [12]. For example, in teams that use English as a common language, Non-native English speakers (NNS) are sometimes less active during meetings because they are

concerned about their imperfect fluency [39], and native English speakers (NS) face challenges making themselves understood by NNS colleagues [20]. Differences in fluency in a team's common language may further contribute to the emergence of language-based subgroups that distance team members from each other [22, 40].

Figure 1. An example of communication conducted via mixed languages. One native English speaker and two native Chinese speakers are having a discussion in English. Among them, the two Chinese speakers may use either English or their native language to communicate.

Using one's native language can help NNS alleviate the burdens of communicating in English. When the team consists of a subset of NNS who share the same native language, they sometimes interact in their native language rather than in English (see Figure 1). Hinds and colleagues [22], for instance, documented cases in which native German speakers temporarily switched to German during English meetings when they felt it was clearer and more efficient to do so. Lønsmann [31] further observed that NNS in multinational organizations that use English as the official working language sometimes talked to each other in their native languages during informal chat. This use of multiple languages had complicated impacts on communication at the team level. On the positive side, speaking in their native language allowed NNS to participate in work discussions more efficiently [1]; on the negative side, NS often reported feeling excluded when they could not comprehend and engage in conversations in the NNS's native language [4].

Researchers have argued that work communication would be most effective if multilingual teams could draw on the benefits of their members' various languages while minimizing the costs [27, 42]. With this goal in mind, a number of investigators have designed and evaluated tools

to facilitate multilingual teamwork using either a common language or everybody's native language [e.g., 14, 15, 16, 19, 37, 42, 44]. For example, Gao and colleagues [15, 16] found that showing Japanese speakers automated transcripts of English speech improved conversational grounding during English-based meetings. Wang et al. [42] found that machine translation tools helped NNS speakers formulate messages during text-based conversations, though they hindered comprehension by both NNS and NS. Hara and Iqbal [19] found that speech translation tools enabled participants with various native languages to have oral conversations, but people needed to adapt their speech production and comprehension styles to compensate for errors induced through the speech recognition and translation processes.

While previous tools to support multilingual teams have sometimes been modestly successful, no tools to date allow for multilingual interaction that is as fluid and natural as that of conversations among native speakers of the same language. One reason for this may be that the tools have taken an "all or nothing" approach; either all text/speech is translated or transcribed, or none of it is [e.g., 19, 42]. However, studies of multilingual teams [e.g.,22, 31] suggest the process of switching among languages is much more subtle than this and that NNS may want or need different levels of support at different points in a conversation.

The goal of the current paper is to understand when and why members of multilingual teams shift between English as a common language and their native language, with the goal of informing the design of tools to better support multilingual teams. We present an in-depth field study of three multilingual teams that aims to understand people's actual practices of language use during teamwork. All teams consisted of both NS and NNS team members. Among the NNS, each person shared a native language with at least another member of the team.

Through extended observation of the team and interviews with team members we identified language shift, the practice through which people move back and forth between using English and non-English, as a central element in multilingual teamwork. These shifts in language use revealed how people draw on their mundane wisdom to balance values and costs of using multiple languages at work. More specifically, NNS team members reported that they constantly negotiated between using different languages. They conducted language shift as this negotiation was happening. They also developed strategies to cope with potential tensions, if any, that arose from language shifts. Our observation data further showed that the ways people shifted between languages differed depending on whether communication occurred in formal meetings, informal face-to-face conversation, or over computer-mediated communication channels.

Our findings provide an anchor for HCI researchers to reflect on the design of collaboration systems that support multilingual teamwork, and suggest strategies to maximize the value of having multilingual teams. We propose design suggestions regarding when and how technology could support teamwork by facilitating language shift.

RELATED WORK AND RESEARCH QUESTIONS

In this section, we first review literature on the complexity of language use in multilingual teams. We then describe techniques developed by HCI scholars that have the potential to facilitate teamwork conducted in multiple languages. Based on the review of these two bodies of work, we outline research questions concerning an important yet missing piece of knowledge for both understanding and facilitating multilingual teamwork.

The Multilingual Reality of Multilingual Teamwork

Multilingual teams usually adopt a common working language (e.g., English) that enables communication among all members. Having a common language, however, does not turn all work conversations into monolingual events [1]. People in multilingual workplaces may interact in a variety of languages depending on the situation [2, 4]. Barner-Rasmussen and Aarnio [4], for example, interviewed employees in Finnish subunits of English-speaking multinational companies and found that participants reported communicating frequently in both their native languages and in English. Peltokorpi and Vaara [38] similarly interviewed employees from Western subsidiaries in Japan and found that people conducted a considerable amount of work in their native languages rather than the common language. Tange and Lauring [40] interviewed employees from 14 multinational organizations in Denmark and found that communication, especially spontaneous chat, often occurred in a mixture of English, Danish, and several other languages.

