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Analysing communicative diversity via the Stag Hunt

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Abstract. What is the influence of the diversity of the targeted audience on how and what is communicated? Although Gricean pragmatics studies the effect of context on *what* is being communicated, the question *how* things are communicated is mostly ignored. Moreover, the impact of the size (and thus expected diversity) of the targeted audience is typically not addressed at all. In this paper we will study these questions making use of game theory, the theory of rational interaction. In particular we will argue he above questions can be addressed making use of insights gathered on the equilibria solutions of the Stag Hunt game.

1 Introduction

The original stag hunt game traces back to 1773, when Rousseau proposed the story of a stag hunt to represent a choice in which the benefits of cooperation conflict with the security of acting alone. In the story, two individuals must each choose to hunt a stag or to hunt a hare. Hunting stags can only be successful with cooperation, while hunting a hare does not require the other players help. The idea is that the stag offers both hunters a lot more meat than the hare. Thus, the stag hunt obliges a choice between productivity and security. Studies show that cooperatively hunting stag will only come out in case the trust between the partners is high.

Communication behaviour can be characterised as either safely (explicit and polite language use), or more efficient but also more risky (implicit, using e.g. irony) as well (Sally, 2003; van Rooij & Sevenster, 2006). Therefore, modelling these strategic communication choices in terms of the Stag Hunt game seems very natural. And also here it holds that the form of communication depends on the level of trust between the participants involved.

Language Typologists note that there is a difference between languages used by a lot of people (e.g., languages used as lingua franca) and languages used by smaller groups. The latter languages tend to be much more specific and complex both syntactically and semantically. In this paper we will also sketch how the diversity between the different languages (lingua franca versus not) can be explained making use of insights gathered on the Stag Hunt game.

2 The Stag hunt

Rousseau's Stag Hunt is described by Lewis (1969) as a simple two-player symmetric game with two strict equilibria (if both ϵ and ϵ' are higher than 0): both playing Risky (hunting Stag) or both playing it Safe (hunting Hare). It is obvious that equilibrium $\langle$Risky, Risky$\rangle$ is payoff-dominant.

Stag hunt:

	Risky	Safe
Risky	$1+\epsilon, 1+\epsilon$	$-\epsilon', 0$
Safe	$0, -\epsilon'$	$1, 1$

Following Harsannyi and Selten (1988), we will say that Nash equilibrium $\langle a^*, b^*\rangle$ is risk-dominant iff for all Nash equilibria $\langle a, b\rangle$ of the game,

$$(U_i(a^*,b^*) - U_i(a,b^*)) \times (U_i(a^*,b^*) - U_i((a^*,b)) \geq$$
$$(U_i(a,b) - U_i(a^*,b)) \times (U_i(a,b) - U_i((a,b^*))$$

In the above example this is exactly the case for $\langle$Safe, Safe$\rangle$ if $\epsilon' \geq \epsilon$. For this reason, we will call a player *risk-loving* iff $\epsilon > \epsilon'$, he is *risk-neutral* iff $\epsilon = \epsilon'$, and he is *risk-averse* iff $\epsilon < \epsilon'$.

For the analysis in this paper it is useful to also consider the following non-symmetric variant of the Stag hunt game:

Stag hunt* :

	S_1	S_2
Risky	$1+\epsilon, 0$	$1-\epsilon', 0$
Safe	1,1	1,1

Also this game has two equilibria, $\langle$Risky, $S_1\rangle$ and $\langle$Safe, $S_2\rangle$, but in contrast to the previous game one equilibrium $\langle$Safe, $C_2\rangle$ is not a strict one: it doesn't matter what Column plays if Row plays Safe. If Row takes both Collumn strategies to be equally likely, the expected utility of playing Risky is higher/equal/lower than the expected utility of playing Safe if and only if $\epsilon > / = / < \epsilon'$, just as in the original Stag hunt.

3 Irony and metaphor

In western cultures we can think of the use of irony and metaphor as risky speech. In Easern cultures, instead, risky speech is being implicit: speaking with hints (where the likely costs are miscoordination, rather than irony, where the likely costs are insults). We can model the usefulness of irony in western cultures as follows, using two different types of audiences: intimates and strangers

Irony:

	Intimate	*Stranger*
Irony	$1+\epsilon, 1+\epsilon$	$-\epsilon', 0$
literal	$0, -\epsilon'$	$1, 1$

Te above payoffs can be at least partly explained by the following quote of Fowler:

> Irony is a form of utterance that postulates a double audience, consisting of one party that hearing shall hear and shall not understand, and another party that, when more is meant than meets the ear, is aware both of that more and of the outsiders'

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incomprehension. [It] may be defined as the use of words intended to convey one meaning to the uninitiated part of the audience and another to the initiated, the delight of it lying in the secret intimacy set up between the latter and the speaker. Fowler (1965, pp. 305-306)

The conclusion is indeed that the use of irony is risky, but can be advantaguous.

