Universal Principles of Human Communication: Preliminary Evidence from a Cross-Cultural Communication Game

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Abstract

The present study points to several potentially universal principles of human communication. Pairs of participants, sampled from culturally and linguistically distinct societies (Western and Japanese, N=108: 16 Western-Western, 15 Japanese-Japanese and 23 Western-Japanese dyads) played a dyadic communication game in which they tried to communicate a range of experimenter-specified items to a partner by drawing, but without speaking or using letters or numbers. This paradigm forced participants to create a novel communication system. A range of similar communication behaviors were observed among the within-culture groups (Western-Western and Japanese-Japanese) and the across-culture group (Western-Japanese): they (1) used iconic signs to bootstrap successful communication, (2) addressed breakdowns in communication using other-initiated repairs, (3) simplified their communication behaviour over repeated social interactions and (4) aligned their communication behaviour over repeated social interactions. While the across-culture Western-Japanese dyads found the task more challenging, and cultural differences in communication behaviour were observed, the same basic findings applied across all groups. Our findings, which rely on two distinct cultural and linguistic groups, offer preliminary evidence for several universal principles of human communication.

1. Introduction

A defining feature of the world's 6,000 to 8,000 languages is their diversity, seen at every level of linguistic organization (Evans & Levinson, 2009). By contrast, there are striking similarities in interactive language use (Levinson, 2016). One example is turn-taking in conversation (Sacks, Schegloff, & Jefferson, 1974). Across a range of languages, interlocutors follow a one-at-a-time rule during conversation, speaking turns tend to be short (around 2 seconds) and the gaps between speaking turns tend to be very brief (around 200 milliseconds; Heldner & Edlund, 2010; Stivers et al., 2009). Similarly brief turn transition gaps are seen in sign language (De Vos, Torreira, & Levinson, 2015). Another example is the use of other-initiated repairs (OIRs) to signal trouble and address breakdowns in communication (Schegloff, 2000; Schegloff, Jefferson, & Sacks, 1977). OIRs are a frequent feature of conversation that is observed across a diverse range of languages (Byun, de Vos, Bradford, Zeshan, & Levinson, 2017; Dingemanse & Enfield, 2015; Dingemanse, Roberts, et al., 2015). The implication is that whereas language is socially learned, there may be innate and universal principles of language use.

Using an experimental-semiotic communication game that is played among and across native English and native Japanese speakers (N= 108), the present study points to several potentially universal principles of human communication: (1) the use of iconic signs to bootstrap communication, (2) the use of other-initiated repairs to address breakdowns in communication, (3) a tendency to simplify communication behaviour over repeated social interactions and (4) a tendency to align communication behaviour over repeated social interactions.

1.1. Experimental-semiotic communication games

Experimental-semiotic communication games are being increasingly used to investigate the emergence and evolution of human communication systems (for reviews see Fay, Ellison, & Garrod, 2014; Galantucci, 2017; Tamariz, 2017). To simulate the emergence of novel human communication systems, participants communicate without using their existing language, often in a different modality: for example, by drawing (Galantucci, 2005; Garrod, Fay, Lee, Oberlander, & MacLeod, 2007; Sulik, 2018) or through gesture (Christensen, Fusaroli, & Tylén, 2016; Fay, Arbib, & Garrod, 2013; Schouwstra & de Swart, 2014). Researchers examine how the communication systems arise and evolve over participants' repeated social interactions.

In Garrod et al. (2007), participants tried to communicate a set of recurring items (a series of words) to a partner by drawing on a shared whiteboard. Like the game Pictionary, participants were not permitted to speak or use letters or numbers in their drawings, forcing them to create a novel communication system. Over repeated social interactions three things happened: communication success improved, the signs used to communicate the different items were transformed from complex iconic signs (i.e., signs that resemble their meaning) to simpler symbolic signs (i.e., signs that share a more arbitrary relationship to their meaning), and interlocutors increasingly used the same signs to communicate the same item (i.e., their communication behaviour aligned; see Fig. 1). This pattern of results has been widely replicated (Caldwell & Smith, 2012; Fay, Garrod, Roberts, & Swoboda, 2010; Fay, Walker, Swoboda, & Garrod, 2018; Garrod, Fay, Rogers, Walker, & Swoboda, 2010; Sulik, 2018; Theisen, Oberlander, & Kirby, 2010) and analogous findings are returned by verbal referential communication experiments (Clark & Wilkes-Gibbs, 1986; Garrod & Anderson, 1987).

This paradigm provides a valuable tool to identify universal principles of human communication with minimal contamination from participants' pre-existing language[1]. In addition, because task performance does not rely on having a shared language, it can be used to directly compare the communication behaviour of participants drawn from different linguistic and cultural groups.