Code-switching, or shifting from one language to another during the same conversation [2], has also been observed in multilingual teams. Ethnographic research has found this specific form of language use during both formal meetings [e.g., 22] and informal chat [e.g., 31] in multilingual workplaces. According to self-report data, NNS and NS who attended the same English conversation usually held different views of code-switching. While NNS reported switching to their native languages to reduce anxiety about speaking English and to make better arguments for their perspectives, NS colleagues reported feeling disconcerted and excluded when code-switching occurred [22].

Techniques to Support Multilingual Teamwork

A number of scholars have designed and evaluated tools to enhance multilingual teamwork [e.g., 14, 15, 16, 19, 37, 42, 44]. In general, this work has taken one of two approaches: maximizing the value of communicating in a common language or facilitating the use of multiple native languages.

In the first line of work, researchers have tried to improve the quality of English communication at meetings between NNS and NS of English. For example, Yamashita and

colleagues helped NNS follow an English conversation by applying a variety of speech processing techniques, such as inserting artificial transmission lags between NS's utterances [44], showing automated transcripts of everyone's speech [15], and providing NS with information about how NNS interacted with automated transcripts [16].

In the second line of research, a number of techniques have been explored to support entire conversations in each person's own native language. For example, machine translation (MT) tools have been used to mediate various types of conversations between multilingual dyads, including text-based brain-storming [42], text-based hidden profile tasks [14, 45], and oral chats on casual topics [19]. NNS of English were found to be more talkative when they could communicate in their native language rather than in English, although message comprehension was sometimes challenged by translation errors [e.g., 42].

These two lines of work have achieved modest success at supporting multilingual teamwork but have rarely been able to support conversation that is as fluid and comprehensible as conversation among native speakers of a language. In part we argue that it is because researchers have generally taken an "all or nothing" approach such that either all messages were transcribed and/or translated or none of them were. However, as the field studies discussed earlier in this section suggest [e.g., 22, 31], NNS speakers in multilingual groups shift back and forth between the common language and their native language depending on the current context and goals.. To make multilingual collaboration systems more successful, we argue that these systems need to consider the contextual aspects of language use: when and why NNS shift between the team's common language and their native languages. The goal of this study is to provide an in-depth understanding of these processes in order to inform the design of future multilingual communication tools.

RQ1. When and why do members of multilingual teams use their native language instead of a common language (e.g., English), and vice versa, at work?

RQ2. How do members of multilingual teams balance the value and the cost, if any, of using their native language vs. a common language?

In the rest of this paper, we present a field study that aims to answer these research questions.

METHOD
We conducted a field study of multilingual teams from a university in the United States. Following the theoretical sampling process suggested by grounded theory [18], we iterated through generating codes from collected data and checking and elaborating these codes by collecting more data. We stopped our data collection once all the core variables were saturated and checked. The final dataset consisted of observations and interviews with three multilingual teams, each of which was observed and interviewed for about 100 hours. All three teams yielded similar insights, which provided a robust, in-depth view of language practices for this type of team.

Basic Information of Selected Teams
To best capture the dynamics of language use, we looked for teams that met the following requirements:

1) The team must include 4 or more members;
2) The team must use English as its only common language;
3) There should be at least 2 different native languages (including English), each spoken by a subset of members within the team;
4) The team had at least 1 ongoing project that required communication between multiple members of the team.

We started with an initial set of three teams that met these requirements. Each included several PhD students and one advisor who conducted research in an engineering and technology field. Two teams also had senior undergraduate and/or master's research assistants (RAs) who were involved in idea development, technical execution, and paper writing. All teams had a similar collaboration structure: The PhDs led each research project working with each other and RAs directly, and the advisor supervised all projects using a hands-off style.

All NNS of English in these teams passed the language exams for entering graduate school in the U.S. (e.g., TOEFL and GRE). Their self-reported level of fluency in English as described in the Interagency Language Roundtable (ILR) scale [25] was above professional working proficiency but below native proficiency. The composition of each team is summarized in Table 1.

Team	Distribution of NS and NNS of English	
A	NS	4 native speakers of English (1 advisor, 3 RAs)
	NNS	2 native speakers of C (2 PhDs)
		2 native speakers of H (1 PhD, 1 RA)
B	NS	2 native speakers of English (2 PhDs)
	NNS	2 native speakers of C (1 PhD, 1 RA)
		2 native speakers of K (1 PhD, 1 RA)
		2 native speakers of H (1 advisor, 1 PhD)
C	NS	3 native speakers of English (1 advisor, 2 PhDs)
	NNS	2 native speakers of C (2 PhDs)

Table 1. The linguistic composition of observed multilingual teams (the names of languages spoken by NNS were replaced by randomly assigned letters C, K, and H).

