Equilibrium Selection in Cheap Talk Games: ACDC Rocks When Other Criteria Remain Silent

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EQUILIBRIUM SELECTION IN CHEAP TALK GAMES: ACDC ROCKS WHEN OTHER CRITERIA REMAIN SILENT [1]

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Currently no refinement exists that succesfully selects equilibria across a wider range of Cheap Talk games. We propose a generalization of criteria based on credible deviations, such as neologism proofness and announcement proofness. According to our Average Credible Deviation Criterion (ACDC), the stability of an equilibrium is determined by the frequency and the size of credible deviations. In our experiment, we find support for the relevance of credible deviations. In addition, we find support for ACDC in settings where other criteria remain silent. ACDC also explains results from previous experiments.

KEYWORDS: cheap talk, neologism proofness, announcement proofness, credible deviation, ACDC, experiment.

1. INTRODUCTION

Crawford and Sobel (1982) showed how meaningful costless communication between an informed Sender and an uninformed Receiver can be supported in equilibrium. Their seminal paper inspired many applications ranging from the presidential veto (Matthews, 1989), legislative committees (Gilligan and Krehbiel, 1990) and political correctness (Morris, 2001) to double auctions (Matthews and Postlewaite, 1989; Farrell and Gibbons, 1989), stock recommendations (Morgan and Stocken, 2003) and matching

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markets (Coles, Kushnir, and Niederle, 2009). These cheap talk games are characterized by multiple equilibria which differ crucially in their prediction about how much information will be transmitted. Standard signaling refinements have no bite in this setting, as messages are costless. Hence, this raises the important issue of equilibrium selection. As of yet, however, no satisfying refinement exists that works well for a wide range of cheap talk games.

To overcome the selection problem, Farrell (1993) pioneered the approach of what we call credible deviations. Farrell observed that, in contrast to what is assumed in standard game theory, communication in real life is based on a pre-existing natural language.[1] Hence, out-of-equilibrium messages can be sent that.will be understood, although not necessarily believed. Farrell proposes a criterion, under which out-of-equilibrium messages, or neologisms, are credible and, hence, should be believed by a Receiver. Arguably, an equilibrium is not stable if some Senders can send a credible neologism that would induce a rational Receiver to deviate from equilibrium. Equilibria that admit no credible neologism are 'neologism proof.' Alas, neologism proofness is too effective and tends to eliminate all equilibria, in particular in games of a continuous nature. Matthews, Okuno-Fujiwara, and Postlewaite (1991) address important conceptual issues with neologism proofness and propose three alternative accounts of what constitutes a credible deviation. Unfortunately, these 'announcement proofness' criteria also fail to be predictive in most leading continuous games.

Partly for this reason, several other criteria have been proposed that distinguish between stable and unstable equilibria but are not founded on the idea of credible deviations. These criteria typically work in the situations for which they were designed, but fail to discriminate successfully across

[1] See Blume, DeJong, Kim, and Sprinkle (1998) and Agranov and Schotter (2009) for studies on the role of natural language in cheap talk games.

different Cheap Talk settings.

We take a different tack: we propose a criterion which is based on credible deviations but allows for a finer distinction than stable and unstable equilibria. Our first conjecture is that credible deviations matter, in the sense that an equilibrium which does not admit credible deviations is more stable than one that does. Our second conjecture is that credible deviations matter gradually: of two equilibria that allow for credible deviations,the one with smaller deviations will predict better and an equilibrium that allows only for small deviations will perform comparably to a similar equilibrium that allows no deviations at all. A binary stability criterion is appropriate for rational agents, but may unnecessarily lose predictive power when applied to human behavior, which is seldom completely in (or out of) equilibrium.

We formalize this in the Average Credible Deviation Criterion (ACDC). According to ACDC, the behavioral stability of an equilibrium is a decreasing function of its Average Credible Deviation (ACD), which measures the mass of types that can credibly deviate and the size of those induced deviations (as measured by the difference in Sender payoff between the equilibrium and deviating action). Comparable equilibria will perform better if they have a lower ACD on this account. In particular, ACDC selects in a game the equilibrium with the smallest ACD ('ACDC-equilibrium') as the most plausible one. Hence, an ACDC equilibrium may not be neologism proof, but still be a good – or at least the best – predictor of behavior.

We illustrate ACDC theoretically by a 'neologism dynamic,' a simple best response dynamic with the additional feature that Senders send credible neologisms which are believed by Receivers. In the game we study, the neologism dynamic supports the conclusions of ACD.

We carry out an experiment that allows us to test our two conjectures. First, do credible deviations matter? And second, do credible deviations matter gradually? The game we study is a continuous cheap talk game with veto threats, which is similar to the game Matthews (1989) analyzes, except that the disagreement point does not lie on the line. We vary the boundary parameter B specifying the interval $[0, B]$ from which Sender types are drawn. The game has the following key properties for $B \geq 120$. It only has a pooling and a size-2 semi-separating equilibrium (from now on 'separating equilibrium'). Furthermore, credible neologisms and credible (weak or ordinary) announcements are equivalent in this game. The pooling equilibrium is never neologism proof and the separating equilibrium is only neologism proof for $B = 120$. The ACD of both equilibria is increasing in B and the separating equilibrium always has smaller ACD than the pooling equilibrium. Our experimental design consists of three treatments: $B = 120$, $B = 130$ and $B = 210$.

Our results confirm our hypotheses. First, credible deviations matter, both within and across games. For $B = 120$, the neologism proof separating equilibrium performs significantly better than the pooling equilibrium. Furthermore, the separating equilibrium performs significantly better for $B = 120$ than for $B = 210$, when it is not neologism proof. Given the absence of a systematic empirical study of credible deviations, this is a relevant result in itself. Second, credible deviations matter gradually. In $B = 130$, the separating equilibrium performs significantly better than the pooling equilibrium. And the separating equilibrium performs better for $B = 130$ than for $B = 210$. The differences between $B = 120$ and $B = 130$ are small. This provides evidence that ACDC can predict the stability of (non-neologism proof) equilibria within and across games.

In addition, we show that ACDC-equilibrium exists and leads to meaningful results in settings that have been analyzed previously theoretically and experimentally. As we show in De Groot Ruiz, Offerman, and Onderstal (2010b), ACDC selects the (unique) maximum size equilibrium in the leading uniform quadratic case of the Crawford-Sobel game. In addition, the maximum size equilibrium becomes more stable as the bias parameter becomes smaller according to ACDC, which is not predicted by existing criteria. The main result of the scarce experimental work on (discrete) Crawford-Sobel games (Dickhaut, McCabe, and Mukherji (1995) and Cai and Wang (2006)) is that the maximum size equilibrium predicts best, but that there is overcommunication. This is picked up by ACDC and the neologism dynamic. We also look at how ACDC performs in a range of discrete games analyzed by Blume, DeJong, Kim, and Sprinkle (2001) and find that ACDC organizes the main features of the data. In De Groot Ruiz, Offerman, and Onderstal (2010a), we study a generalization of the current veto threats game and find that ACDC selects a unique (maximum) size equilibrium in these games.[2]

Our paper has the following structure. In section 2, we present our working model and discuss the related refinement literature in some detail. In section 3, we introduce ACDC and theoretically illustrate how a neologism dynamic supports its predictions. In section 4 we present the experimental design and in section 5 we present the experimental results. In section 6, we give a more general definition of ACDC. In section 7, we discuss different applications of ACDC. Section 8 concludes. All proofs are relegated to appendix A.

