Language and Coordination Games*

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1 Introduction

Intuitively, if players can communicate, they should be able to reach coordinated play in a coordination game. However, simply adding a communication stage before the play of the game does not render coordination as a unique prediction. This multiplicity of equilibria prevalent in cheap talk games is not alleviated by refinements often applied in signaling games because every message is equally costless.

Farrell [9] and Aumann [1] both propose equilibrium refinement by assuming that if the sender's statement of intention is credible, it should be believed and thus coordination should be achieved. Farrell [9] argues that the sender's cheap talk statement regarding planned behavior is credible if it is *self-committing.* In other words, if the sender believes that the statement will be believed, the sender will have the incentive to follow through. Aumann [1], on the other hand, argues that, in addition to being *self-committing*, a credible cheap talk statement must also be *self-signalling*; that is, the sender wants it to be believed only if the sender indeed plans to carry it out.

Farrell [9] and Aumann [1] both make their cases informally, and although Baliga and Morris [2] formalize Aumann's intuition, they do so only by changing the game into one with incomplete information. On the other hand, we obtain qualitative results similar to [2] and [1] both formally and without changing the game.

We observe that a common language is a prerequisite for effective communication;yet, language itself is absent from cheap talk models. We explicitly model the existence of a common language in one-sided cheap talk extension of static complete information games by restricting beliefs on how messages are used when information is believed to be transmitted. We show that if the stage game is both *self-committing* and the *self-signaling*, then every iteratively admissible outcome in the language model constitutes a coordinated play and gives the Sender her Stackelberg payoff. We also identify a class of games that violate the

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		Receiver's actions	
		Go out	*Stay in*
Sender's actions	*Go out*	1	0
	Stay in	0	1

Table 1. 2x2 game

	"I will go out"	"I will not go out"
Constant Out	*Go out*	*Go out*
Constant In	*Stay in*	*Stay in*
Literal	*Go out*	*Stay in*
Perverse	*Stay in*	*Go out*

Table 2. Set of Receiver Strategies in a 2x2 game

self-signaling condition where every iteratively admissible outcome of the stage game is also an iteratively admissible outcome in the language model.

We do not sharpen the prediction by assuming away any outcome—in that every equilibrium outcome in the standard cheap talk model remains an equilibrium outcome in our language model. Thus, our results are driven by the combination of iterative admissibility and common knowledge of language.

The remainder of this paper is structured as follows. Section 2 models a common language in 2x2 games and provides intuition on the role of the self-signaling condition. Section 3 describes the language model in general. Section 4 presents the main results. Section **??** discusses a crude language. Section **??** discusses some related literature, and Section 5 concludes.

2 Motivating Examples

2.1 Modeling Language

Consider a complete information game between a Sender (S, she) and a Receiver (R, he) as in Table 1 where the numbers represent R's payoffs. This setup represents all 2x2 games where R does not have a dominant action. Call this the stage game.

In this game, when R acts, R knows only that S's action belongs to $\{Go\ out, Stay\ in\}$. Suppose S has an opportunity to convey information about her action before they play the stage game by saying either "I will go out" or "I will not go out". Denote the message set by M. After S speaks, R may either believe (a) that he learns S's action, in which case his subjective information system consists of two information sets, $\{Go\ out\}$ and $\{Stay\ in\}$, or (b) that he has not learned anything from S's statement and, therefore, retains his original information set $\{Go\ out, Stay\ in\}$. Using information transmission as the primitives for strategic choice, a pure strategy (behavioral strategy) for R should assign an action (the probability to play *Go out*) to every information set in R's subjective information system, whereas a pure strategy for S should consist of an action, a^S, and the information she delivers. Because S either lets R know her action or does not, the information she delivers is either her action $\{a^S\}$ or the trivial information $\{Go\ out, Stay\ in\}$. These strategies do not reference messages and are called information strategies.

The standard model of this cheap-talk extension game uses messages to represent the strategic aspect of information transmission. In this model, S's strategy space is $M \times A^S$, and R has four strategies as listed in Table 2. Call these strategies message strategies. This model of communication never reduces the stage game multiplicity of predictions.[1]

We argue that this multiplicity arises because language is absent in the standard model. The two messages "I will go out" and "I will not go out" can be replaced with anything else (e.g., "drink coffee" and "eat cake,") without changing the game. In addition, the *Literal* strategy and the *Perverse* strategy are essentially the same in that they both respond to one message by going out and the other message by staying in, albeit in reversed labeling. A rational Receiver that believes that the Sender will let him know whether she will go out or stay in may use either *Literal* or *Perverse* depending on his belief of how the Sender uses messages. A rational Receiver who believes that the Sender will convey the information as to whether she will go out may still believe that he will not learn the Sender's action and use a constant strategy because he is uncertain how the Sender uses messages to convey the information. In other words, the Receiver's belief about what he will learn after the Sender speaks depends not only on his belief of what information the Sender will convey (information strategy) but also on his belief of how the Sender uses messages.