Each team had its own workspace where all members sat either side-by-side or back-to-back and worked together. Near each team's workspace there were conference rooms for formal meetings. A sketch of the physical space each team was located in is given in Figure 2.
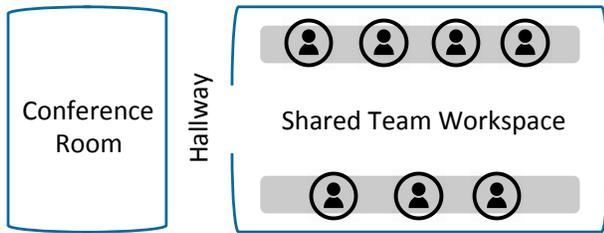
Figure 2. A sketch of each observed team's physical spaces. All teams had similar spatial arrangements.

Data Collection

The first author of this paper, a bilingual English-Mandarin Chinese speaker, conducted on-site observations and interviews with each team between July and November of 2015. The full dataset consists of observation notes and interview transcripts generated from about 100 hours of field work for each team. The use of multiple sources of data deepens our understanding of people's language use through a process of triangulation [10].

During the observation phase, the first author stayed in the same workspace as a team and took notes on communication events as they happened. The notes documented multiple aspects of the conversation [24], including: the physical environment, the participants, the topic, the form of turn-taking, gestures and facial expressions, the medium (e.g., face-to-face vs. online), and the language (e.g., English vs. Mandarin). When the conversation was conducted in a language that we didn't understand, we sought clarification from participants afterwards. No audio or video recording was conducted due to team concerns over the proprietary nature of their topics of conversation.

Whenever possible, we asked people to reflect immediately after a communication event they just participated in. This retrospection allowed us to understand how people interpreted key aspects of the conversation such as the context, the perceived norms, people's motivations for using a particular language, and people's reactions to others' language choices [24].

In addition to the observations and the immediate retrospections, we performed semi-structured interviews with each member of the team. The interview included questions about (a) the interviewees' native language and cultural background; (b) the work s/he was doing in the team; (c) his/her general reflections on how and why s/he used each language; (d) perceived benefits and costs when using a common language vs. his/her native language; and (e) the role of technology in team communication.

Analysis

We followed an inductive approach guided by grounded theory [10] to analyze all of our data. To maintain the natural structure of the data, we linked observation notes and interview transcripts by putting everything related to the same communication event together. Through multiple iterations of open coding, we identified language shift as a strong and central theme emerging from the data. We then conducted selective coding to explore the connection between language shift and other emerged categories. Finally, we iterated through both the data and related literatures, reflecting on the role of language shift within the entire communication flow at the team level. Our detailed findings are presented in the following section.

FINDINGS

Our data suggested that NNS in the observed teams often shifted between English and their native language. Among all the communication events that included subsets of NNS who share the same native language, we witnessed different patterns of language shift in different communicative contexts including formal meetings, informal conversations, and instant messaging (IM). People's demographic background (e.g., gender and age) and roles in a team did not show clear association with the shift of language.

In the next four sections, we first describe in detail how and why NNS shifted languages in these three contexts (formal meetings, informal conversation and IM conversation). For each context, we draw on observation notes and/or interview data to examine the norms of language use, language shifts and their association with other shift(s) in the conversation, and other team members' reactions to language shift. After this, we present findings regarding the role of language shifts within the flow of team communication across contexts. For anonymization purposes, we recode part of the information in observation and interview quotes: the names of languages spoken by NNS were replaced by randomly assigned letters (e.g., C refers to language C), and name of participants were replaced by IDs linked to native language (e.g., C1 and C2 refer to different NNS speaking language C).

Language Shift at Formal Meetings

In each team, we observed several formal meetings. Some were general group meetings at which one person presented on his or her work and received feedback from the rest of the team. Others were project meetings at which a subset of team members discussed specific issues regarding that project. These meetings always required advance preparation, including setting an agenda, negotiating a meeting time, and booking a conference room. Finalized information was announced to all participants via group email or online messages. Through this process, people inferred that these meetings were formal and only for work discussions. As one of our interviewees described:

At the meetings, we really need to discuss the research and stay focused. That time is not reserved for a random friendly conversation. That time is reserved to figure out the research and see how we can make it as good as possible. [E7, NS, Team C]

Norms of Language Use

When participants spoke up at formal meetings, they stated that their language use was subtly guided by their

perception of the interpersonal and physical atmosphere of these meetings:

Everybody is expected to speak English at formal meetings, because we need to make sure our thoughts are shared with everybody in this room. Sometimes when I speak, I know maybe I'm not using the best way to express an idea in English, but I just try my best. [C1, NNS, Team A]

At meetings, my rule of thumb is that everyone in this meeting room should understand what I say. There won't be the situation where someone is excluded just because of the language. We share professional discussions, and we use English. [H3, NNS, Team B]

As indicated by the quotes given above, the use of English was perceived as a norm at formal meetings and it was respected by all members of these multilingual teams. Our observation on the actual language use at meetings further confirmed the adoption of this norm.