2. THE MODEL

The model is a two-player cheap talk game $\Gamma(B)$ between an informed Sender and an uninformed Receiver. The outcome of the game x is a point in

[2] The focus of our paper is on what makes communication of private information credible. A different strand of the experimental literature deals with the question how players can credibly communicate their intentions (Davis and Holt, 1988; Cason, 1995; Charness, 2000; Ellingsen and Johannesson, 2004; Gneezy, 2005; Charness and Dufwenberg, 2006; Lundquist, Ellingsen, Gribbe, and Johannesson, 2009; Serra-Garcia, van Damme, and Potters, 2010). Crawford (1998) provides a survey of papers on cheap talk experiments and DellaVigna and Gentzkow (forthcoming) review field evidence on persuasive communication.

the interval $[0, B]$, or the disagreement point $\delta \notin [0, B]$, where B stands for boundary. The Receiver's payoff $U^R(x)$ is common knowledge: he prefers smaller outcomes to larger outcomes. The payoff of the Sender $U^S(t, x)$ depends on her type t. The Sender's type t is uniformly distributed on the interval $[0, B]$. The larger the distance between x and t, the lower the Sender's payoff. Both players receive a payoff of 0 if δ is the outcome. The Receiver prefers all outcomes on the line smaller than 150 to δ; the Sender prefers δ to all outcomes on the line more than 60 away from her type t. More specifically:

$$
\begin{aligned}
& U^R(x) = 60 - \frac{2}{5}x \;\; \forall x \in [0, B] \\
(2.1) \qquad & U^S(t, x) = 60 - |x - t| \;\; \forall x \in [0, B] \\
& U^R(\delta) = U^S(\delta, t) = 0
\end{aligned}
$$

The game proceeds as follows. Nature informs the Sender of her type t. Subsequently, the Sender sends a message $m \in M$ to the Receiver (where $M \supseteq [0, B]$). Next, the Receiver proposes action $a \in [0, B]$. Finally, the Sender accepts or rejects action a. If the Sender accepts a, a is the outcome of the game; if she rejects a, then δ is the outcome. Note that all messages are costless to the Sender. In the remainder, we will restrict ourselves to $B \geq 120$ because this leaves the set of equilibrium actions unaffected. The model is close to the cheap talk game with veto threats of Matthews (1989), the main difference being that the disagreement point is not in the interval.

Following Matthews (1989), we look at a further refinement of perfect Bayesian equilibrium. First, we restrict the Receiver to play pure strategies. Second, we require that Senders who are indifferent between all messages (because they would veto all equilibrium actions) only induce actions that are payoff-maximizing to them (if they were to accept them). This refinement is based on Selten (1975)'s trembling hand perfection, as it lets the Sender consider the possibility that she would tremble and accept the proposal with a small chance. From now on, we will refer to a perfect Bayesian equilibrium satisfying these two requirements simply as 'equilibrium.'

An outcome of this game can be characterized by specifying the action $a(t)$ each Sender type t induces and which actions $v(t,a)$ type t accepts. $v(t,a)$ equals 1 if the Sender of type t accepts action a and 0 otherwise. It is easy to check that an outcome $\{a(t), v(t,a)\}$ is an equilibrium outcome if and only if:

$$
\begin{aligned}
& a(t) \in \arg\max_{a \in A} \int_0^B U^R(a) v(\tau, a) I(\tau) d\tau \ \forall t \\
& \quad \text{with } I(\tau) = 1 \text{ iff } a(\tau) = a(t) \text{ and } I(\tau) = 0 \text{ otherwise} \\
& t \in \arg\max_{t' \in T} U^S(t, a(t')) \ \forall t \\
& v(t,a) \in \arg\max_{v \in \{0,1\}} U^S(t,a) \cdot v \ \forall t, a
\end{aligned} \tag{2.2}
$$

There may be many equilibria that can induce the same equilibrium outcome. These essentially equivalent equilibria just differ in the message and action strategies leading to the same outcome. The game has two equilibrium outcomes: one pooling equilibrium outcome and one separating equilibrium outcome (for $B \geq 120$). For both equilibria, the set of actions the Receiver takes does not depend on B:

Proposition 2.1 $\Gamma(B)$ *has two equilibrium outcomes. In the pooling equilibrium outcome, all Sender types induce action* $a = 45$*. In the separating equilibrium outcome, all Sender types in the interval* $[0, 30]$ *induce action* $a = 0$ *and all Sender types in the interval* $(30,\ B]$ *induce action* $a = 60$*. The Sender accepts an action if and only it gives her positive payoff and rejects an action otherwise.*[3]

The intuition behind the proposition is simple. Players best respond in

[3] Senders who are indifferent can either accept or reject. Since the set of indifferent types has measure 0 in equilibrium, it does not matter what they do.

the following way. Given that the Receiver believes types are uniformly distributed in an interval $[\underline{t}, \overline{t}]$, he faces the following trade-off: as the proposal increases (up to $\overline{t} - 60$), the probability of acceptance increases, but the utility if accepted decreases. Senders choose to induce the proposal closest to their type. As in any cheap talk game, there is a pooling equilibrium where all Senders employ the same message strategy and the Receiver ignores all messages. We show that all equilibria must be partition equilibria and that the partition cannot have a size larger than 2. Since all equilibria with the same outcome are essentially equivalent, from now on we will use the terms 'the pooling equilibrium' and 'the separating equilibrium' as shorthand for 'any pooling equilibrium' and 'any separating equilibrium.'

At this point two questions arise. Is one equilibrium more plausible than the other? And does B influence the stability of the equilibria? We first look at theories of credible deviations. The neologism proofness criterion of Farrell (1993) is based on the concept of neologisms. Neologisms are out-of-equilibrium messages which are assumed to have a literal meaning in a pre-existing natural language. Farrell considers neologisms which literally say: "propose action $\overline{a}$, because my type is in set N." Farrell deems a neologism credible if and only if it is self-signalling. A neologism is self-signalling if (i) all types t in N prefer $\overline{a}$ to their equilibrium action $a(t)$, (ii) all types t not in N prefer their equilibrium action $a(t)$ to $\overline{a}$ and (iii) the best reply of the Receiver after restricting the support of his prior to N is to play $\overline{a}$.[4] We will denote credible neologisms by $\langle \overline{a}, N \rangle$. An equilibrium is neologism-proof if it does not admit any credible neologism. Farrell argues that only neologism proof equilibria are stable, since rational players would move away from equilibria which admit credible neologisms.

Matthews, Okuno-Fujiwara, and Postlewaite (1991) consider more elab-

[4] Farrell does not consider cheap talk games with veto-threats. In line with the trembling hand refinement, we assume that types induce a neologism if $U^S(t, \overline{a}) > U^S(t, a(t))$, even if they veto the neologism anyhow.

orate messages, called announcements, and propose three credibility criteria. Weakly credible announcements are similar to neologisms, but allow deviating types to distinguish amongst themselves. A weakly credible announcement that should be believed if the Receiver's realizes that types can send multiple announcements is a credible announcement. A credible announcement that survives a rigorous Stiglitz-critique is strongly credible. Equilibria that admit no (weakly/strongly) credible announcements are called (strongly/weakly) announcement proof. In our game, strong announcement proofness, announcement proofness and neologism proofness coincide.[5,6] Consequently, for ease of exposition we can limit our discussion of credible deviations to credible neologisms.

In our game two types of credible neologisms can exist. A 'low' neologism which roughly says "I am a low type and prefer 0 to any equilibrium action and so do you, so play 0," and a 'high' neologism which roughly says "I am a high type, and it is probable that I will not accept the highest equilibrium action, so it is better for both of us if you propose something higher." As the following proposition shows, the pooling equilibrium is never neologism-proof and the separating equilibrium is only neologism proof if $B = 120$.