Suppose the Sender and the Receiver speak the same native tongue and come from the same cultural background. There should be no uncertainty about how messages are used; the only question is what information will be transmitted. After all, a common language provides a focal way to use messages to transmit information. Using the framework with information strategies, a common language implies that R believes he will learn whether S will go out if R believes that S will deliver such information. Condition 2.1 expresses this idea using message strategies.

If R believes that S will let him know whether she will go out or not, then R believes that S uses "I will go out" to mean that she will go out and "I will not go out" to mean she will stay in.

This condition renders the two messages asymmetric when information is expected to be transmitted. On the other hand, when R believes that S will not convey any information, language plays no role and the two messages are symmetric and give the Receiver the same information, namely, no information. Because they belong to the same information set, they should be assigned the

[1] Every stage game equilibrium outcome is the outcome of a babbling equilibrium in this cheap-talk extension game. In a babbling equilibrium,the Receiver uses a constant strategy, and thus the Sender is indifferent between messages and might as well randomize and reveal no information.

	"I will go out"	"I will not go out"
Constant Out	*Go out*	*Go out*
Constant In	*Stay in*	*Stay in*
Literal	*Go out*	*Stay in*

Table 3. Set of Receiver strategies in a 2x2 game with language

same action. This point is clear in the information framework. Condition 2.1 expresses this symmetry using message strategies.

If R believes that S will not let him know whether she will go out or not, then R uses constant strategies.[2]

With these two conditions, each information strategy is represented by one message strategy. For example, for R who believes he will learn whether S goes out, R's information strategy that matches S's action is described by the message strategy *Literal*; for R who believes he will not learn S's action, R's information strategy that chooses *Go out* at his sole information set is described by the message strategy *Constant Out*. S's information strategy that uses action *Stay In* and conveys trivial information $\{Out, In\}$ is described by choosing *Stay In* and saying "I will go out"; S's information strategy that uses action *Stay in* and conveys the information $\{In\}$ is described by choosing *Stay in* and saying "I will not go out". Note that when S uses the latter strategy, R will receive the information $\{In\}$ only if R believes that S can convey such information and interprets the message "I will not go out" as such. If R believes that S will not convey such information, R will interpret the message as conveying only the trivial information.

In a world with common language where R is rational, the support of R's strategy must belong to Table 3. Modeling language as a direct restriction on the Receiver's pure strategy set can be viewed as a short cut to modeling communication with a common language and common knowledge of rationality. We take this short cut to incorporate language because an epistemic analysis is not the focus of this paper.

[2] Condition 2 is an implication of rationality unless R believes that S does not convey information and R holds a non-generic belief about S's actions such that R is indifferent between actions. When R holds such a belief, all mappings from M to A^R (including constant mappings) are R's best responses and the two messages are completely symmetric. If S believes that R holds such a belief, then there is no reason why one message is better than the other. Condition 2 uses constant strategies to represent this symmetry. If we take the superficial differences between messages seriously, then Condition 2 does restrict the strategy space of the Receiver who holds such a belief. This is not a real restriction because restating both conditions as "if S believes R believes..., then S believes R..." does not change the conclusions. This restatement implies that the R's pure (behavioral) strategy space is all mappings from M to A^R (ΔA^R) . We do not choose this definition because it makes the description more cumbersome without achieving more.

		Receiver's actions	
		Opera	*Club*
Sender's actions	*Opera*	2,1	0,0
	Club	0,0	1,2

Table 4. Battle of Sex Game

	"opera"	"club"
Constant Opera	*Opera*	*Opera*
Constant Club	*Club*	*Club*
Literal	*Opera*	*Club*

Table 5. Receiver's Strategies in Battle-of-the-Sex Game with Language

2.2 A Self-signaling Coordination Game

In the battle-of-the-sexes game in Table 4, there are two pure strategy Nash equilibria: both go to the *Opera* and both go to the *Club*. The Sender prefers the first equilibrium and the Receiver prefers the second. A Pareto inefficient mixed strategy equilibrium also exists. The promise "I will go to the opera" is self-committing because if the Sender thinks that the Receiver will believe this statement and play his best response, *Opera*, the Sender would prefer to go to the *Opera* and carry out her promise. The promise is also self-signaling because, had the Sender not intended to go to the *Opera* (i.e. she intended to go to the *Club*), she would prefer the Receiver to go to the *Club* instead of the *Opera* and, hence, would not want the Receiver to believe the promise "I will go to the opera."