Language Shift and Its Association with Content Shift

We witnessed language shift at a very small proportion of formal meetings. The following segment of our observation notes documents a typical case of this kind of shift:

At some point, H1 tried to make a comment on the idea C2 just proposed. H1 said "so maybe we can first make a prototype with the…". H1 made a pause here while looking toward H2. H1 then said something in [H] using a rising tone. H2 replied "oh, you mean Play-doh" and smiled. H1 nodded and said "oh, with the Play-doh" and continued to the next speech. [Group meeting, Team A]

During the immediate retrospection afterwards, H1 gave a detailed explanation of his/her language shift:

I didn't finish that sentence in English, because I didn't know the exact word in English. I got stuck there. So I asked H2 for help and explained what I wanted to say in [H]. If it is in writing, I usually stop and Google it. But when talking in person, I ask the question out because it keeps the flow of the conversation. My question is very short anyway. [H1, NNS, Team A]

The above case of language shift, consistent with other cases we observed, showed that NNS may use their native languages when they encounter speech content that they cannot accurately express in English. This content, as we observed and heard from interviewees, usually referred to non-academic vocabularies and/or knowledge that was initially adopted in non-English education.

Language shift at formal meetings usually ended within just one or two speaking turns. Through the shifts, NNS tried to solve potential grounding problems [7] collaboratively with people who shared their native language. Once this goal was achieved, they shifted back to English immediately. Figure 3 illustrates the general pattern of language shift we observed at formal meetings.

Reactions to Language Shift

In all the cases we observed, there were no negative reactions from other participants to language shifts at formal meetings. People reported that they were fine with this temporary use of an unknown language, because "*it's short and it's clear from the context that they are trying to figure out something we all understand* [E9, NS, Team C]".
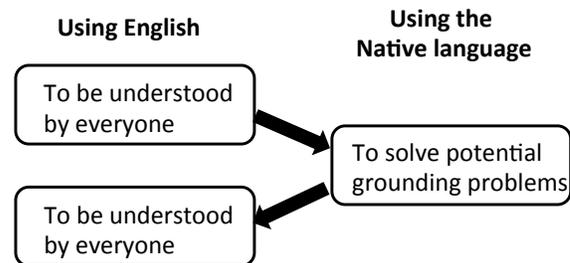

Figure 3. The general pattern of NNS's language shift at formal meetings.

Language Shift at Informal Conversations

Informal conversations were mostly conducted in a team's workspace rather than the conference room, and they comprised the vast majority of communication in all observed teams. Spontaneity was identified as the most important feature of informal conversations by almost all interviewees:

When we talk at our seats, the conversation could be about everything. It could be I run into a problem about work, so I ask another person a question. It could also be random chat, or many things mixed together. This is why I feel it's different from conversations at formal meetings. There is a lot of freedom. Other people can join and leave your conversation at any time. [C1, NNS, Team A]

Most of the time, we just turn to each other and say hey and we start talking. It's more like spontaneous interactions, like talking about something that we are doing at the moment. I just sit there and I spontaneously decide I may need someone's input on this or I'm going to use something for the next step. [E8, NS, Team C]

Norms of Language Use

When people initiated an information conversation, they usually started by picking one specific addressee rather than talking to a whole group of people as they did at formal meetings. The addressee was usually claimed through either gestures (e.g., tapping a shoulder, gazing at someone) or verbal announcement (e.g., calling one's name). When the speaker and the addressee spoke different native languages, they used English as a common language to communicate. When the conversation happened between NNS with a shared native language, however, they often started the conversation in their native language rather than English. Our interviews indicated that NNS, regardless of which native language they spoke, were highly aware of this norm. NNS interviewees described their native language as the default way to communicate with one another:

I think [C] is the default language for me to have face-to-face conversation with another [C] speaker. It's just our natural way of talking. It is the language for us to best express ourselves and understand others. [C2, NNS, Team A]

When I talk to K2 in the office, we usually talk in [K]. It's natural and it's more intimate and efficient. We chat about research and we chat about life. Everything in our one-on-one conversation is in [K]. [K1, NNS, Team B]

One interesting observation regarding NNS' language use was that they often inserted English words or phrases into their speech although the main body of their conversation was in their native language. These inserted words were always theoretical concepts and/or technical terms. NNS reported that they kept these words in English because they could not find equivalents in their native language. As one of the interviewees said:

When H3 comes to my seat, we often talk in [H] because it's easier to build your speech. But technical terms are a little bit awkward to translate. There might be counterparts of them in [H]? But I don't know what they are. So we say them in English and insert that into [H] conversations. [H4, NNS, Team B]

Language Shift and Its Association with Participant Shift
Although informal conversations between NNS often started in their native language, we saw many cases in which NNS shifted back and forth between their native language and English during the conversation. Our data analysis indicated a close association between NNS' language shift and shifts in conversation participants. More specifically, since informal settings in the workspace do not set a clear boundary of who can or cannot participate in a conversation, the same participant may play different roles as the conversation goes on. Here, we adopt vocabulary from previous literature (e.g., [9], [8], [17]) to differentiate four basic types of participants:

- The **speaker** who makes the speech;
- **Addressee(s)** to whom the speaker's speech is directed;
- **Side participants** who are not addressees but who are perceived by the speaker as a part of the conversation;
- **Overhears** who listen in on a conversation but are not considered by the speaker to be participants in the conversation.