PROPOSITION 2.2 *Let $B \geq 120$. The pooling equilibrium admits the credible neologisms $\langle 0, [0, 22.5] \rangle$ and $\langle \min\{B-60, 75\}, [\min\{\frac{B-15}{2}, 60\}, B] \rangle$. The separating equilibrium is neologism proof if $B = 120$. For $B > 120$, the separating equilibrium admits the credible neologism $\langle \min\{B-60, 80\}, [\min\{\frac{B}{2}, 70\}, B] \rangle$.*

For $B > 120$, neologism-proofness is silent about the stability of the separating equlibrium vis-a-vis the pooling equilibrium and about whether

[5] The reasons are that no weakly credible announcements exist that are not equivalent to a credible neologism (for similar arguments that there is at most a size-2 equilibrium) and that all types can send at most one credible neologism.

[6] All equilibria in Gamma are weakly announcement proof, but this is not so interesting as this holds in almost all cheap talk games.

the separating equilibrium is more stable if $B = 121$ than, say, if $B = 210$.

Rabin and Sobel (1996) propose the recurrent mop criterion, which can select equilibria that, although not impervious to credible deviations, are likely to recur in the long run, because they are frequently deviated to. Unfortunately, the authors define the recurrent mop for games with a finite number of actions as it may run into problems in continuous games, for instance because the deviation correspondence may not converge in these settings. For $\Gamma(B)$, one can additionally show that even if the deviation correspondence would converge, neither equilibrium lies in the deviation correspondence of the other for $B > 120$.[7] Since neither equilibrium is stable, neither equilibrium is recurrent for for $B > 120$.[8]

Partly due to the predictive problems of credible-deviation based criteria, several other approaches have been tried. Unfortunately, these tend not be predictive accross a wider range of Cheap Talk games, often because they are designed for particular settings.

The Communication Proofness (CP) criterion of Blume and Sobel (1995) singles out equilibria that would not be destabilized if new opportunities to communicate arose. CP looks for partitions that distinguish good and bad equilibria, where in each partition good equilibria cannot be destabilized by other good equilibria. An equilibrium survives CP if it is a good equilibrium in some such partition. In $\Gamma(B)$ all equilibria are stable according to CP, as in each equilibrium some Sender-type in each partition-element receives

[7] The deviation correspondence of the pooling equilibrium (the most interesting case), for instance, contains only message strategies with three messages (say 'low', 'medium' and 'high'). In any Receiver strategy in this correspondence, the Receiver proposes 0 after 'low ', 0 or 45 after 'medium' and some higher action after 'high'; furthermore, the correspondence will contain the strategy in which the Receiver proposes 45 after 'medium.' Hence, type t = 45 will seperate and send 'medium' in any best response to a full-support strategy of the Receiver. Because the deviation correspondence only contains message strategies with three messages, it will not converge to either equilibrium. A similar reasoning holds for the separating equilibrium.

[8] Rabin and Sobel's dynamic perspective on credible deviations was, nonetheless, an inspiration for the criterion we will propose.

her maximum payoff, so that no equilibrium can ever be destabilized.

The recently introduced No Incentive to Separate (NITS) (Chen, Kartik, and Sobel, 2008) is the only refinement based on some notion of stability up till now that can successfully select an equilibrium in the Crawford-Sobel setting. NITS starts by specifying a 'lowest type,' a type with the property that all other types prefer to be revealed as themselves rather than as that lowest type. An equilibrium survives NITS if the lowest type has no incentive to separate, i.e. if the lowest type prefers her equilibrium outcome to the outcome she would get if she could reveal her type. In Crawford Sobel, only the finest equilibrium outcome satisfies NITS (under some general monotonicity assumption). In our game, such a 'lowest type' can unfortunately not easily be formulated. All types in $[0, 60]$ are in fact lowest types according to Chen et al.'s definition. The pooling equilibrium survives NITS relative to types in $[37.5, 52.5]$, whereas the separating equilibrium is NITS relative to types in $[0, 37.5] \cup [52.5, 60]$. Still, one might argue that $t = 0$ is a natural lowest type in our game. Under this assumption, for each B only the separating equilibrium is NITS in our game. Hence, NITS would predict that the separating equilibrium is always stable regardless of B.

Finally, some may argue that the most influential equilibrium (i.e. the equilibrium which induces the largest number of actions) or the ex ante Pareto-efficient equilibrium is the most plausible equilibrium, aside of any stability considerations. In our game, these criteria predict thet the separating equilibrium is always chosen regardless of B.

Also non-equilibrium concepts exist, which predict no or little communication in $\Gamma(B)$. Rabin (1990) introduces the concept of Credible Message Rationalizability (CMR). This non-equilibrium concept proposes conditions under which communication can be guaranteed to happen. It assumes that rational players take truth-telling as a focal point, but use the strategic incentives of the game to check whether truth-telling is rational. In $\Gamma(B)$, CMR can only guarantee that the 0 type can send a communicative message (and is silent about what other types do). CMR requires that all Sender-types who send a communicative message receive an action in which they achieve their maximum payoff. In $\Gamma(B)$, this would imply that the Receiver does not best respond to communicative messages (of all types except 0), which is another requirement of CMR. [9]

Blume, Kim, and Sobel (1993) introduce Partial Common Interest (PCI). A partition of the typeset satisfies PCI "if types in each partition element unambiguously prefer to be identified as members of that element, and there is no finer partition with that property." PCI predicts no communication in $\Gamma(B)$, as no partition of the type space satisfies PCI. The main reason is that the highest Sender-type of a partition-element always prefers the Receiver to believe that the upper boundary is higher than the true boundary (except, of course, for types $t = 0$ or $t = B$). Finally, the 'partition' $\{0\}$ and $(0, B]$ is not PCI, as 0 (which is the best response if the Sender is 0) is also a best response to some Receiver-beliefs on the interval $(0, B]$.

In sum, existing criteria provide no or only a partial answer to the question how stable equilibria in $\Gamma(B)$ are for $B > 120$.

3. ACDC

In our view, the idea of credible deviations is sound, but a rationalistic binary division between stable and unstable equilibria is inadequate to fully capture the continuous and noisy patterns of human behavior. Our conjecture is that two aspects will affect the behavioral stability of an equilibrium. The first concerns the mass of types that can credibly induce a deviation. The smaller this mass, the lower the instability as the equilibrium will be disturbed less frequently. The second aspect concerns how much the devi-

[9] Rabin also introduces an equilibrium version of CMR, Credible Message Equilibria (CME), but as a consequence of the previous analysis, neither equilibrium in $\Gamma(B)$ can be a CME.

ation profile differs from the equilibrium profile in terms of Sender payoffs. The larger this difference is, the larger the perturbation to the equilibrium and the higher the incentive of the Sender to deviate become. As a consequence, if the deviating mass and the induced deviations from equilibrium are small, the equilibrium is likely to be a good predictor of behavior. In particular, if Senders and Receivers choose their actions in a noisy way, boundedly rational players may not notice the difference between equilibrium play and deviating play, so that the equilibrium may not be disturbed noticeably.

For instance, the separating equilibrium is not neologism-proof if $B = 121$. However, we do not expect behavior in the game $\Gamma(121)$ to be very different to behavior in $\Gamma(120)$. After all, the induced deviations from equilibrium are very small: types in $[60.5, 121]$ induce 61 instead of 60. Hence, Senders can at most earn 1 by deviating and, if they deviate, the resulting profile is very similar to the equilibrium profile.