Following the previous discussion of the cheap-talk extension game with a common language, the support of a rational Receiver's strategy belongs to table 5. If the Sender believes that the Receiver is rational, then sending the message "opera" and going to the *Club* is weakly dominated for the Sender by sending the message "*club*" and going to the *Club*. This is because if the Sender is going to the *Club*, she prefers the Receiver to go to the *Club*. If what the Sender says affect what the Receiver does, she gets her preferred action only if she says "*club*." Likewise, the strategy ("*Club*", *Opera*) is weakly dominated for the Sender by the strategy ("*Opera*", *Opera*).

Given this, both constant strategies for the Receiver are weakly dominated by the strategy *Literal*. Thus coordinated play is always achieved by sending the right message. Because the Sender prefers (*Opera*, *Opera*) to (*Club*, *Club*), the optimal strategy for her is to say "opera" and go the the *Opera*. Thus, we obtain the unique outcome that the Sender and the Receiver coordinate on the Sender's preferred equilibrium.[3]

[3] The same argument goes for symmetric coordination games. The point here is to illustrate speaker advantage.

		Receiver	
		$Invest$	$NotInvest$
Sender's actions	$Invest$	$2, 2$	$-1, 1$
	$NotInvest$	$1, -1$	$0, 0$

Table 6. Investment Game

	"*invest*"	"*not*"
Constant Invest	Invest	Invest
Constant Not	Not	Not
Literal	Invest	Not

Table 7. Receiver's Strategies in Investment Game with Language

2.3 A Coordination Game Violating Self-signaling Condition

The investment game in Table 6 illustrates the role of the self-signalling criterion. This game contains three equilibria. $(Invest, Invest)$ is the unique Pareto efficient equilibrium. The promise "I'm going to invest" is self-committing but not self-signaling because if the Sender intends to choose Not, possibly due to lack of confidence that the Receiver is really going to $Invest$, she still prefers the Receiver to use the strategy $Invest$, and thus, as Aumann argues [1], this promise is not credible because the Sender would like the Receiver to believe her promise regardless of her intended action.

In the game with a common language, rationality implies that the support of the Receiver's strategy belongs to Table 7. Given this, sending message "*not*" and choosing $Invest$ is weakly dominated by sending the message "invest" and choosing $Invest$, because when the Sender invests, she prefers that the Receiver invest, and whenever talking affects the outcome, she gets her preferred action only by saying "invest." Because the Sender has the same preference regarding the Receiver's actions no matter which action she takes, the same argument shows that ("*not*", Not) is weakly dominated by ("*invest*", Not). Thus, only the message "invest" survives. The Sender may choose $Invest$ and deliver this information, but the Sender may choose $Not\ Invest$ and deliver trivial information. Therefore, if the Receiver believes that the Sender delivers trivial information and chooses $Not\ Invest$, he will use *Constant Not.* Because *Constant Not* cannot be ruled out by this reasoning, we cannot rule out the Sender strategy by which the Sender delivers no information and chooses $Not\ Invest$. The iterative process stops here.

2.4 Matching-Pennies Game

Consider the matching-pennies game in Table 8. If R is rational, then R's strategies in a world with common language can be represented in Table 9. Given this, both ("Heads",$Heads$) and ("Tails",$Tails$) are weakly dominated. Note that ("Heads",$Tails$) represent S's strategy to convey the trivial information

		Receiver	
		$Heads$	$Tails$
Sender's actions	$Heads$	$-1, 1$	$1, -1$
	$Tails$	$1, -1$	$-1, 1$

Table 8. Matching-Pennies Game

	"$Heads$"	"$Tails$"
$Constant\ Heads$	$Heads$	$Heads$
$Constant\ Tails$	$Tails$	$Tails$
$Literal$	$Heads$	$Tails$

Table 9. Receiver's Strategies in Matching-Pennies Game with Language

$\{Heads, Tails\}$ and then to choose $Tails$. If R reasons that S does not use weakly dominated strategies, then he also reasons that S will not convey any information and thus will use constant strategies because both messages give the same trivial information.[4] The language model provides a unique prediction in which no information is transmitted.