Building on this vocabulary, we analyzed three selected examples from the observation notes, each of which described language shift in association with one specific form of participant shift.

Example 1: Overhearers vs. Addressees
C5 and C6 were having a casual chat at their seats in [C]. In the middle of this conversation, E8 walked into the office, sat down, and said "hey guys, how are you doing?" in

English. The three people then started chatting about each other's research and life, all in English. This conversation lasts for about 4 minutes. Then E8 took out a laptop and started replying to emails. Soon after this, C5 said something short to C6 in [C]. C6 replied a short sentence also in [C]. The conversation ended after C5 left the office. [informal conversation among 1NS and 2NNS who speak language C, Team C]

In the above example, the two NNS shifted languages when E8 entered the conversation. During the immediate retrospection, *C6* reported that they shifted from language C to English because "*E8 said hi to us, so we felt maybe we should include E8 into our conversation*". Their use of English stopped once E8 distanced himself from the conversation and became just an overhearer.

Example 2: Overhears vs. Side-Participants
H3 walked to H4's seat and initiated a conversation in [H]. H4 replied, also in [H]. While they were talking, they faced each other and exchanged gaze. After three rounds of turn-taking, H4 suddenly said something in English, "You know there will be a talk this week, right? It's about X (the research topic). I feel it's very related to your project and maybe also others' in our group". H3 replied, "cool, I will check that", also in English. This whole conversation lasted for just a few minutes. It ended when H3 walked away. While this conversation was happening, most people in this team were just seating in the workspace and working on their own stuff. [Informal conversation between 2NNS who speak language H, Team B]

This example showed an interesting case in which the speaker used different languages as s/he assigned different roles to people who are not the direct addressee of a speech. As H4 reported in the immediate retrospection, they used language H during the first part of the conversation because "*we were talking about one of H3's papers, so it's not related to others. I don't think it deserves other's attention. They may not even care about it*". However, as the conversation went on, they mentioned a talk that was related to not only H3's work but also other people's research in this team. H4 then shifted to respond in English, with the consideration that "*other people might find that information useful as well*". Here, people who were initially overhearers could become side-participants and share the information exchanged in the team's common language.

Example 3: Addressees vs. Side-Participants
E1 and C2 were having an English conversation at their seat about a technical problem they encountered while working on a project. After 3 minutes of talking, they went to C1 for some suggestions. The three people then stood in a circle and continued the conversation, still in English. At some point, C2 looked at E1 and said "give us one minute, we will discuss this [refers to several candidate solutions] in [C]". E1 smiled and said "okay". C2 and C1 then shifted to [C] to continue the discussion. Both people talked much faster than when they were talking in English. E1

stood there quietly looking at them talking. After about 2 minutes, they shifted back to English and said "okay, we found a solution". They then explained the solution in English to E1 in two sentences. While this whole conversation was happening, E2 and H1 were sitting in the workspace working on with their laptops. [Informal conversation among 1NS and 2NNS who speak language C, Team A]

Different from the other two examples, this is a case in which NNS switched to their native language in the middle of an English conversation. As we found across all cases similar to this, the segment of native language communication was usually separated from the rest English communication by a shift-beginning marker and a shift-ending marker. In Example 3, specifically, C2 marked the beginning of language shift by giving E1 a heads-up in English (e.g., "*give use one minute, we will discuss this in [C]*"), and the ending of this shift was marked by the two NNS indicating a closure of their conversation in language C (e.g., "*okay, we found a solution*"). These markers were provided intentionally for "*being polite*" to other participants in the conversation. During the immediate retrospection, C1 and C2 both reported that they shifted to language C for improving the efficiency of the technical discussion. As C2 described:

We used [C] because it's way more efficient for problem solving. That discussion was about a lot of very detailed things, like many possible methods and also many terms. There were things that I didn't know if I could express precisely in English, and I believe it's the same for C1. But we have no problem getting everything clear in [C]. [C2, NNS, Team A]

While the two NNS talked in their native language, E1 was turned from a direct addressee to a side-participant because of the language shift. Both C1 and C2 were aware of the shift of E1's role. Once they finished the discussion in their native language, they included E1 as an addressee again by shifting back to English and updating him/her on what had been discussed in C. However, it is worth noting that the update was given as a summary rather than in detail. C1 explained that they omitted the details because "*the solution itself was what really mattered for all of us*".
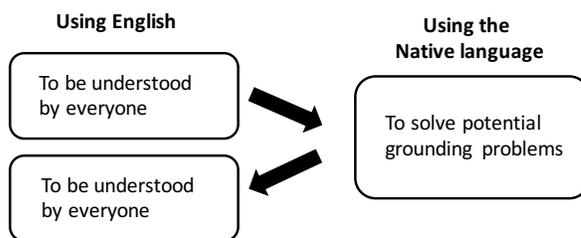
Taken together, our analysis shows that NNS's language shift in informal conversations is closely associated with shifts in perceived conversational participants. Figure 4 diagrams the general pattern of language shift we observed in informal conversations.