In particular, if $B = 121$ the separating equilibrium seems more plausible than the pooling equilibrium, where neologism deviations are substantial ($\langle 0, [0, 22.5] \rangle$ and $\langle 61, [53, 121] \rangle$). Furthermore, the separating equilibrium seems more stable if $B = 121$ than if, say, $B = 210$, when types in $[70, 210]$ can credibly induce 80 rather than 60. As a consequence, Senders have a large incentive to deviate to a profile which is very different from the equilibrium profile. We formalize these ideas in the concept of the Average Credible Deviation (ACD). ACD is the expected value of credible deviations from equilibrium. More precisely, let $a^{\sigma}(t)$ be the equilibrium action induced by type t in equilibrium σ; and let $\overline{a}^{\sigma}(t)$ be the deviating action type t induces if she plays a credible neologism. Let $\overline{a}^{\sigma}(t) = a^{\sigma}(t)$ if Sender type t cannot play a credible neologism. Then we define the ACD of equilibrium σ as $ACD(\sigma) = E[U^S(t, \overline{a}^{\sigma}(t)) - U^S(t, a^{\sigma}(t))]$, which in $\Gamma(B)$ reduces to

$\frac{1}{B}\int_0^B \left\{U^S(t,\overline{a}^\sigma(t)) - U^S(t,a^\sigma(t))\right\} dt$. Note that the ACD of an equilibrium only depends on the equilibrium outcome.

Our hypothesis is that the theoretical ACD of an equilibrium is positively correlated with the empirical average error of prediction of an equilibrium. It allows us to establish which equilibrium is more stable within a game, and to compare the stability of similar equilibria across games. In particular, we can formulate the ACD-Criterion (ACDC) which selects those equilibria that have the smallest ACD. ACDC can select equilibria when neologism proofness is silent and reduces to the latter if neologism proof equilibria exist.

The following proposition gives the ACD of the pooling and separating equilibrium outcomes of $\Gamma(B)$.

Proposition 3.1 *The ACD of the pooling equilibrium outcome is equal to* $\frac{1}{4B}(B^2 + 30B - 12150)$ *for* $120 \leq B < 135$ *and equal to* $\frac{15}{4B}(8B - 405)$ *for* $B > 135$. *The ACD of the separating equilibrium outcome is equal to* $\frac{1}{4B}(B^2 - 14\,400)$ *for* $120 \leq B < 140$ *and equal to* $\frac{20}{B}(B - 75)$ *for* $B > 140$.

Corollary 3.2 *The ACD of the separating equilibrium is always strictly smaller than that of the pooling equilibrium for given* B. *Hence, only the separating equilibrium survives ACDC. Furthermore, the ACD of both the pooling and separating equilibrium is strictly increasing in* B.

We can now see why this model provides a good testing ground for our ideas. The game is interesting as it contains the features that makes (continuous) cheap talk games difficult to refine. In contrast to Crawford and Sobel (1982) and Matthews (1989), however, in our model non-trivial parameters exist for which some equilibrium is neologism-proof. Hence, our model allows us to test the relevance of neologism proofness in a continuous setting. Furthermore, it allows us to test the idea that stability is not all-or-nothing, as we can gradually increase the number of types that could send a neologism (in comparable equilibria) by increasing B.

To further illustrate the idea behind ADCD, we present a stylized dynamic. Consider the simplest best response dynamic, in which Sender and Receiver best respond to the other's strategy in the previous period. We again assume that Senders induce the action they prefer most. If Senders are indifferent, they randomize between their optimal actions. The outcome of the best response model depends very much on the initial conditions and we will look at the two natural starting points: a babbling strategy and a naive strategy. In the babbling strategy no information is transmitted: Senders randomize in the interval $[0, B]$ and Receivers take the optimal prior action 45 regardless of the message (this corresponds to a random level-0 in a level-k analysis). In the naive strategy all information is transmitted: Senders report their type and this is believed by Receivers (this corresponds to a truthful level-0 in a level-k analysis). If players babble in the first period, then the dynamic forever stays in this pooling equilibrium, regardless of the boundary. If players use a naive strategy in the first periods, then the dynamic converges to the separating equilibrium, regardless of the boundary. Hence, such a dynamic model cannot distinguish between the two equilibria nor between different values of B.

Now we introduce a small twist to create a 'neologism dynamic': Sender types who can send a credible neologism with respect to the Receiver's strategy in the previous round will do so and such a credible neologism will be believed. In all other respects, the dynamic is the same as above. If we analyze this dynamic for 3 values of B, ($B = 120$, $B = 130$ and $B = 210$), then we see that it leads to entirely different results. First, the outcome becomes less dependent on the initial conditions. Second, when the ACD is small, the dynamic converges to behavior that resembles the separating equilibrium. Finally, the dynamic converges to behavior that is closer to the separating equilibrium than the pooling equilibrium. (A level-k analysis yields qualitatively the same result as the best response dynamic.)

If $B = 120$, the dynamic converges to a steady state that corresponds to the separating equilibrium for both random and naive first-period strategies. If players have a naive strategy in period 1, then Senders realize in period 2 that they should send their type plus 60, leading to an inflation of language. Types higher than 60 pool at the highest message of 120. In period 3, Receivers recognize the language inflation and propose 0 to any message smaller than 120. In addition, they propose 60 if they receive 120. In period 4, the players are already in the separating equilibrium. Note that as long as the Receiver proposes 0 and an action higher or equal to 60, no neologism can be played.

Suppose players start with a babbling strategy. Then in period 2, Senders in $[0, 22.5)$ send a low neologism of 0 and Senders in $(57.5, 120]$ send a high neologism of 60. In period 3, the Receiver realizes that types who do not send a neologism accept 0, and propose 0 to them and 60 to others. As a result, in period 4 equilibrium is reached. This illustrates the selective power of neologism-proofness.

If $B = 130$, the dynamic starts out (for both initial conditions) similar to that of $B = 120$, but does not converge to the non-NP separating equilibrium. Instead, the dynamic converges to a four-cycle that, nonetheless, stays pretty close to the separating equilibrium.

If $B = 210$, the dynamic converges to a (non-steady) state, where the Receiver proposes actions $0, 30$ and 90, and the Senders in $(90, 210]$ send a neologism of 90. Hence, the dynamic does not come close to the separating equilibrium. We summarize the findings in the table I. Figure 1 shows the equilibrium outcomes and the attractors of the neologism dynamic.[10]

[10]We have held the discussion of the neologism dynamic informal. For proofs and