3 The Model

Let g denote a finite complete information game between the Sender (S, she) and the Receiver (R, he). Each player i chooses simultaneously an action $a^i \in A^i$ and obtains a payoff $g^i\left(a^S, a^R\right)$. We study the cheap talk extension game where S sends a costless message before S and R play the stage game g.

We denote the best response correspondences in g by $b^i : A^j \rightarrow A^i$ where $i, j \in \{S, R\}$ and $i \neq j$. (In following discussions, "*best response*" refers to the best response in the cheap talk extension game.) For simplicity, we assume that b^i is a function for $i = S, R$, and no action in g is weakly dominated.[5] Extend the definition to 2^{A^j} by defining $b^i(A)$ to be the set of best responses to all conjectures concentrating on $A \subset A^j$.

In the standard model G of this cheap talk extension game, a pure Sender strategy, denoted by s^S, belongs to $M \times A^S := S^S$, whereas a pure Receiver strategy, denoted by $s^R \in S^R$, is a function from M to A^R. As we argue in the previous discussion of modeling language, this setup is a model of communication without a common language. We now describe how the standard model G can be transformed into the language model G_L by adding restrictions on beliefs to

[4] This is by way of Condition 2.1. If we restate the conditions according to Footnote 2.1, all mappings from M to A^R are iteratively admissible in the language model. However, the conclusion remains that S does not convey any information and that R believes so.

[5] The conclusions in this paper go through without these assumptions. The assumptions make the proof easier to read.

incorporate the existence of a common language. We use iterative admissibility as the solution concept for G_L.[6]

3.1 Incorporating Language

We assume a large message set M that can express every decreasing sequence of subsets of Sender actions $A_1A_2...A_n$, denoted by "$A_1A_2...A_n$" and referred to as hierarchical claims. This can be achieved if M contains an expression for every $A_1 \subset A^S$ and an expression for concatenation such as "in particular". These expressions abound in any natural language just as sentences can be conjoined to form a paragraph of speech.

All hierarchical claims that share a beginning sequence $A_1...A_j$ are called a message branch, denoted by $M(A_1...A_j)$. They all express the same idea $A_1...A_j$, though differing in further details within A_j. Among $M(A_1...A_j)$, messages starting with $A_1...A_j(A_j \backslash A_{j+1})$ express the further idea $A_j \backslash A_{j+1}$. They are thus related to messages starting with $A_1...A_jA_{j+1}$ via negation. Two message branches related by negation, eg. $M(A_1...A_jA_{j+1})$ and $M(A_1...A_j(A_j \backslash A_{j+1}))$, are called a message bundle.

In the language model, a pure Sender strategy consists of an action and the information she delivers, whereas a pure (behavioral) strategy of R assigns an action (a probability distribution over A^R) to every information set R believes he may obtain, where the system of information sets R believes he may obtain is determined by what information R believes S will convey.[7] This model can be represented by the standard model G restricted to condition 3.1.[8]

If R believes that S will convey information as to whether she takes an action in A_1 or not, and if in A_1, in $A_2 \subset A_1$ or not, ..., and if in A_{j-1}, in $A_j \subset A_{j-1}$ or not, but not whether a^S is in $A_{j+1} \subset A_j$ or $A_j \backslash A_{j+1}$, then R believes that messages in $M(A_1...A_j)$ are used to convey the information that a^S is in A_1, in A_2, ... and in particular in A_j and that messages in $M(A_1...A_{j-1}(A_{j-1} \backslash A_j))$ are used to convey the information that a^S is in A_1, in A_2,... and, in particular, in $A_{j-1} \backslash A_j$, but all messages in $M(A_1...A_jA_{j+1})$ and $M(A_1...A_j(A_j \backslash A_{j+1}))$ belong to the same information set and are responded to with the same action.

Let "$A_1...A_n$" be a hierarchical claim and $a^S \in A_j \backslash A_{j+1}$ where $j \leq n$.[9] Then $\left(\text{"}A_1...A_n\text{"}, a^S\right)$ represents S's strategy that takes action a^S and conveys

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[6] The role weak dominance plays is to capture the idea that the Sender does not completely rule out the possibility that the Receiver is responsive to messages. If the stage game is such that order does not matter in applying iterative weak dominance, then order does not matter in the language model. This is because messages are costless for both the Sender and the Receiver, thus satisfying the necessary condition in [10] for iterative weak dominance to be order-independent.