Reactions to Language Shift
Overhearers of these informal conversations reported a mixed feeling toward NNS's language shift. All interviewees reported that they wouldn't mind their colleagues speaking a different language for making the conversation more efficiently. However, many of them also

expressed the concern of getting excluded from discussions that they should have been included:

Conversations started in multilingual groups:

Using English — **Using the Native language**

To be understood by everyone → To solve potential grounding problems

To be understood by everyone →

Conversations started in monolingual groups:

Using the Native language — **Using English**

To communicate more naturally or efficiently → To include people who are not the original addressees and/or side-participants

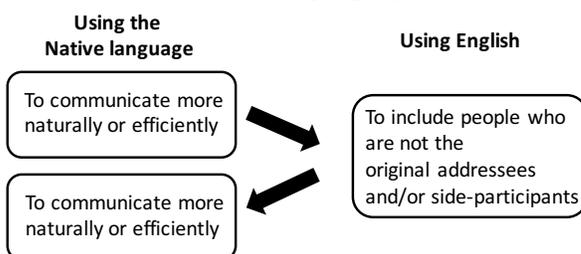To communicate more naturally or efficiently →

Figure 4. The general pattern of NNS's language shift in informal conversations. NNS start a conversation in English or their native languages in multilingual (as example 3) or monolingual groups (as example 1 and 2), respectively. They shift between English and their native language as they assign different roles to other participants in the conversation.

I would prefer people in the lab to speak a language that we all understand, because, you know, sometimes that makes me feel excluded. I don't mind if they are just talking about their personal stuff. There is no reason for me to be involved in those conversations. But I would like to be involved in work related conversations. Maybe I could contribute something to those conversations, you know. But again, I feel it would be rude to say 'hey, please speak English'. [E8, NS, Team C]

This interviewee pointed out an important issue that was confirmed by most other interviewees across the three teams: understanding the main topic of a conversation matters a lot to overhearers. People would love to understand research discussions that are related to the shared interests of the team, but they usually did not mind others talking about minor details of their own project or their personal life in a different language. Thus, when NNS were willing to explain the main topic of their work-related conversations, as what we saw in Example 3, other people always reported this as something they highly appreciated.

When NNS would not share the topic of their native language conversation voluntarily, other people sometimes relied on certain cues to guess the topic of the conversation. A primary cue mentioned by most interviewees was English loan words inserted in non-English conversations. People reported that these English words enable them to get a sense

of the conversation: *"(I can) sort of say they are talking about this or that, even though I don't really understand what they are talking about* [E5, NS, Team B]".

Language Shift at Instant Messaging (IM)
We also looked at how people conducted online communication through IM. Two of the teams we observed relied on Slack[1] to set up online communication. On the Slack page of these teams, there are a number of group channels built for sending out announcements to the whole team or having project-centered discussions among specific subsets of people. People could also set up one-on-one chat on Slack by clicking another person's name and creating a private channel.

For the team that didn't use Slack, online communication was mainly conducted via Google Hangout. All team members had Google accounts associated with their working email addresses assigned by the university. People could sign into Google Hangout by opening either the client-side application or the Gmail webpage.

During our observations, we saw people keep their Slack or Hangout window open once they arrived at the office. Some people also installed the mobile application of these IM platforms, so that they could receive messages even without a laptop. People perceived both Slack and Google Hangout as communication platform specifically for the team's work conversations. As some of our interviewees said:

Slack is the place where we talk about work coordination, or ask research related questions, or many other things about working in this group. All the people you can see on this Slack page are people you work with here. You won't add your friends out of work into this channel. Also, all conversations here are organized under themes, that's usually the name of each project. It helps us structure the messages, and it's good. [H2, NNS, Team A]

We use Google Hangout to discuss about work online. For example, I get an idea for the next step of the research, so I send it to other people through Hangout. We also talk on Hangout to discuss the time for a meeting. It's mostly only for work, maybe because it's connecting with your work Email. The whole network here is your professional network. [C5, NNS, Team C]

Norms of Language Use
We asked people to open their Slack or Hangout conversation history and reflect on their language use. Interestingly, the conversation history showed that NNS rarely exchanged messages in their native language on either platform.

During the interview, many NNS reported that they used English for these IM conversations intentionally, so that messages could be found more easily in the future:

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[1] https://slack.com/is

I try to use as much English as possible here (refers to Slack), because we are talking about the research and these messages are archived. I may want to review or even copy some of this content when I write papers in the future. That will be in English. I don't do publications in [K]. Face-to-face conversations don't have such record, so there is no other use of a conversation outside the current physical environment. [K1, NNS, Team B]

On Hangout I only text in English. I know my English is not perfect, but conversations here are always about work and they are archived. There is a benefit of using English here. When I go back and search for stuff using keywords, it's always easy to do it in English. I'm actually not sure how the search would work in [C]. It's like when you are using Google scholar, you never search a keyword using [C]. [C6, NNS, Team C].