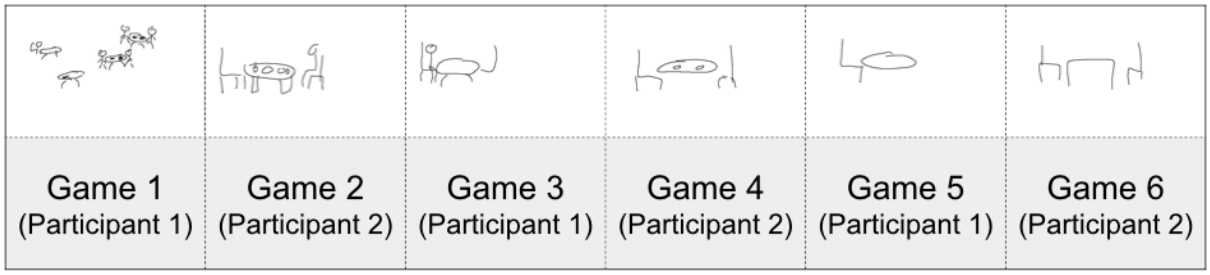

Fig. 1. Sign simplification and behaviour alignment for the item 'Restaurant' across 6 games between a pair of participants from the current experiment (Western-Western dyad). Participants switched between directing and matching roles from game to game. At Game 1 'Restaurant' was communicated using a complex iconic sign that included several tables and chairs, diners and meals. By Game 6 the sign had lost much of its initial iconicity, evolving into a simpler, more symbolic representation, communicated by a schematic drawing of table and two chairs. Also, the signs produced by members of the dyad became increasingly similar, or aligned, over repeated social interactions.

1.2. The present study: Theoretical motivation and predictions

The findings from experimental-semiotic studies are restricted to participants from Western societies (Galantucci, 2017). The present study asks if similar communication behaviours

[1] Linguistic competence is necessary to read and understand the experimental items, but all task communication is non-linguistic.

are observed among non-Western participants from an Eastern society (Japan). Although Japan is also an educated, rich, industrialized and democratic society (Henrich, Heine, & Norenzayan, 2010), it is culturally and linguistically distinct from Western society. If similar communication behaviours are observed among Western-Western participants, Japanese-Japanese participants and Western-Japanese participants, this would constitute preliminary evidence for universal principles of human communication.

Historically, sign arbitrariness was considered a design feature of language (Hockett, 1960). Now, iconicity is thought to be a general property of language (Dingemanse, Blasi, Lupyan, Christiansen, & Monaghan, 2015; Perniss, Thompson, & Vigliocco, 2010). Furthermore, iconic forms, gestured or spoken, facilitate effective cross-cultural communication (Kantartzis, Imai, & Kita, 2011; Pizzuto & Volterra, 2000). Experimental-semiotic studies using Western participants suggest that sign iconicity may be especially important in the earliest stages of language creation, as interlocutors try to bootstrap a rudimentary communication system (Fay et al., 2013; Perlman & Lupyan, 2018; for a theoretical model see Lister & Fay, 2017). The more iconic a sign is, the more likely it is that its meaning will be correctly identified on first encounter (Garrod et al., 2007; Perlman & Lupyan, 2018). So, if dyad communication success is significantly higher than chance on first encounter we can conclude that participants are using iconic signs to bootstrap communication. We predict that communication success will be higher than chance at Game 1 (i.e., first encounter) for within-culture dyads and for across culture-dyads, indicating that participants were using iconic sign to bootstrap communication.

When communication problems arise, they can be repaired. Other-initiated repairs (OIRs) are a frequent feature of conversation that is seen across a diverse range of languages (Dingemanse & Enfield, 2015; Dingemanse, Roberts, et al., 2015). Three broad

types of OIRs were identified by Dingemanse and Enfield (2015): Open requests, restricted requests and restricted offers. Open requests, such as 'huh', are unspecific with regards to the communication problem. By contrast, restricted requests query specific parts of the message, often with a Wh- question. Restricted offers are instances where an alternative conceptualization is suggested by the conversation partner. Following Dingemanse et al (2015), we predict that OIRs will be a similarly frequent feature of social interaction among dyads drawn from the same cultural and linguistic groups (Western-Western and Japanese-Japanese). Because people from different cultures cannot fall back on shared cultural knowledge, we predict that OIRs will be more frequently used by across-culture dyads (Western-Japanese).

Over repeated social interactions iconic signs are transformed into simpler more symbolic signs, and this makes communication more efficient (see Fig. 1). This process of incremental sign simplification is consistent with the principle of least collaborative effort in pragmatics (Clark & Wilkes-Gibbs, 1986; Clark, 1996). This principle asserts that interlocutors minimize their joint effort by developing messages that are informative and brief (see also the maxim of quantity in conversation, Grice, 1975; and the least effort principle in language, Zipf, 1949; Piantadosi, Tily, & Gibson, 2011). Interlocutors achieve this through an interactive grounding process, where information is shifted from the message to common ground, or mutual knowledge. Over repeated social interactions this facilitates increasingly efficient communication because more succinct versions of the earlier message are sufficient to activate common ground. Consistent with a principle of least collaborative effort, we predict the graphical signs will be progressively simplified over repeated social interactions in each group.

Behaviour matching is a fundamental feature of social interaction (Chartrand & Bargh, 1999; Dijksterhuis & Bargh, 2001). This is especially true for communication behaviour, where interlocutors tend to align their linguistic behaviour over repeated social interactions (Pickering & Garrod, 2004). Linguistic alignment, or establishing a 'conceptual pact' (Brennan & Clark, 1996), signals successful communication and sets an expectation that a particular description will be consistently used to pick out a particular referent, thereby reducing uncertainty and aiding mutual understanding (Kronmüller & Barr, 2015). Consistent with a general alignment principle, we predict that the graphical signs produced by dyads will become progressively more similar over repeated social interactions in each group.