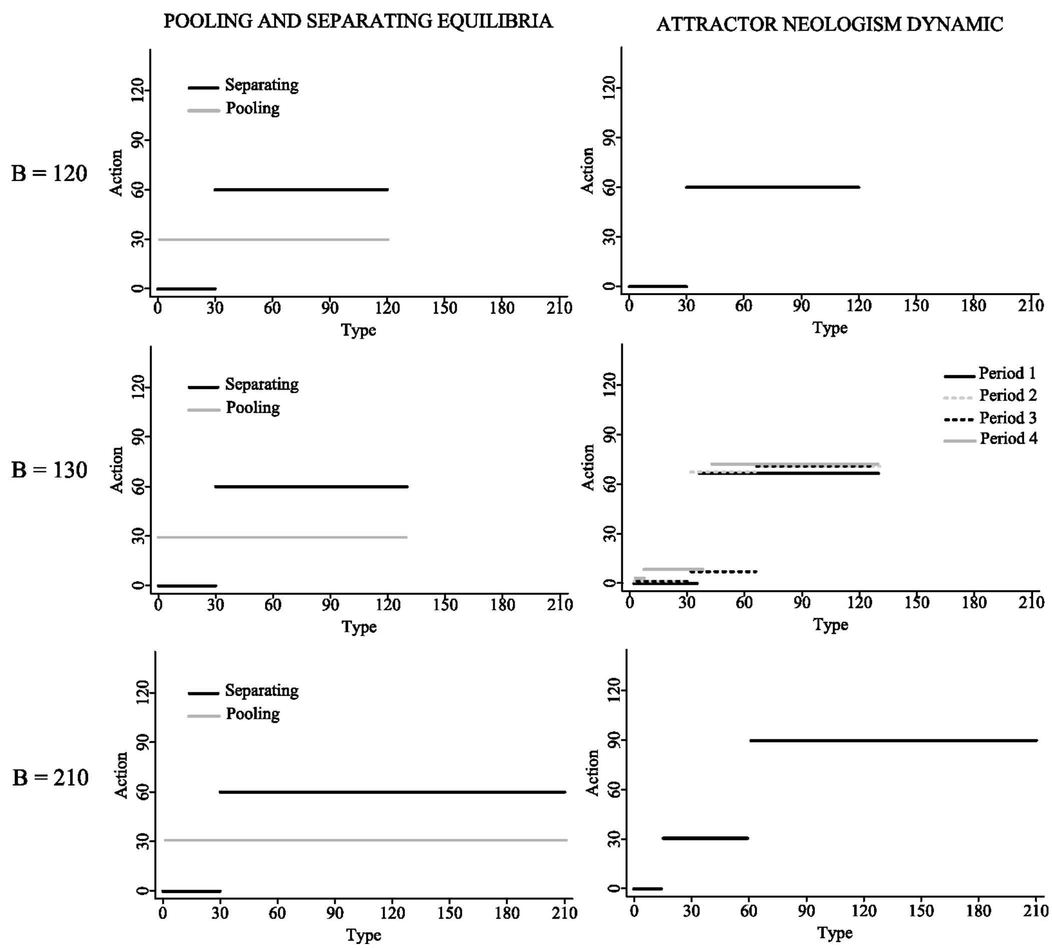

FIGURE 1.— The figure shows the type-action plots for the equilibria and the attractors of the neologism dynamics for boundaries B = 120, 130, 210. The left panels shows the plots for the separating (black) and pooling (grey) equilibria. The right panels show the plots for attractor of the neologism dynamic. For B = 120 and B = 210, the attractor is a single strategy profile. For B = 130, the attractor is a four-cycle.

TABLE I

Summary Properties Neologism Dynamic With Respect To Equilbria

Boundary B	Attractor (actions Receiver)	ACD Equilibria Pooling	ACD Equilibria Separating	Distance to Attractor Equilibria Pooling	Distance to Attractor Equilibria Separating
120	$0, 60$	12.2	0	22.5	0
130	$\{0, \frac{450}{7}\}; \{0, \frac{450}{7}, 70\}; \{0, \frac{50}{7}, 70\}; \{0, \frac{50}{7}, \frac{450}{7}\}$	16.6	4.8	29.4	11.5
210	$0, 30, 90$	22.8	12.9	40.7	27.9

Notes: This table summarizes the properties of the neologism dynamic for different values of the boundary B. The second column shows the actions the Receiver plays in the attractor. For B = 120 this is a steady state and for B = 210 an attracting strategy profile (which is no steady state). For B=130, the attractor is a four-cycle; hence the cell specifies the Receiver-actions for each of the four profiles in the cycle.The third and fourth column show the ACD of the pooling and separating equilibrium respectively. The fourth and fifth columns show how well the equilibria would predict, if agents would play the Neologism dynamic. In particular, the distance of the equilibrium to the attractor is defined as the expected distance between the action a type induces in equilibrium and the action a type induces in the neologism dynamic.

4. EXPERIMENTAL DESIGN AND PROCEDURES

We ran 3 treatments in which subjects played $\Gamma(B)$. We changed the boundary of the Sender's type between treatments from 120 ('B-120') to 130 ('B-130') to 210 ('B-210'). The treatments were identical otherwise. We used a standard procedure to recruit subjects from the student population of the University of Amsterdam. The computerized experiment was run at the CREED lab. The software was written with z-Tree (Fischbacher, 2007). At the start of the experiment, subjects were randomly assigned to the role of Sender ('chooser' in the terminology of the experiment) or Receiver ('proposer'). Subjects kept the same role throughout the whole experiment. Subjects read the role-specific instructions on paper at their own pace. (See appendix B for the instructions.) After reading the instructions, subjects had to answer several questions testing their understanding of the

details, we refer to appendix C. The calculations are straightforward, but tedious.

instructions. Only when all subjects had answered all questions correctly, the experiment started.

Subjects received a starting capital of 100 points. In addition, subjects earned points with their decisions in each of the 50 periods. (Subjects were informed that the experiment would last for approximately 50 periods.) At the end of the experiment, total point earnings were exchanged to euros at a rate of 1.5 euro for 100 points.

In a session, we ran 2 matching groups simultaneously, each consisting of 5 Senders and 5 Receivers. In every period, each Sender was randomly rematched with a Receiver in the own matching group. In total, 180 subjects participated who on average earned 25.5 euro in approximately 2 hours, with a minimum of 10.10 euro and a maximum of 33.70 euro. Each subject only participated once.

The procedure within a period was as follows. In each period, the Sender was informed of her own type. All subjects knew that each individual Sender's type in each period was an independent draw from the uniform distribution on $[0, B]$.[11] After having been informed of the own type, each Sender sent a message ('suggestion' in the terminology of the experiment) to the Receiver. The Receiver was informed of the message but not of the Sender's type. Then the Receiver chose an action ('made a proposal') that was either accepted or rejected by the Sender. Messages and actions had to be integers in $[0, B]$. [12] Payoffs were then calculated according to (2.1). At the end of the period, Senders and Receivers were informed of the state of the world (the Sender type) and all the decisions made by the pair they were part of. In addition, each subject was shown her own payoff and how

[11] To maximize the comparability of the treatments, we drew a set of types for one treatment and then rescaled this set for each of the other treatments.

[12] We chose for this message space instead of a free chat in order to be able to provide a history screen, facilitate learning and have data that can be interpreted clearly. Notice that the message space is rich enough for the communication of all credible neologisms in both equilibria, as in our game a neologism action uniquely identifies a credible neologism.

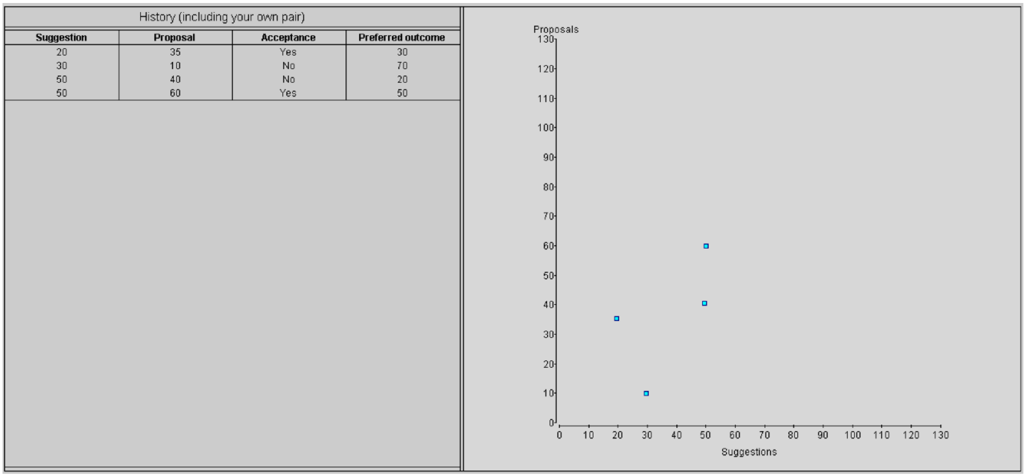

FIGURE 2.— Example of Social History Screen (for Senders)

it was calculated.

At any moment, subjects were provided with information about the social history in order to facilitate learning.[13] At the bottom of the screen they saw how play had unfolded in the 15 most recent periods in their own matching group. For Senders the information was organized as follows. The left-hand side showed a table summarizing the choices of the pairs in the own matching group. Each row contained a pair's suggestion (message), proposal, acceptance and preferred outcome (type of the Sender). The table was first sorted on suggestion, then on proposal, acceptance and finally on preferred outcome. The right-hand side showed the corresponding graph that listed the proposals as function of the suggestions. Figure 2 shows an example of the information that Senders received.