4 Risk of implicit communication

Suppose that two meanings, t_1 and t_2, can be expressed literally by m_1 and m_2, respectively.. In addition, however, we have a lighter expression m_u whose use yields a bonus of $\epsilon > 0$ above the others. If the relative probabilities of t_1 and t_2 are not shared between speaker and hearer, the benefit of communicating with a light expression must be very high in order to overcome the *risk* of miscommunication. We are going to discuss a case like that of game below.

implicit :

	S_1	S_2
Risky	$1+\epsilon, 1$	$1-\epsilon', 0$
Safe	$1, 1$	$1, 1$

The Safe strategy is to send the correct explicit message in the relevant state, while the Risky strategy is to use the light message with the underspecified meaning. S_1 and S_2 are the strategies that interpret the explicit messages in the expected way, and they interpret m_u as t_1 and as t_2, respectively. Unsuccessful communication has a payoff of 0, i.e., we assume that $\epsilon' = 1$; and the benefit of successful communication with the light underspecified expression m_u instead of the conventional explicit expression m_1 is ϵ, which is higher than 0. Notice that the speaker prefers to play Risky if she takes strategies S_1 and S_2 to be equally likely iff $\epsilon > 1$, (given that $\epsilon' = 1$).

The hearer interprets m_u as t_1 if he takes t_1 to be more likely, and he interprets m_u as t_2 if he takes t_2 to be more likely. The speaker's payoffs of these two strategies in the different situations are given by following tables:

t_1	S_1	S_2
Implicit	$1+\epsilon$	0
Explicit	1	1

t_2	S_1	S_2
Implicit	0	$1+\epsilon$
Explicit	1	1

The speaker doesn't know how the hearer will interpret the underspecified message m_u because she does not know whether the hearer will take t_1 or t_2 to be more likely. We have seen above already that if the speaker takes S_1 and S_2 to be equally likely, the benefit of using the underspecified message has to be at least 1, $\epsilon \geq 1$. But what if the speaker doesn't think strategies S_1 and S_2 are equally probable? Let us assume that the speaker believes with probability n that $P(S_1) > P(S_2)$ (and thus with probability $1 - n$ that $P(S_1) \leq P(S_2)$). It follows that the speaker takes implicit communication to be worthwhile in situation t_1 if and only if $n \times (1+\epsilon) > 1$. That is, for the expected utility of being implicit to be higher than the expected utility of being explicit it has to be the case that $\epsilon > \frac{1-n}{n}$.

Obviously, if n is very close to 0 the use of m_u will be a bad choice, but also for other choices of n, it probably won't pay to be implicit: if n is $\frac{1}{3}$ or $\frac{1}{4}$, for instance, the value of ϵ has to be 2, or 3, respectively, which seems to be much too high.

Being explicit is a *safe* strategy. It is optimal under the maximin strategy and the minimax strategy. Things are more complicated when expected utility is at issue, for now it also depends on the relative weight of n and ϵ. But the obvious, conclusion is always that it is safer to be explicit if—because of diversity— you don't know (for sure) what your conversational participants takes to be the most salient situation of T, and that it is risky to be implicit.

5 Risky lying or not?

As another example of risky communication, we will consider under which circumstances it is advantageous to lie. In this example, the preferences are diametrically opposed for one choice of action of column player. The two players of the game are speaker (the row-player) and hearer (column-player). Suppose the speaker wants the hearer to perform a certain action, say a_1, but that it is commonly known between speaker and hearer that the latter will only perform a_1 if he thinks the speaker is of a high quality. Otherwise, hearer will perform action a_2 which the speaker disprefers to a_1. In fact, the speaker is not of a high quality. The hearer, however, doesn't know this, which gives the speaker the possibility to mislead her conversational partner by lying about her quality. Thus, the speaker has two strategies: she either is honest, or lies about her quality. We assume that the hearer will always perform action a_2 in case the speaker is honest about his low quality. However, in case the speaker says that she is of a high quality, and thus is lying, the speaker might be able to verify (or better, falsify) what the speaker says. Thus the hearer has now two strategies: he either checks whether what the speaker said is true or he trust the speaker on her words. In the actual situation where the speaker has a low quality, this means that if the hearer does not check the truth of what the speaker said, he will play a_1, otherwise he will play a_2. Moreover, we will assume that the hearer will punish the speaker in case he finds out that the latter was lying. In that case the hearer gets, let us say, a payoff of $-\epsilon$. This situation might be described by the following kind of utilities for the speaker (where v stands for the action of verifying):

	'I am low' $\rightarrow a_2$ 'I am high' $\rightarrow \neg v + a_1$	'I am low' $\rightarrow a_2$ 'I am high' $\rightarrow v + a_2$
Lying	$1, 0$	$-\epsilon, 1$
Honest	$0, 1$	$0, 1$

We want to know under which circumstances it is still favorable for the speaker to lie. Suppose n is the probability that the hearer will not verify whether the speaker is lying. We want to know what the value of ϵ should be in order for it to be beneficial for the speaker to lie. This is so if the expected utility of lying is higher than the expected utility of being honest, $EU(lying) > EU(honest)$. This is the case when $n > (1-n)\epsilon$. This inequality this gives rise to the function $\epsilon = \frac{n}{(1-n)}$, which can be plotted in the following graph.