2. Method

2.1. Participants

One hundred and eight participants (mean age= 21.10 years; females= 42) took part in exchange for payment (equivalent of £10). Participants in the Western-Western group were native English speakers recruited from the University of Glasgow, Scotland (N=32, or 16 dyads). Participants in the Japanese-Japanese group were native Japanese speakers recruited from Doshisha University, Japan (N=30, or 15 dyads). Western participants from the Western-Japanese group were intern students at the Advanced Telecommunication Research Institute International, Japan. All were native English speakers (from the US, Canada, UK) who had been living in Japan for less than 6 months (N=23). Japanese participants from the Western-Japanese group were native Japanese speakers recruited

from Doshisha University, Japan (N=23). 23 dyads were tested in the Western-Japanese condition.

2.2. Task and Procedure

The goal for each participant was to graphically communicate a series of confusable items in such a way that their partner could identify their intended referent (see Table 1 for a complete listing). Like the game Pictionary, participants were prohibited from using letters or numbers in their drawings. The Director drew each item from their list (12 target items plus 4 distractor items) and their partner, the Matcher, tried to guess which item was being communicated from their list of the same items.

The task was administered using a virtual whiteboard tool that recorded all drawing activity (Healey, Swoboda, & King, 2002). This tool has been used in a range of similar studies (Fay et al., 2010, 2018; Garrod et al., 2010; Healey, Swoboda, Umata, & King, 2007; Theisen et al., 2010). All communication was done across networked computers. Drawing and item selection was done using a stylus on a Wacom tablet. For the Director, each to-be-depicted item was highlighted in white text on a dark background at the top of the interface. Director drawing was restricted to black ink and Matcher drawing was restricted to green ink (to distinguish between the participants). By clicking an erase button on the interface, participants were able to erase parts of their own drawing and their partner's drawing. All drawing and erasing activity was displayed simultaneously on the Director and Matcher's computers. When the Matcher believed they had identified the Director's intended referent they selected the relevant button at the top of the interface, where there was a list of buttons corresponding to the different items. Item selection brought the current trial to an end and initiated the next trial. No time limit was imposed, and

participants were given no explicit feedback with regard to their communication success. Having participants communicate remotely across networked computers meant they were unaware of their partner's identity.

Participants completed the experiment in one of three groups: Western-Western, Japanese-Japanese (within-culture groups) and Western-Japanese (across-culture group). Pairs of participants played 6 consecutive games of the Pictionary-like task with the same partner, using the same item set on each game. For the Director, the first 12 items on the list were the target items and the final 4 items were the distractor items. Distractor items were included to ensure that Matchers could not use a process of elimination to identify the final target item. However, over the course of the experiment, participants may have realized the distractor items were never communicated, and may have used a process of elimination to identify the final target item on the later games.

For the Matchers, all 16 items were presented in a different random order on each game. Participants alternated between directing and matching roles from game to game (i.e., Participant 1 was the Director on games 1, 3 and 5 and the Matcher on games 2, 4 and 6, and Participant 2 was the Director on games 2, 4 and 6 and the Matcher on games 1, 3 and 5). Participants were randomly allocated to the Director or Matcher role at Game 1. Matchers could provide graphical feedback within a trial, allowing them to initiate repairs. A Matcher might initiate a repair by annotating a part of the Director's drawing or by offering a graphical alternative (see Fig. 2).

Table 1. The set of experimental items communicated by Directors (in English and Japanese). For each dyad 12 target items were communicated 6 times over 6 Games.

Experimental Items			
Arnold Schwarzenegger アーノルド・シュワルツネッガー	Art Gallery アート・ギャラリー	Clint Eastwood クリント・イーストウッド	Computer Monitor コンピューターのモニター
House 家	Museum 博物館	Robert De Niro ロバート・デニーロ	Television テレビ
Actor 役者	Breakfast 朝食	Cartoon 漫画	Drama 芝居
Monument 記念碑	Parliament 国会	Restaurant レストラン	University 大学

2.3. Measures

2.3.1. Sign Iconicity

The more iconic a sign is, the more likely it is that its meaning will be correctly identified on first encounter (Garrod et al., 2007; Perlman & Lupyan, 2018). In the present study chance identification accuracy is 6.25%. So, if dyad communication success is significantly higher than 6.25% at Game 1 (i.e., first encounter) we can conclude that participants are using iconic signs to bootstrap communication.

2.3.2. Other-Initiated-Repairs

Other-initiated-repairs (OIRs) were operationalized as any trial in which the Matcher provided graphical feedback. Because OIRs were infrequent, occurring on average on 6.06% of trials (9.78, 6.05, 5.87, 4.64, 5.40, 4.63% of trials across games 1-6), the data was collapsed across games and we did not distinguish between the different types of OIR identified by Dingemanse and Enfield (2015).

2.3.3. Sign Complexity

Sign complexity was measured using Pelli, Burns, Farell, and Moore-Page's (2006) information theoretic measure of perimetric complexity [Perimetric complexity = (inside + out- side perimeter)^2/ink area]. Previous work indicates this to be an effective scale-free measure of drawing complexity (Garrod et al., 2007; Tamariz & Kirby, 2014).

2.3.4. Behaviour Alignment

To measure behaviour alignment, pairs of drawings from each dyad (at Game 1-2, 2-3, 3-4, 4-5 and 5-6) were presented side-by-side on a computer screen and were rated for similarity (by author BW). Pairs of drawings were presented in a random order. The drawings were rated on a Likert scale from 0-9, where 0= very dissimilar and 9= very similar. In total 3240 pairs of drawings were rated for similarity (12 items × 5 pairs of adjacent games × 54 dyads). A randomly selected subset of drawings was rated for similarity by a second judge (by author NF) (648 pairs of drawings; 174 from the Western-Western group, 177 from the Japanese-Japanese group and 297 from the Western-Japanese group). The raters were blind to the group or the game the drawings were sampled from. The two sets of ratings showed strong inter-coder agreement $(r = .870, p < .001)$.