For Receivers the information was communicated in a slightly different way. In their table, each row listed a pair's suggestion, preferred outcome, proposal and acceptance. The table was first sorted on message, then on preferred outcome, proposal and finally on acceptance. In their graph, pre-

[13]Miller and Plott (1985) showed how a social history can help subjects understand the strategic nature of signaling games.

TABLE II

SUMMARY OF EXPERIMENTAL DESIGN

Treatment	Distribution Senders	# matching groups	Size matching group
B-120	U[0,120]	6	10
B-130	U[0,130]	6	10
B-210	U[0,210]	6	10

Notes: The three treatments only differ in the value of the boundary B.

ferred outcomes were shown as function of the suggestions.

Table II summarizes the main features of the experimental design.

5. EXPERIMENTAL RESULTS

We present the experimental results in two parts. In section 5.1, we deal with the issue of equilibrium performance (and therefore focus exclusively on the final 15 periods of the experiment). We find that credible deviations matter and matter gradually, as predicted by ACDC. In section 5.2, we will take a closer look at the dynamics in the data. All statistical tests have been done treating each matching group as one independent data point. For comparisons within a treatment we use Wilcoxon signed rank tests, and for comparisons between treatments we use Mann-Whitney ranksum tests. *, **, *** indicate significance at the 1%, 5% and 10% level respectively (for two-tailed tests).

5.1. *Equilibrium selection: neologism proofness and ACDC*

We start with some descriptive statistics of the final 15 periods of the experiment. Figure 3 presents a histogram of the actions the Receiver proposes in the three treatments. Recall that in each treatment the proposals generated in the separating equilibrium are equal to 0 and 60, while the proposals in the pooling equilibrium equal 45. In accordance with the sep-

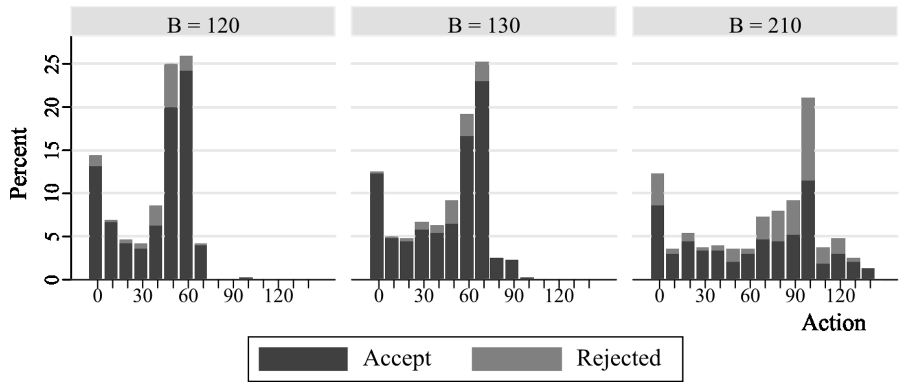

FIGURE 3.— The figure shows the histogram of the Receiver's actions for the three treatments. The bins run from [0,5], (5,15], ..., (B-5, B].

arating equilibrium, the histogram is bimodal in each treatment. The frequency of proposals equal to 60 steadily decreases with the boundary of the type space. Even though the histogram of B-210 is still bimodal, the (high) mode is relatively far from the equilibrium prediction. Note that the pooling proposal of 45 always receives only a modest number of hits in all treatments. Further, the percentage of proposals that are rejected increases with the boundary. Even though Senders' acceptance decisions are not perfectly in line with the model's assumption, they come pretty close. Conditioning on the cases where the Receiver's action leaves a positive amount of money on the table for the Sender, Senders accept in an overwhelming 95.9% of the cases.

Figure 4 plots the Receivers' actions as a function of the Senders' types for each of the three treatments together with the equilibrium predictions. Consistent with the separating equilibrium we find that Senders with low types tend to elicit an action of 0, while the Senders with high types tend to trigger a high action. The actions elicited by Senders with high types are much more spread out when the boundary equals 210.

Table III reports how often actual play was close to equilibrium. We say that an outcome is consistent with equilibrium if the actual proposal

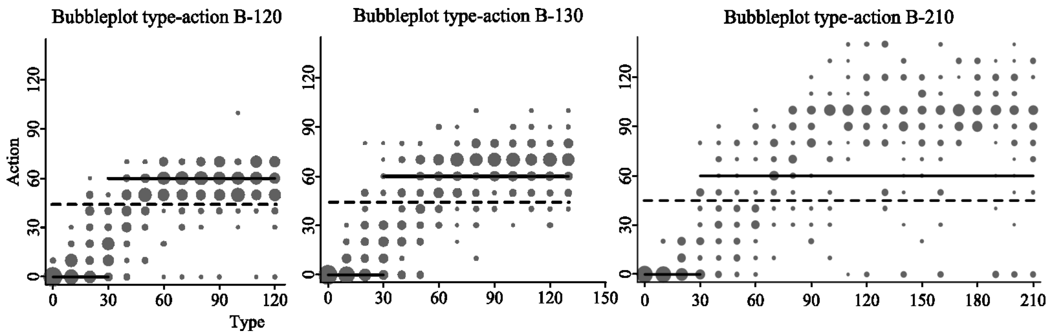

FIGURE 4.— This figure shows which types (x-axis) induced what action (y-axis) in the (last 15 periods of the) experiment. Bubbles are clustered on a 10-grid. Each bubble represents all observations in a $(t-5, t+5]/(a-5, a+5]$ neighborhood. The size of each bubble is proportional to the number of observations.

lies within a bandwidth of 10 and if the acceptance decision was correctly predicted. The absolute numbers in the table are obviously dependent on the chosen bandwidth. Here, we are interested in the relative magnitudes of the numbers, for which the exact level of the bandwidth turns out not to matter. In addition, the qualitative results are identical (and significant) if we compare the average (absolute) prediction error of the equilibria, which is a parameter-free measure of predictive success.

We first deal with the question whether credible deviations (and hence neologism and announcement proofness) have a bite. For this question, two comparisons are relevant. First, within treatment B-120 the separating equilibrium is neologism proof while the pooling equilibrium is not. In accordance with neologism proofness, more outcomes are consistent with the separating equilibrium than with the pooling equilibrium. The difference is both substantial and statistically significant. Second, when we move from treatment B-120 to B-210, the separating equilibrium ceases to be neologism proof. While the separating equilibrium does a good job in B-120, it organizes only a bleak minority of the data in B-210. This conclusion is valid when we take the data for all types as well as when we condition on

TABLE III

Percentage outcomes correctly predicted by equilbria

Boundary	All observations			Observations with $t \leq 120$		
	Equilibria		Diff	Equilibria		Diff
	Pooling	Separating		Pooling	Separating	
120	.39	.69	.30**	.39	.69	.30**
130	.13	.57	.43**	.14	.59	.45**
210	.09	.18	.09**	.09	.28	.19**
Diff 120-130$^{(1)}$	.25**	.12		.25**	.09	
Diff 120-210$^{(1)}$	.30***	.51***		.29**	.40***	
Diff 130-210$^{(1)}$	.05**	.39***		.05	.31***	

Notes: The table shows per treatment the median (over matching groups) of the percentage of correctly predicted outcomes by the equilibrium. We classified a prediction as correct if both (a) the distance between the predicted and observed proposal was not larger than 10 and (b) the acceptance decision was correctly predicted. We used the data of the last 15 periods. 'Diff' denotes 'difference'.

the outcomes with types less than 120. So also when we compare the behavioral stability of the same equilibrium across treatments, we find support for neologism proofness.