Table 1 :

	$n + n\epsilon < \epsilon$ ('I am t_L' is best) iff
$n = 0$	always
$n = 0.25$	$\epsilon > \frac{1}{3}$
$n = 0.5$	$\epsilon > 1$
$n = 0.7$	$\epsilon > \frac{3}{2}$
$n = 0.75$	$\epsilon > 3$
$n = 0.8$	$\epsilon > 4$
$n = 0.9$	$\epsilon > 9$
$n = 1$	impossible

We can certainly assume that the cost of lying in case you are verified is higher than its potential benefit. Thus $\epsilon > 1$. The table above shows that if the chances that the hearer will verify the speaker's message increase, the benefit of lying, $1 + \epsilon$, has to increase rapidly in order for it to be expected.

6 Linguistic Complexity

In linguistics it is generally agreed that there are no differences in languages in terms of over-all complexity: all languages are supposed to be equally complex. Indeed, it is very unclear how to compare languages in terms of *theoretical complexity*. Should one compare languages in terms of the number of (syntactic) rules it can be described theoretically? But how then to compare a language with more but less complex rules against another language with less rules which are more complex? Moreover, given that the rules used to describe the language are theory-dependent, which theory should be used to describe the languages? On the other hand, Jacobson (1929) argued that the more diffuse the geographical range of languages, the simpler the system, because of ease of learning and discrimination, or understanding. In dialectology Trudged (2001) argued that languages differ in complexity, both in their phonology, morphology and syntax, and that these differences can be related to characteristics of speech communities. Others (e.g. Thurston, 1992; McWhorter, 2001) have argued that elaborateness and esotericity are more likely to be found in small closed speech communities, where the language has more a symbolic than a communicative function; languages used by larger populations tend to be less complex.

In this paper we will follow Kusters (2003), who studied complexity from an *empirical* point of view. He defines complexity from the point of view of an *outsider*. An outsider, in turn, is defined as a non-native speaker who learns the language at a later stage, who does not have much shared background knowledge with other members of the speech community, and is more interested in clear transmission of information than in expressing personal and group identity and aesthetic feelings.

He finds that languages typically used as 'lingua franca' (such as Arabic, Quechua, Swahili) are more adapted to outsiders, ie. less complex. In communities where a more complex language is spoken, emphasis is laid on native language learning, production and symbolic use.

Let us represent the situation as a game. We assume that the speaker either uses a complex language or a simple one. The hearer is either an insider (an 'Inner') or an outsider (an 'Outer').

Language game :

	Inner	Outer
Complex	$1+\epsilon$,$1+\epsilon$	$0,0$
Simple	$1,1$	$1,1$

If n is the chance that the speaker meets an insider, the expected utility of using a complex language, $EU(C)$, is $n \times (1+\epsilon)$, while the expected utility of using a simple language, $EU(S)$, is 1. It depends on both ϵ and n when it pays off to use a complex language. For instance, if $\epsilon > 1$, it pays of to use a complex language if you think it is at least as likely that the hearer is an insider than that (s)he is an outsider. In general, $EU(C) > EU(S)$ iff $n > \frac{1}{1+\epsilon}$.

This shows that using a complex language only pays off if you have a good chance to meet an insider. In case you want to communicate a lot with outsiders, it is better to use a simple language. It follows that languages that are used a lot as 'lingua franca', such as Arabic, are by this analysis predicted to be simpler (in the above mentioned sense) than those not used as a lingua franca. As such, our analysis of risky speech seems a natural model to account for the data found by Kusters (2003).

The use of language (at least) fulfils two functions. On the one hand, they are used to reliably communicate information. On the other hand, they can be used to express one's own identity, or that of the group to which one belongs. The above considerations suggest the natural conclusion that for languages used as lingua franca, the second function is less important than for more 'local' languages.

7 Conclusion

Sally (2003) discusses how the notion of 'risk' might be important in conversational situations between speakers and hearers. In van Rooij & Sevenster (2006) it is shown how Sally's work can be embedded within Lewisian signaling games, and how some additional ways of speaking can be considered to be risky. In this paper we extended this work again, by making a link between the extend of diversity between speaker and hearer and the risk that is (rationaly) taken by the speaker, and by suggesting the complexity of languages can be explained in terms of risky linguistic behavior as well.

In a sense, these insights were already present in Hume's Treatise:

> Two men who pull the oars of a boat, do it by an agreement or convention, tho' they have never given promises to each other. Nor is the rule concerning the stability of possession the less derived from human conventions, that it arises gradually, and acquires force by a slow progression In like manner are languages establish'd by human conventions without any promise.

> Two neighbors may agree to drain a meadow, which they posses in common; because 'tis easy for them to know each others mind, and each may perceive that the immediate consequence of failing in his part is the abandoning of the whole project. But 'tis difficult, and indeed impossible, that a thousand persons shou'd agree in any such action.

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