3. Results

Fig. 2 gives examples of the signs used to communicate the item 'Cartoon' by the different groups (Western-Western, Japanese-Japanese and Western-Japanese) and their simplification and alignment over repeated social interactions (Games 1-6).

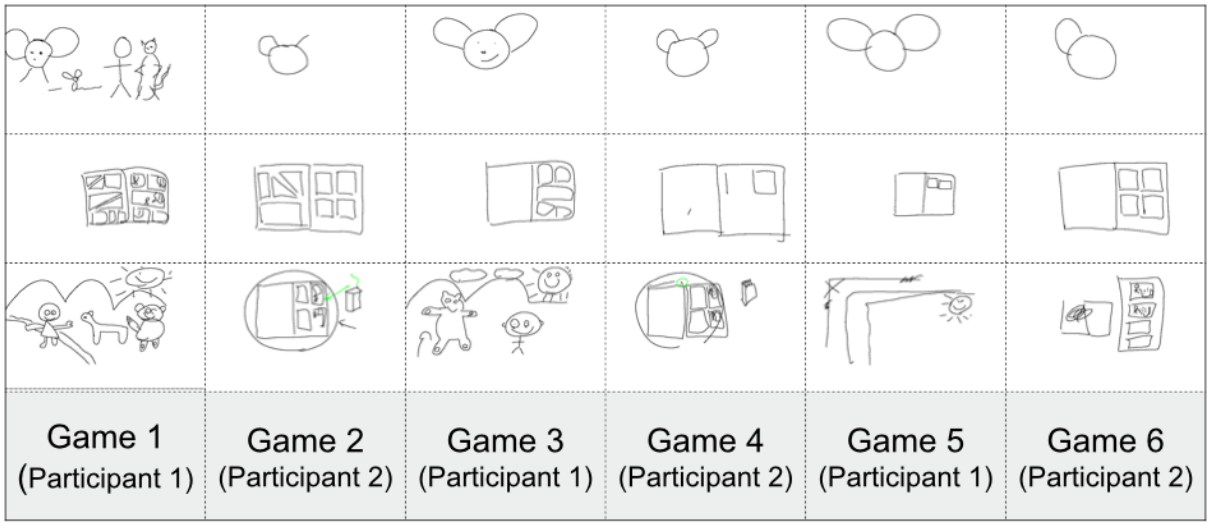

Fig. 2. Sign simplification and alignment for the item 'Cartoon' across 6-games in a dyad from each group. At Game 1 in the Western-Western dyad (first row) 'Cartoon' was communicated using a complex iconic sign that included several characters, two of whom had exaggerated rabbit/mouse ears. By Game 6 the dyad had aligned on a simplified version of the initial sign, composed of two circles (one corresponding to the character's face and the other to its exaggerated ear). The Japanese-Japanese dyad (second row) aligned on a simplified version of the iconic Game 1 drawing of a manga-style comic strip. In the Western-Japanese dyad (third row) there is more modest sign simplification and no evidence of behaviour alignment over games. The Western participant (Participant 1) drew a group of children's cartoon characters, whereas their Japanese partner (Participant 2) drew a manga-style comic strip. In addition, there were two instances of other-initiated repair in this dyad. Analogous to a restricted request, at Games 2 and 4 the Western participant queried part of the Japanese Director's drawing (in green).

The data was analysed using logistic and linear mixed effects modelling, with crossed random effects for dyads and for items. All analyses were performed and all figures were

created in R (R Core Team, 2013). Statistical models were estimated using the glmer() and lmer() function of lme4 (Bates, Maechler, Bolker, & Walker, 2013). The maximal random effects structure justified by the experiment design was specified where possible (Barr, Levy, Scheepers, & Tily, 2013). Descriptive statistics for each analysis are provided in the supplementary materials.

3.1. Iconic Signs

The communication success data was analyzed using a logistic mixed effects model. Group (factor coded) and Game (centered) were entered as fixed effects with interaction. The random effects structure included by-Dyad and by-Item random intercepts, as well as by-Item random slopes for Game. This was the maximal model that would converge. Group and Game significantly affected communication success (Table 2, Fig. 3). Communication success was higher in the within-culture Western-Western and Japanese-Japanese groups compared to the across-culture Western-Japanese group, although this only reached statistical significance for the Western-Western group. There was no evidence of a statistical difference in communication success between the within-culture groups (p=0.220). In all groups communication success improved over games.

In each group communication success at Game 1 was substantially higher than chance (6.25%) ($M_{\text{Western-Western}}$=76.94%, SD=14.78; $M_{\text{Japanese-Japanese}}$=73.59%, SD=11.04; $M_{\text{Western-Japanese}}$=71.74%, SD=14.81), supporting the importance of iconic signs to bootstrapping communication.

Table 2. Communication Success: Results of the logistic mixed effects model. The Western-Japanese Group was specified as the reference group.