[7] This is the framework with information strategies described in Section 2.1

[8] Rigourously speaking, the model should include belief hieararchies. We take this short cut because we only need the belief hierarchy to define rationality and a full-blown epistemic analysis is not the focus of this paper.

The discussion in footnote 2.1 applies as well.

[9] Let $A_0 = A^S$ and $A_{n+1} = \emptyset$.

information that her action belongs to A_1, A_2, ...and in particular A_j, but doesn't convey the information whether her action is in A_{j+1} or not. If R believes that S uses $\left(\text{“}A_1...A_n\text{”}, a^S\right)$, then R will respond to all messages in $M\left(A_1...A_j A_{j+1}\right) \cup M\left(A_1...A_j\left(A_j \backslash A_{j+1}\right)\right)$ with the same action, which belongs to $b^R\left(A_j\right)$ if R is rational.

In the language model G_L, rationality implies that any pure strategy R uses is a language-based response.

Definition 1. *s^R is a language-based response if for all decreasing sequence $A_1...A_j A_{j+1}$ in A^S, either s^R is constant on*

$$M\left(A_1...A_j A_{j+1}\right) \cup M\left(A_1, ..., A_j\left(A_j \backslash A_{j+1}\right)\right),$$

or $s^R(m) \in b^R\left(A_{j+1}\right)$ for all $m \in M\left(A_1...A_j A_{j+1}\right)$ and $s^R(m) \in b^R\left(A_j \backslash A_{j+1}\right)$ for all $m \in M\left(A_1, ..., A_j\left(A_j \backslash A_{j+1}\right)\right)$.

Consider again $A^S = \{a, b, c, d\}$. Denote by the capital letter of the Sender's action the Receiver's stage-game best response. In Figure **??**, the function *illegal* is not a language-based response because it responds to message “$\{a, b, c\}\{b\}$” with action $C \notin \{B\} = b^R(\{b\})$ but is not constant on $M\left(\text{“}\{a, b, c\}\{b\}\text{”}\right) \cup M\left(\text{“}\{a, b, c\}\{a, c\}\text{”}\right)$.

Condition 3.1 captures a common language without ruling out any outcome. In the language model, if the Sender knows that the Receiver is rational, the Sender knows that his strategy is represented by a language-based response. Knowledge of rationality alone, however, does not imply that S knows R's response to a particular message m. Note that every constant function from M to $b^R\left(A^S\right)$ is a language-based response. In addition, every equilibrium outcome in the standard model G is still an equilibrium outcome in the language model. It suffices to observe that, for any subset of undominated actions in A^R, a language-based response exists whose range is equal to that subset.

3.2 Solution Concept

Let $\left(I, \left(S^j\right)_{j \in I}, \left(U^j\right)_{j \in I}\right)$ be a normal form game. Denote by ΔX the set of probability distributions on X, and by $\Delta^+ X$ the set of probability distributions which put a positive weight on every element of X. We rewrite the definition of iterative admissibility taken from Brandenburger et al. [3].

Definition 2. *Fix $\left(X^j\right)_{j \in I} \subseteq \left(S^j\right)_{j \in I}$. A strategy s^i is weakly dominated with respect to X^{-i} if there exists $\hat{\sigma}^i \in \Delta X^i$ such that $U^i\left(\hat{\sigma}^i, s^{-i}\right) \geq U^i\left(s^i, s^{-i}\right)$ for every $s^{-i} \in X^{-i}$ and that $U^i\left(\hat{\sigma}^i, \hat{s}^{-i}\right) > U^i\left(s^i, \hat{s}^{-i}\right)$ for some $\hat{s}^{-i} \in X^{-i}$. Otherwise, say that s^i is admissible with respect to $\left(X^j\right)_{j \in I}$. If s^i is admissible w.r.t. $\left(S^j\right)_{j \in I}$, simply say that s^i is admissible.*

Definition 3. *Set $S^i(0) = S^i$ for $i \in I$ and iteratively define*

$$S^i(k+1) = \left\{ \begin{array}{c} s^i \in S^i(k) : \\ s^i \textit{ is not weakly dominated with respect to } \left(S^i(k)\right)_{i \in I} \end{array} \right\}.$$

Write $\cap_{k=0}^{\infty} S^i(k) = S^i(\infty)$ and $\cap_{k=0}^{\infty} S(k) = S(\infty)$. A strategy $s^i \in S^i(\infty)$ is called iteratively admissible.