In addition to concerns about the long-term functionality of messages, some NNS interviewees further pointed out that IM allowed them to "*double check the grammar and adjust the wording with the help of online dictionaries before a message was sent out* [C1, NNS, Team A]". Thus, they usually felt it was easier to use English at IM conversations than in face-to-face conversations.

Language Shift and Its Association with Medium Shift
Slack and Hangout were online platforms used by NNS to have work discussions in English, but they were not the only platforms for these discussions. We witnessed many cases in which NNS used their personal IM platforms, such as WhatsApp or Facebook messenger, to have both work-related and personal conversations. On these platforms, NNS always shifted to their native language to communicate with other NNS. NNS explained during interviews that these local IM platforms "*were initially set up for contacting friends rather than colleagues, so there is little sense of obligation to use English* [C3, NNS, Team B]".

Reactions to Language Shift
Our interviews indicated that people were usually not aware of others' online conversations outside Slack or Google Hangout. However, some interviewees reported that there was reason to expect NNS with the same language use their local platforms to communicate. One of the interviewees said:

They (refers to NNS who share the same native language) probably communicate to each other through other channels, and I will never be a part of those conversations. I don't know if that's actually true or not, but that's the expectation. [E5, NS, Team B]

Language Shift within The Whole Flow of Team Communication
Language shift not only complicated the communication in each specific context (formal meetings, informal chat, and online communication), but also had complex influences on the whole flow of communication across contexts. During

the observations and interviews, we found cases in which NNS conducted informal conversations in their native languages and took advantage of these discussions to improve their later participation in formal English meetings. People reported that these informal conversations allowed them "*to polish the ideas better beforehand and they make the later English meetings way more efficient* [H1, NNS, Team A]". However, we also witnessed cases in which NNS set up a series of conversations on the same research idea across different languages and mediums. As a result, it usually "*requires extra effort to translate all the information between languages and integrate them together, so that the information could be shared with the whole group at the later stage (of the research)* [C4, NNS, Team B]".

In sum, our data showed that language shift has both benefits and costs for team communication, depending on the context in which it happened.

DISCUSSION

Consistent with previous research [e.g., 12, 31], our findings showed that NNS did not use the team's common language or their own native language for all conversations. Instead, they chose between different languages based on the context. In the rest of the discussion, we considered the association between NNS's language shift and their interpretation of the most salient need under each context.

Formal meetings set up the context in which a whole group seeks to establish common ground. The use of English, as indicated by the interviews, enabled both NS and NNS to satisfy this contextual need. Previous work on bilingualism found that bilingual speakers temporarily switched to another language to clarify content that could not be grounded in the current language [13]. The NNS in our study used a similar practice as a strategy for building common ground in English conversations with a multilingual audience. Furthermore, we found that NNS tried to minimize the salience of their language shifts during formal meetings. They shifted to their native language for just one or two turns and then shifted back to English immediately; or, they had informal discussions in their native languages prior to formal meetings.

Although some research on multilingual teams reported cases in which NNS had lengthy discussions in their native language at English meetings or even converted the rest of the meeting into their native language [e.g., 22, 31], we did not see similar cases during our study. One possible explanation of this difference is the macro language environment where these multilingual teams immersed in. Since previous research [e.g., 4, 22, 31, 38] was often conducted in multinational organizations located in non-English speaking countries, NNS of English may perceive their local language as having equal legitimacy in the workplace as English [31]. In our study, however, all teams were from a university in the United States where the local language is English. Our study, along with previous

research, indicated that language shift is a common practice of communication in multilingual teams regardless of what the dominant language is at the societal level.

Besides formal meetings, informal communications also play a crucial role in teamwork especially at executing work-related tasks and sharing knowledge between co-workers [26, 43]. Previous CSCW research has indicated that NNS of English living in English-speaking countries prefer to communicate with fellow speakers using their native language during informal conversations [46]. Our study extends this work by digging deeper into how NNS use different languages to communicate in the workplace. Specifically, we found that NNS often perceived two different but interlaced needs during informal conversations: to properly include certain participants in a conversation, and to maximize conversational grounding efficiency. Linguistic choices that addressed one need might fail to fulfill the other [5]. As we demonstrated through some examples, two NNS can communicate most efficiently in their native language, but this excludes others from the conversation; speaking English allows both NS and NNS to be included in the same conversation, but it hinders NNS's ability to express complicated thoughts. Every time NNS opted for English vs. his/her native language, this choice generated ripple effects on later stages of the conversation. NNS then made further language shifts as these rippled effects happened. They used shift-markers as a technique to help balance benefits and costs associated with their choosing and re-choosing on language.