Fixed Effects	Estimate	Standard Error	z value	Pr(>|z|)
Western-Western	0.573	0.281	2.040	0.041
Japanese-Japanese	0.193	0.282	0.685	0.493
Game	0.266	0.051	5.220	<0.001
Western-Western*Game	0.046	0.069	0.667	0.505
Japanese-Japanese*Game	0.063	0.067	0.933	0.351

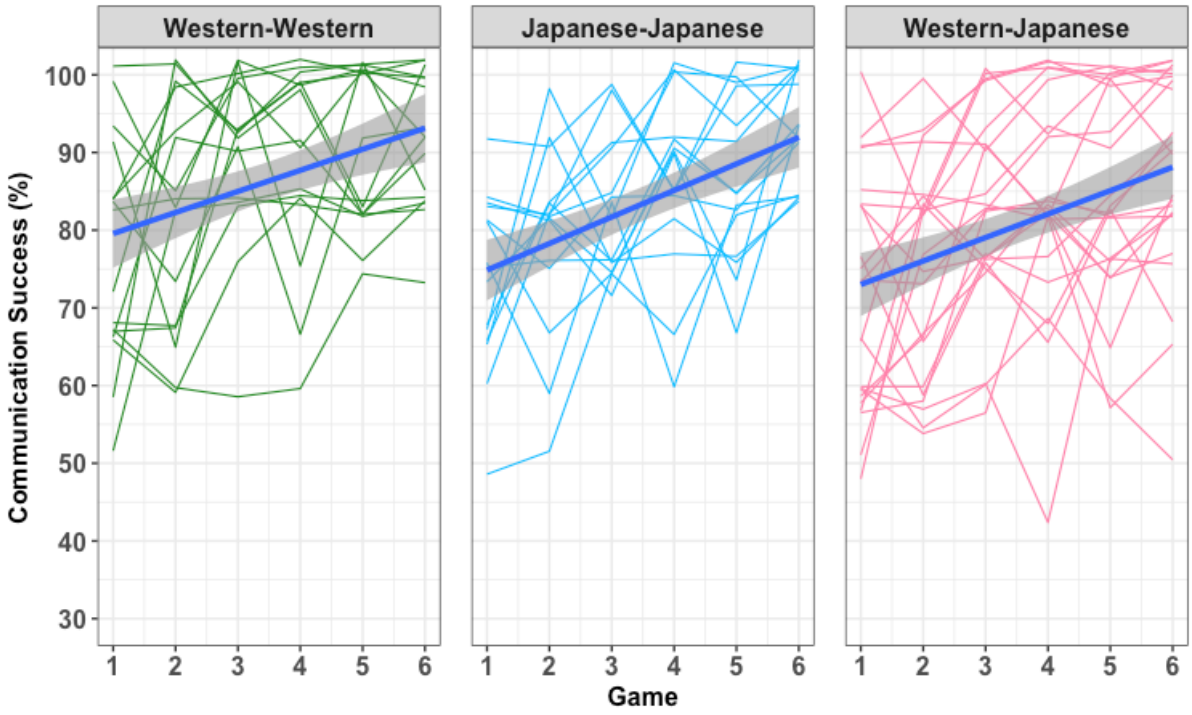

Fig. 3. Change in communication success (expressed as percentages, and plotted for each dyad) across Games 1-6 for each group. A small amount of noise was added to the scores to reduce over-plotting. This caused some scores to go slightly above 100%. The blue straight line is the linear model fit and the light grey shaded area is the 95% confidence interval.

3.2. Other-Initiated Repairs

The other-initiated repair (OIR) data was analyzed using a logistic mixed effects model. Group (factor coded) was entered as a fixed effect. The random effects structure included by-Dyad and by-Item random intercepts. This was the maximal model that would converge. Group significantly affected the rate of OIRs (Table 3, Fig. 4). The rate of OIRs was lower in the within-culture Western-Western and Japanese-Japanese groups compared to the across-culture Western-Japanese group, although this only reached statistical significance for the Western-Western group. The rate of OIRs was similar between the within-culture groups ($p=0.139$).

OIRs were used by all groups, supporting their universality as a means of addressing breakdowns in communication (Byun et al., 2017; Dingemanse & Enfield, 2015; Dingemanse, Roberts, et al., 2015). As predicted, OIRs were more frequently used by across-culture dyads, probably to bridge their lack of shared cultural knowledge. This interpretation is consistent with the lower communication success of the across-culture dyads compared to the within-culture dyads.

Table 3. Other-initiated repair: Results of the logistic mixed effects model. The Western-Japanese Group was specified as the reference group.

Fixed Effects	Estimate	Standard Error	z value	Pr(>|z|)
Western-Western	-1.223	0.508	-2.41	0.016
Japanese-Japanese	-0.740	0.499	-1.48	0.139