To investigate whether credible deviations matter gradually and ACDC is relevant, we ran treatment B-130. Here the separating equilibrium is no longer neologism proof but the ACD measure remains rather small relative to B-210. So if ACDC makes sense, the results of B-130 should be closer to B-120 than to B-210. Table III confirms that this is indeed the case. Like in B-120, the separating equilibrium is much more successful than the pooling equilibrium. The separating equilibrium attracts behavior a bit less in B-130 than in B-120, but the difference is not significant. (Since this result also holds when the analysis is restricted to observations with $t \leq 120$, this is not a measurement artefact due to a changing boundary but can be ascribed to credible deviations.) In contrast, the difference between B-130 and B-210 is much larger. In B-210, significantly fewer cases are consistent with the separating equilibrium than in B-130. So even though the separating

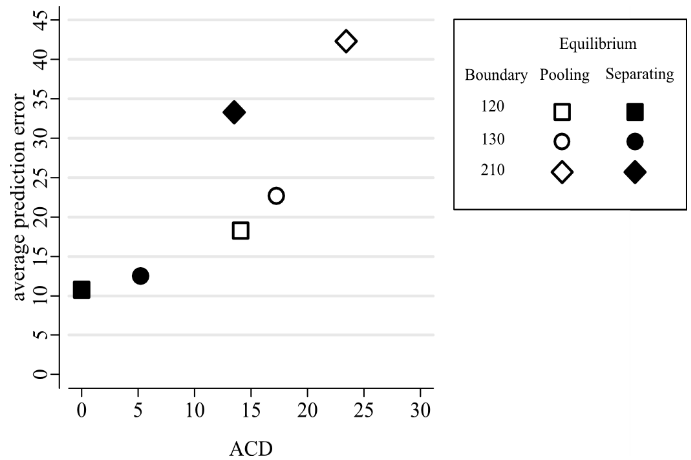

FIGURE 5.— The figure plots for each equilibrium in each treatment its theoretical ACD against its empirical prediction error. We report the median (over matching groups) of the average prediction error. Let $a^\sigma(t)$ be the equilibrium action of the Receiver given type t and $\widehat{a}_i(t_i)$ the observed action for observation i. Then the average prediction error (within a matching group) is $\frac{1}{n}\sum_i |\widehat{a}_i(t_i) - a^\sigma(t_i)|$. We used the data of the last 15 periods.

equilibrium is not neologism proof in either treatment, it traces the data much better in B-130 than in B-210, as predicted by ACDC.

The power of ACDC is further illustrated in Figure 5. This figure lists the mean prediction error of a particular equilibrium and treatment as a function of its ACD. In agreement with ACDC, the higher the ACD measure, the larger the mean prediction error tends to be. Notice in particular that the mean prediction error of the separating equilibrium only rises slightly when it just ceases to be neologism proof (relative to the differences with B-210).

5.2. *Dynamics*

In this section we deal with the question how subjects adapted their behavior during the experiment. Figure 6 shows plots of the messages sent by different types of Senders (left-hand side), plots of Receivers' proposals conditional on message received (middle) and plots of proposals triggered by different types of Senders (right-hand side). The data are separated between treatments and parts (first 15 periods versus last 15 periods). The type-message plots show that Senders' messages are higher than their types and that gradually Senders learn to exaggerate more. In the last 15 periods of each treatment, Senders overstate the true state more than in the first 15 periods. Thus, there is inflation in language.

Receivers' proposal-message plots provide the mirror image of Senders' type-message plots. That is, in the first part of the experiment Receivers tend to propose actions slightly below the messages received. In the final part of the experiment, Receivers have learned to subtract larger amounts from the messages received.

The type-action plots on the right hand side illustrate how close the actually triggered proposals are to the equilibrium predictions. For treatment B-130 and especially treatment B-120, the data are closer to the separating equilibrium in the final part of the experiment than in the first part of the experiment. A similar trend is not observed in B-210. To the contrary, in this treatment the data remain far from equilibrium throughout the whole experiment.

We now turn to the questions how easily subjects reached the separating equilibrium in the different treatments and when they did, how likely it was that they stayed there. Table V presents the relevant statistics separately for the first part and the final part of the experiment. In the first part of the experiment, subjects more easily reached the separating equilibrium from a state of disequilibrium in treatments B-120 and B-130 than in B-210. When subjects were approximately playing according to the separating equilibrium in the previous period, they were much more likely to stay there in treatments B-120 and B-130 than in treatment B-210. The lower part of the table shows that the differences between treatment B-210 and

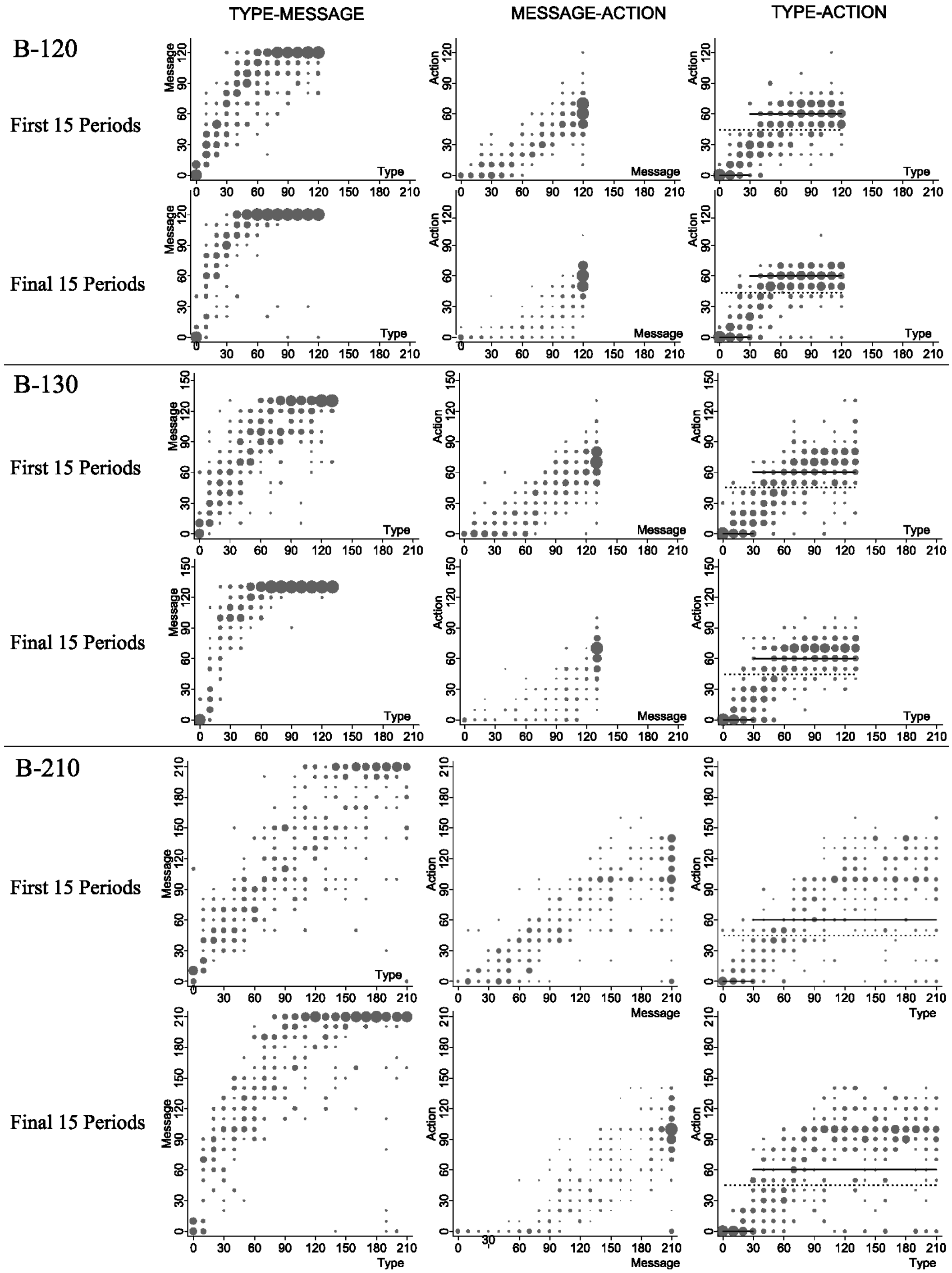

FIGURE 6.— This figure compares the chosen strategies (type-message, message-action) and the resulting profile for the first 15 and last 15 rounds. The bubbleplots are clustered on a grid of 10. In the last column, the solid line represents the separating equilibrium and the dotted line the pooling equilibrium.

the other treatments became even more pronounced in the final part of the experiment. It is striking that the separating equilibrium was rarely reached in treatment B-210 and in the cases where it was reached it turned out to be unstable.