When NNS communicate using work-focused IM platforms, their language use is closely associated with contextual needs guaranteed by the "perceived affordance [36]" of the medium. More specifically, since messages exchanged via IM are usually archived, it offers the potential for people to review, search, and reuse the content of their earlier conversations. The use of English further consolidates the long-term functionality of IM messages by simplifying the process of information retrieval. In the field of HCI and CSCW, substantial research has examined the use of IM for lightweight communication [e.g., 6], work coordination [e.g., 33], and multitasking [e.g., 26]. While these studies emphasized the immediate delivery of IM messages, little research has examined the "archiveabilty" of IM messages and its influence on teamwork. The current study helps address this question by connecting the archiving of messages and NNS's language use in multilingual teams. Further, our observations showed that NNS usually shift to their native language when having work-related conversations on personal IM platforms that are not always noticed by others. This use of hidden platforms can decrease the communication visibility at the team level [11, 29]. Using NNS's native languages on these platforms can further intensify the lack of communication visibility between subsets of people who speak different languages.

It is worth noting that people's contextual use of language as we discussed here was qualified by certain attributes of our observed teams. These attributes include but may not limited to: collocated, research-oriented, non-industrial and requiring high English language competence. Future research will be needed to verify to what extent our findings can be transferred to other forms of multilingual teams.

DESIGN IMPLICATIONS
Findings from this study provide insights for the design of multilingual collaboration systems. These insights concern how technology could be applied to facilitate multilingual communication based on the context in which it happens.

Machine Translation (MT) Tools and Formal Meetings
Formal meetings are usually dominated by English conversations. NNS may shift to their native languages, but only temporarily, in order to translate words and expressions. This suggests a new way to incorporate MT modules into multilingual meeting systems. Instead of using MT to translate all messages, as most previous research has done [e.g., 19, 42], tool designers should consider giving users full control over when to turn the MT module on or off. Moreover, interviewees in our study mentioned that interacting with translation tools can break the natural flow of an oral conversation. To address this concern, automatic language identification (LID) could be implemented into the MT module. When NNS choose to turn the MT module on, the system could detect language shift and provide MT output automatically.

Non-Human Agents and Informal Communications
NNS's language use in informal communication was closely associated with their perception of who was participating in a conversation. NS who are perceived as overhearers may want to join in but they cannot do so if the conversation is conducted in an unknown language. Based on this finding, we suggest that a system might sense the environment and prompt users with information about the context of conversation. More specifically, systems may help speakers stay aware of the potential participants and what roles each participant may take over the conversation [20, 32]. Systems might also increase speakers' awareness of different value interpretations held by different participants.

Further, our interviewees reported that it would be rude to ask others to shift to English. They also did not want to interrupt others if the topic of the conversation was about personal matters. Based on this finding, we suggest using non-human agents to alleviate the social awkwardness associated with language shift. Research in human-robot interaction has demonstrated how interpersonal interactions that are problematic between people could be facilitated by the use of robots and agents [e.g., 3, 23, 41]. Following this line of thoughts, we propose implementing non-human agents, such as desktop robots or intelligent avatars on tablets, into the physical workspace to facilitate interactions between speakers of different native languages. When an agent detects conversations in a language that is not understood by overhearers, it could ask the speaker whether s/he would like to explain the topic of the conversation using the common language. In this way, the speaker could be reminded to reflect on their language choice based on the current context. Overhearers would benefit from this reflection without interrupting others abruptly.

Text Annotation Tools and Instant Messaging (IM)
We found that NNS hold work-related conversations not only on work-focused IM platforms (e.g., Slack) but also on personal IM platforms. The languages they chose to use on different platforms were often different, requiring extra effort to integrate and translate all the information surrounding a single work task. Previous work has shown how text annotation tools can help NNS better process and structure information in English IM conversations [e.g., 30]. We propose implementing similar tools in IM platforms used by NNS. Annotation tools could automatically generate English tags based on the text exchanged in IM chat. Once key words, such as a particular technical term, are detected, the annotation tool could mark this part of the conversation and categorize it into a note. It might also generate auto-reminders to NNS to ask if they would like to move the conversation to a work-focused platform or summarize the conversation in English. When NNS need to integrate information across IM platforms and languages, they could use the automated tags to organize and/or translate these conversations with less effort.

CONCLUSION
To better understand and facilitate communication in teams consisting of speakers of multiple native languages, we conducted a field study of language use in three multilingual teams. Each team consisted of some native English speakers (NS) and some non-native English speakers (NNS) who shared a native language with at least one other team member. We found that NNS in these teams often moved back and forth between using English and using their native language. This shift of language may happen in different ways and serve for different purposes under various contexts of communication. Our analysis also showed that language shift can have complicated impacts on communication at the team level, depending on the context in which it happened. Based on these findings, we propose design ideas for facilitating communication in multilingual teams during formal meetings, informal conversations, and instant messaging, respectively.

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