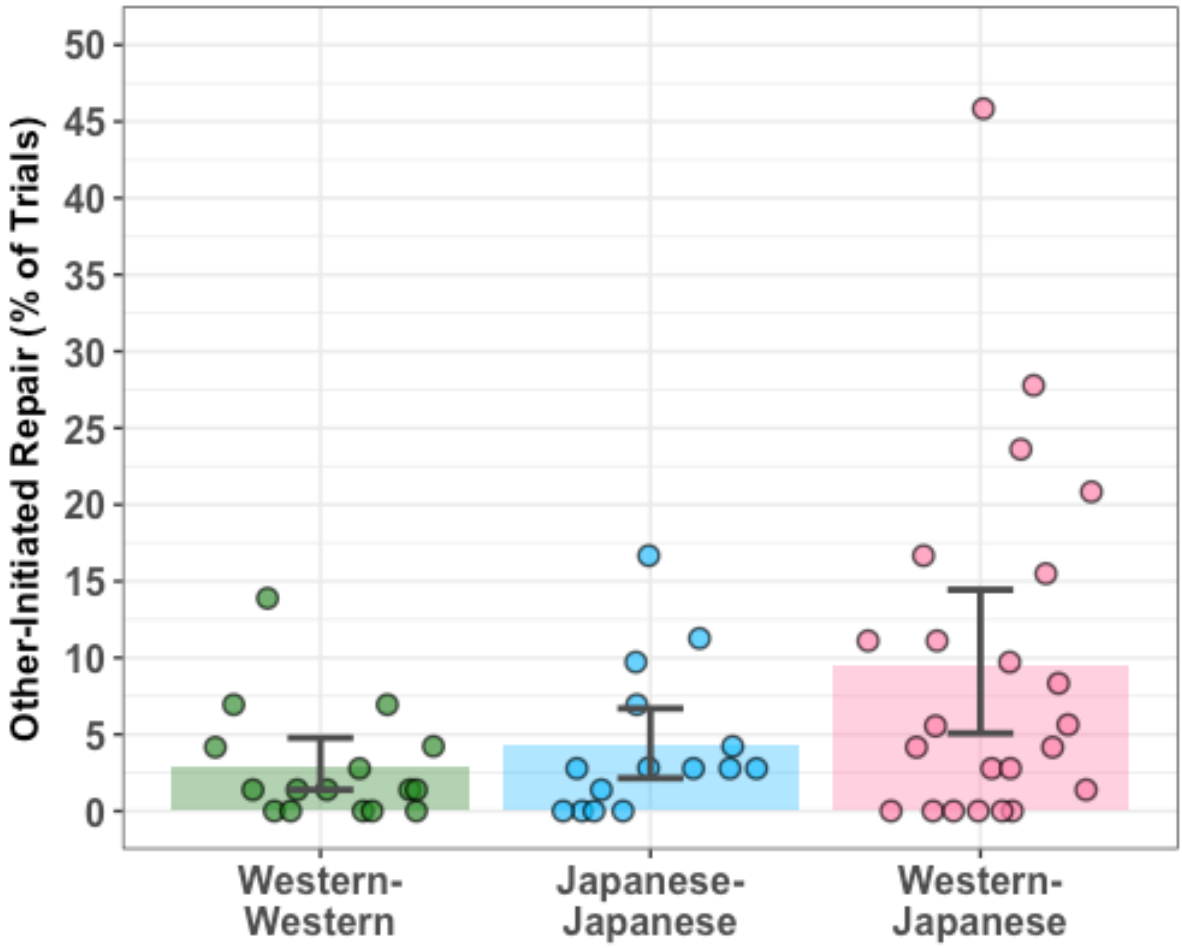

Fig. 4. Frequency of other-initiated repair (% of trials) in the different groups, collapsed across games. Error bars are the 95% confidence intervals around the means.

3.3. Sign Complexity

The sign complexity data was analyzed using a linear mixed effects model. Group (factor coded) and Game (centered) were entered as fixed effects with interaction. The maximal random effects structure was specified. This included by-Dyad and by-Item random intercepts, as well as by-Dyad random slopes for Game and by-Item random slopes for the Group by Game interaction. Group and Game significantly affected sign complexity (Table 4, Fig. 5). Sign complexity was lower among the Western-Western dyads compared to the

Japanese-Japanese dyads ($p<0.001$) and compared to the Western-Japanese dyads (marginal effect). In addition, sign complexity was lower among the Western-Japanese dyads compared to the Japanese-Japanese dyads. Consistent with a principle of least collaborative effort, in all groups sign complexity decreased over games.

Table 4. Sign complexity: Results of the linear mixed effects model. The Western-Japanese Group was specified as the reference group.

Fixed Effects	Estimate	Standard Error	t value	Pr(>|t|)
Western-Western	-826.27	445.04	-1.86	0.068
Japanese-Japanese	913.26	436.94	2.090	0.041
Game	-378.42	79.16	-4.781	<0.001
Western-Western*Game	-49.55	103.77	-0.477	0.635
Japanese-Japanese*Game	11.70	111.52	0.105	0.917