Prior studies have shown that when there are only two players, a strategy is weakly dominated if and only if it is never a best response to a totally mixed strategy.

Lemma 1. *A strategy $\hat{s}^i \in X^R$ where $i \in \{S, R\}$ is admissible with respect to $X^S \times X^R$ if and only if there exists $\hat{\sigma}^j \in \Delta^+ S^j$ where $j \neq i$ such that $U^R\left(\hat{\sigma}^S, \hat{s}^R\right) \geq U^R\left(\hat{\sigma}^S, s^R\right)$ for every $s^R \in X^R$.*

Because we assume that no action in g is weakly dominated, in the language model, the set of admissible pure Receiver strategies is exactly the set of language-based Receiver strategies and all Sender strategies are admissible. Therefore, the analysis in Section 4 and **??** will start from the second iteration.

4 Results

In this section we generalize the intuition gained from the contrast between the battle-of-the-sexes game and the investment game.

Because the action set is finite, let

$$A^S = \{1, 2, ..., N\}.$$

Let ϕ denote a permutation of $\{1, 2, ..., N\}$. Define

$$m_{\phi, N-k} := A_1 ... A_{N-k-1} \{\phi(N-k)\},$$

and $M(\phi, N-k+1) := M(A_1 ... A_{N-k})$, where $A_j = A_{j-1} \backslash \{\phi(j)\}$ for $j \geq 1$ and $A_0 = A^S$. Messages in $M(\phi, N-k+1)$ claim literally that the action taken is not $\phi(1)$, not $\phi(2)$,...,and not $\phi(N-k)$. Message $m_{\phi,N-k}$ claims literally that the action taken is not $\phi(1)$,...,not $\phi(N-k-1)$, and in particular is $\phi(N-k)$.

4.1 A Sufficient Condition to Guarantee Stackelberg Payoff for the Sender

The formal definition of the *self-committing* condition is proposed by Baliga and Morris (2002).

Definition 4 (Baliga and Morris [2]). *The stage game g is self committing if $b^S\left(b^R\left(a^S\right)\right) = a^S$ for all $a^S \in A^S$.*

According to Aumann [1], a statement is *self-signaling* if the speaker would want it to be believed only if it is true. Baliga and Morris [2] formalize the definition as follows.

Definition 5 (Baliga and Morris [2]). *The stage game g is self-signalling (for the Sender) if $g^S\left(a^S, b^R\left(a^S\right)\right) > g^S\left(a^S, a^R\right)$ for every $a^S \in A^S$, and $a^R \in A^R$.*

Define the Sender's Stackelberg payoff to be

$$\max_{\tilde{a}^S} g^S\left(\tilde{a}^S, b^R\left(\tilde{a}^S\right)\right),$$

that is, her highest payoff in g if she were able to choose her action before the Receiver does. An action is the Sender's Stackelberg action if it achieves her Stackelberg payoff were she able to commit.

Proposition 1 gives a sufficient condition for the Sender to be guaranteed her Stackelberg payoff.

Proposition 1. *If the stage game g is self-signalling and self-committing, then every iteratively admissible strategy profile $\left(\left(m, a^S\right), s^R\right)$ in the language model gives the Sender her Stackelberg payoff.*

4.2 Games Violating Self-signaling Condition

Common language and weak dominance reasoning allows the Sender to convey information about her preference over A^R, which indirectly enables the Sender to convey information about her intention when g is *self-signaling* and *self-committing*. Therefore, if the Sender's preference over the Receiver's actions is invariant with her own intention, communication is not necessarily effective.

Proposition 2. *If g is self-committing and the Sender's preference over the Receiver's actions is independent of her own action, then for every $\left(a^S, a^R\right)$, there exists an iteratively admissible strategy profile $\left(\left(m, a^S\right), s^R\right)$ in the language model such that $s^R(m) = a^R$.*

5 Conclusion

We model a common language by adding restrictions on beliefs of how messages are used when information is expected to be conveyed. The language model does not rule out any outcome at hand. We show that, if the stage game is self-committing and self-signaling, then every iterative admissible outcome in the language model gives the Sender her Stackelberg payoff. On the other hand, if the stage game is self-committing but the Sender's preference for the Receiver's actions does not depend on her intended action, every iteratively admissible stage game outcome is also an iteratively admissible outcome in the language model.

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