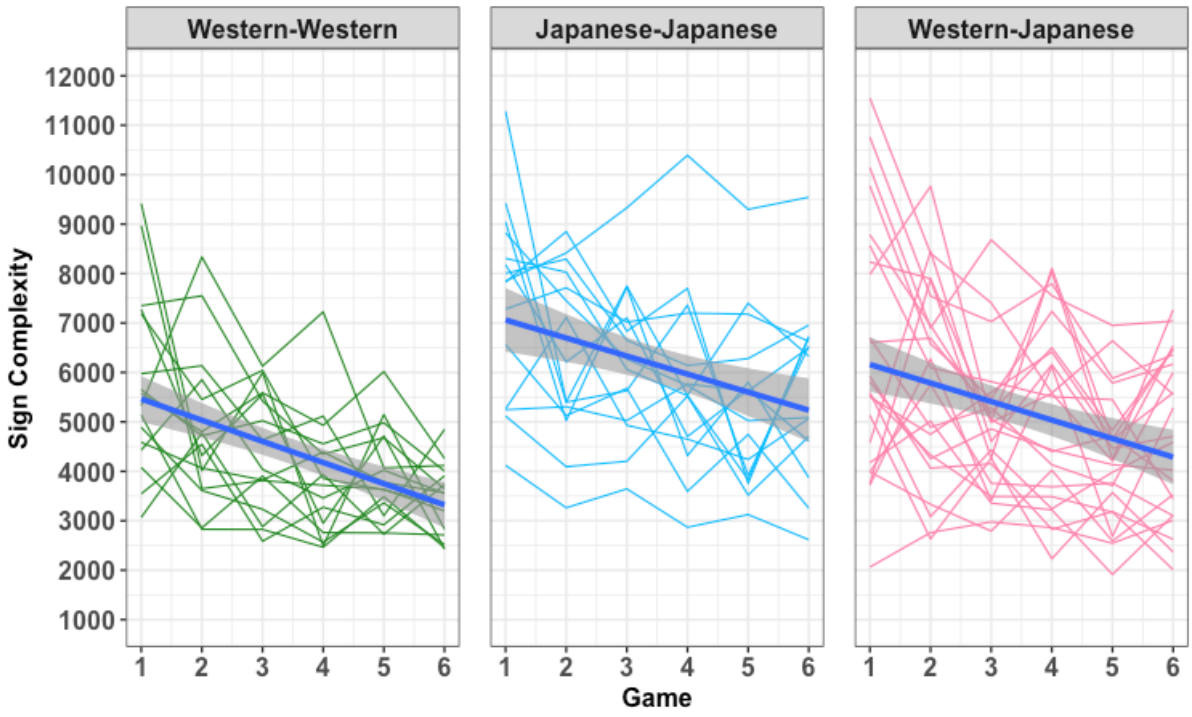

Fig. 5. Change in sign complexity (plotted for each dyad) across Games 1-6 for each group. The blue straight line is the linear model fit and the light grey shaded area is the 95% confidence interval.

3.4. Behaviour Alignment

The behaviour alignment data was analyzed using the same statistical model used to analyze sign complexity. Group and Game significantly affected behaviour alignment (Table 5, Fig. 6). Behaviour alignment was higher in the within-culture Western-Western and Japanese-Japanese groups compared to the across-culture Western-Japanese group, although this only reached marginal statistical significance for the Japanese-Japanese group. There was no evidence of a statistical difference in behaviour alignment between the within-culture groups (p=0.392). Consistent with a behaviour alignment principle, in all groups dyads increasingly aligned their communication behaviour over games.

Table 5. Behaviour alignment: Results of the linear mixed effects model. The Western-Japanese Group was specified as the reference group.

Fixed Effects	**Estimate**	**Standard Error**	**t value**	**Pr(>|t|)**
Western-Western	0.367	0.362	1.013	0.316
Japanese-Japanese	0.672	0.345	1.944	0.057
Game	0.470	0.076	6.144	<0.001
Western-Western*Game	0.001	0.097	0.013	0.989
Japanese-Japanese*Game	-0.143	0.089	-1.605	0.116

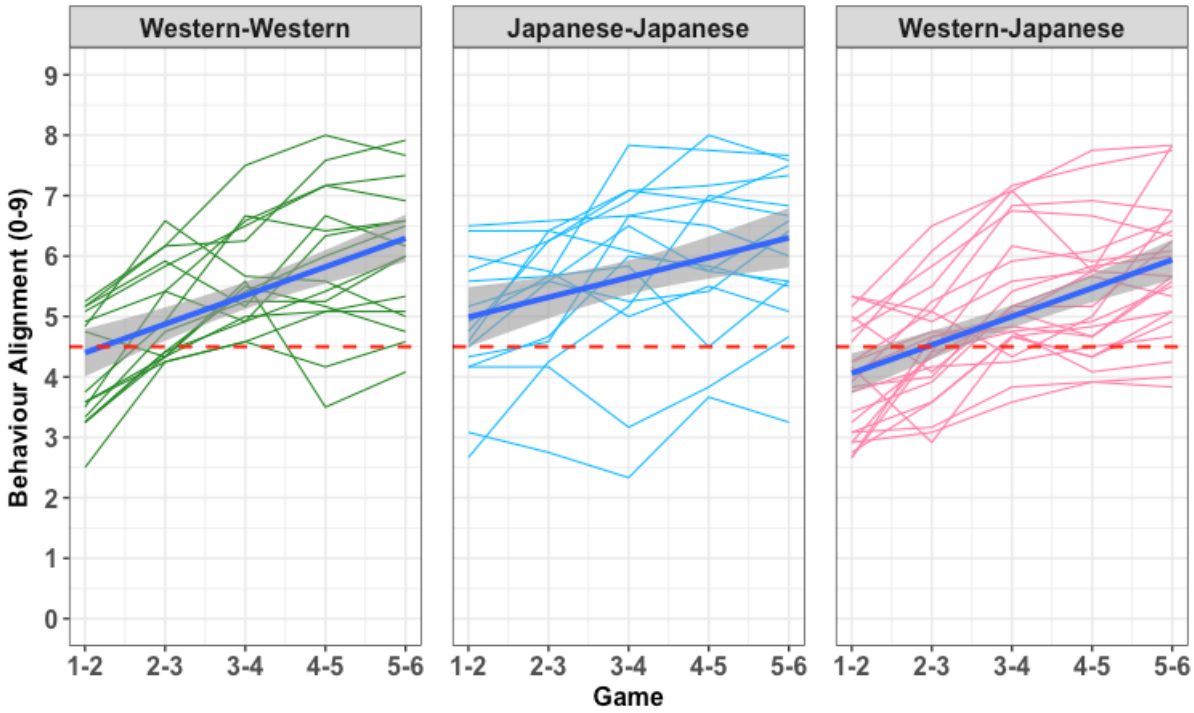

Fig. 6. Change in rated behaviour alignment scores (plotted for each dyad) across Games for each group. Values above the horizontal red dashed line can be considered as similar and values below it as dissimilar. The blue straight line is the linear model fit and the grey shaded area is the 95% confidence interval.

4. Discussion

Despite the great diversity of languages (Evans & Levinson, 2009), there is evidence for universal principles of language use (Levinson, 2016). Across languages, conversation is organised similarly; interlocutors speak one-at-a-time in alternating turns (Sacks et al., 1974; Stivers et al., 2009) and use other-initiated repairs (OIRs) to address breakdowns in communication (Byun et al., 2017; Dingemanse & Enfield, 2015; Dingemanse, Roberts, et al., 2015). Using an experimental-semiotic communication game, the present study replicated the use OIRs as a means of addressing breakdowns in communication, and identified several

additional, potentially universal, principles of human communication. These include the use of iconic signs to ground shared meanings, a tendency to minimize joint effort over repeated social interactions, and a tendency to align communication behaviour over repeated social interactions.

Experimental-semiotic studies indicate that when participants communicate without using their existing language they often use iconic signs to ground shared meanings (e.g., Galantucci, 2005; Garrod et al., 2007). We reasoned that the more iconic a sign is, the more likely it is that its meaning will be correctly identified on first encounter (see also Garrod et al., 2007; Perlman & Lupyan, 2018). For each group (Western-Western, Japanese-Japanese, Western-Japanese) at game 1 (i.e., first encounter), communication success was far higher than would be expected by chance, indicating that iconic signs were being used to bootstrap communication. In addition, communication success improved over repeated social interactions. Although communication success was lower in the across-culture dyads (Western-Japanese) compared to the within-culture dyads (Western-Western and Western-Japanese), communication success was nevertheless high in this group (71.74% at Game 1, rising to 86.96% by Game 6). This finding supports the potential of drawing as a cross-cultural communication tool (Thomas, 1983) and for learning more generally (Ainsworth, Prain, & Tytler, 2011).

Analysis of conversations sampled across a variety of languages indicates that other-initiated repairs (OIRs) are a universal mechanism that is used to address breakdowns in communication (Byun et al., 2017; Dingemanse & Enfield, 2015; Dingemanse, Roberts, et al., 2015). Consistent with this, OIRs were used similarly often among the within-culture dyads tested in the present study. Because participants in the across-culture dyads had less shared cultural knowledge to fall back on, we reasoned that OIRs would feature more

frequently in this group. This prediction was supported, indicating that the Western-Japanese across-culture dyads were sensitive to problems in communication - supported by the lower communication success in this group - and tried to correct them using OIRs.

During conversation interlocutors follow a principle of least collaborative effort (Clark, 1996; Clark & Wilkes-Gibbs, 1986): over repeated social interactions they minimize their joint effort by producing increasingly succinct, yet informative, messages. Consistent with this principle, over repeated social interactions, dyads from each group progressively simplified the graphical signs used to communicate the experimental items. Doing so improved communication efficiency. The consistency of this pattern – the different groups reduced their joint effort to a similar extent over games – suggests the principle of least collaborative effort may be a universal principle of human communication. Interestingly, overall sign complexity was highest among the Japanese-Japanese dyads and lowest among the Western-Western dyads (with the Western-Japanese dyads in between). Experimental-semiotic communication games show that interruption is crucial to sign simplification and symbolization (Fay et al., 2018; Garrod et al., 2007). By selecting an item prior to the director completing their drawing, the matcher cuts short the trial, and this reduces sign complexity. Interruption, whether co-operative or intrusive, is a more frequent characteristic of conversation in English than conversation in Japanese (Murata, 1994). So, the difference in sign complexity scores observed in the present study may be due to a cultural difference, because the Japanese matchers interrupted the director less often, or later in the trial, compared to the Western matchers.

During conversation interlocutors align their communication behaviour (Brennan & Clark, 1996; Pickering & Garrod, 2004). Doing so not only signals communication success, but also improves communication success (Fay et al., 2018). Consistent with a general

alignment principle, over repeated social interactions dyads from each group increasingly used the same signs to communicate the same experimental items. The consistency of this pattern – the increase in behaviour alignment was similar across groups – suggests that alignment may be a universal principle of human communication. Whereas overall behaviour alignment was comparable across the within-culture dyads, it was lower for the across-culture dyads. Given that communication success and behaviour alignment are correlated (Fay, Lister, Ellison, & Goldin-Meadow, 2014; Fay et al., 2018; Fusaroli et al., 2012; Reitter & Moore, 2014), and that communication success was lower among the across-culture dyads compared to the within-culture dyads, this was to be expected.

5. Conclusion

Using an experimental-semiotic communication game, the present study offers preliminary evidence for several universal principles of human communication. Dyads from different cultural and linguistic groups (Western-Western, Japanese-Japanese, Western-Japanese) exhibited a range of similar communication behaviors. They (1) used iconic signs to bootstrap successful communication, (2) addressed breakdowns in communication using other-initiated repairs, (3) simplified their communication behaviour over repeated social interactions (i.e., were guided by a principle of least collaborative effort) and (4) increasingly aligned their communication behaviour over repeated social interactions (i.e. were guided by a behaviour alignment principle). While the across-culture dyads (Western-Japanese) found the task more challenging, and there were cultural differences in overall sign complexity, these basic communication principles were observed across all groups. Based on two distinct cultural and linguistic groups, the present study offers preliminary evidence

for several universal principles of human communication. To be confident of their 'universality', future research should test if these principles hold across a broader range of cultures and linguistic groups.

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7. References

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