Summarizing, the two main features of the dynamics in the data are (i) there is language-inflation and (ii) the separating equilibrium attracts behavior in B-120 and to a slightly lesser extent in B-130, but not at all in B-210. These two features are in line with the simple neologism dynamic described in section 3. Notice that the prediction errors of the separating equilibrium decrease over time in B-120 and B-130, but not in B-210. Also note that this pattern is in line with the neologism dynamic. In other words, the neologism dynamic traces the data well in the sense that it predicts that behavior will converge to the separating equilibrium in B-120, converge to non-equilibrium behavior that remains close to the separating equilibrium in B-130 and does not converge at all to the separating equilibrium in B-210.

6. ACDC FURTHER EXPLORED

In this section, we define and explore the ACDC for more general settings than the one above. This setting includes Crawford and Sobel (1982), Matthews (1989), our model as well as discrete Sender-Receiver games.

We consider the following two-player cheap talk game. The game is played by a Sender and a Receiver. At the beginning of the game, the Sender privately observes her (one-dimensional) type $t \in T \subset \mathbb{R}$, where T is the set of all feasible types. The Receiver's prior belief about the Sender's type is given by distribution function F, with $F(t') = \Pr\{t \leq t'\}$. (Note that this description includes any discrete type-set, as it allows intervals of payoff identical types.) In the next stage, the Sender chooses a message $m \in M$, where M is the set of feasible messages. After having observed the Sender's message, the Receiver chooses an action $a \in A$ where $A \subset \mathbb{R}$ denotes the

TABLE IV

CHANCE MATCHING GROUP IS IN SEPARATING EQUILIBRIUM CONDITIONAL ON PREVIOUS STATE.

		Previous state no equilibrium	Previous state equilibrium
Periods 1-15	B = 120	.46	.60
	B = 130	.41	.51
	B = 210	.10	.09
	Diff 120-130	.05	.09
	Diff 120-210	.36***	.51***
	Diff 130-210	.31***	.42***
Periods 36-50	B = 120	.64	.74
	B = 130	.50	.72
	B = 210	.03	.00
	Diff 120-130	.14	.02
	Diff 120-210	.60***	.74***
	Diff 130-210	.46***	.72**
Difference between periods 36-50 and periods 1-15	B = 120	.18**	.14*
	B = 130	.09	.21
	B = 210	.07	-.09

Notes: A matching group observation is classified as consistent with the separating equilibrium prediction if and only if the acceptance decision was predicted correctly and $|$ equilibrium proposal $-$ observed proposal $| \leq 10$ for at least 3 of the 5 pairs in the matching group; the middle column displays the fraction of equilibrium outcomes given that the previous outcome was not an equilibrium outcome; the right column displays the fraction of equilibrium outcomes given that the previous outcome was an equilibrium outcome.

bounded set of actions. After seeing the action, the Sender chooses to accept ($v = 1$) or reject ($v = 0$) the action. If the Sender rejects, the outcome is some disagreement point δ. If $\delta \in A$ the game has an interior veto threat and otherwise it has an exterior veto threat. In cheap talk games without veto threats, the Sender is forced to accept the action so that v is always 1.

The Sender's and the Receiver's utilities are given by $U^S(t, x)$ and $U^R(t, x)$ respectively for $x \in A \cup \{\delta\}$. Let ΔS denote the set of probability distributions over some set S. Then, a strategy for the Sender consists of a function $\mu : T \longrightarrow \Delta M$ and a function $\nu : T \times A \longrightarrow \Delta\{0, 1\}$ and a strategy of the Receiver is a function $\alpha : M \longrightarrow \Delta A$. $a(m)$ will denote the random variable of the Receiver's action after receiving m and $m(t)$ the random variable of the Sender's message after receiving t. Let $\sigma \equiv \{\mu, \alpha, v\}$ be a strategy profile and Σ the set of all strategy profiles. Finally, let the Receiver have prior and posterior beliefs over the Sender type, $\beta^0 = F$ and β respectively.

A perfect Bayesian equilibrium $\sigma^* = \{\mu^*, \alpha^*, v^*, \beta^*\}$ is characterized by the following four conditions:

$$
\begin{aligned}
& a \in \arg\max_{a \in A} U^R(t, a) E_t[\nu(t, a)|\beta^*] \;\forall\; a \in \text{support } (\alpha^*(.|m)) \\
(6.1) \qquad & m \in \arg\max_{m \in M} E_{a,v}[U^S(t, a) \cdot v|\alpha] \;\forall t \text{ and } \forall\; m \in \text{support } (\mu^*(t)) \\
& v \in \arg\max_{v \in \{0,1\}} U^S(t, a) \cdot v \quad \forall t \text{ and } \forall\; v \in \text{support } (\nu^*(t)) \\
& \beta^* \text{ is derived from } \mu \text{ and } \beta^0 \text{ using Bayes' Rule whenever possible}
\end{aligned}
$$

For cheap talk games with veto threats, one will often want to further refine the set of Bayesian Nash Equilibria (Matthews, 1989). Hence, let Σ^* be the possibly further refined set of Bayesian Nash Equilibria.

The starting point of ACDC is a theory of credible deviations γ. Such a theory associates a deviating profile $\gamma(\sigma^*) \in \Sigma$ with an equilibrium σ^*. A deviating profile specifies firstly which Sender types would deviate and in which way, and secondly, how the Receiver would react. We assume that an equilibrium outcome uniquely specifies a deviating profile outcome, as is the case with credible neologisms and announcements. If no type can send a credible deviation according to γ, then obviously $\gamma(\sigma^*) = \sigma^*$.

Let $a(m(t)))$ be the random variable of the action a Sender induces under σ^* and $a^\gamma(m^\gamma(t)))$ the random variable of the action a Sender induces under $\gamma(\sigma^*)$. We define the Average Credible Deviation (ACD) of an equilibrium σ^* relative to γ as:

$$ACD_\gamma(\sigma^*) = E_t E_{\gamma(\sigma^*),\sigma^*}[U^S(t, a^\gamma(m^\gamma(t))) - U^S(t, a(m(t)))] \tag{6.2}$$

Credible neologisms and credible announcements are the most natural existing concepts to base a deviating theory on. In case types can send multiple credible deviations, a deviating theory should also specify which one(s) Senders would use. (Note that in $\Gamma(B)$, all Senders can send at most one credible deviation.) Which theory of credible deviations predicts behavior best, is an empirical question about which actually very little is known. A theory based on credible neologisms tends to be more tractable as long as each type can send at most one credible neologism. A deviation theory γ based on announcement proofness has the elegant property that it need not specify which credible announcement will be used if more than one can be send. The reason is that if a type can send multiple credible announcements, she must have identical payoff in each of them.

Based on the ACD, we formulate the ACD-Criterion (ACDC), which says that an equilibrium σ^* will perform better (in the sense that it will have a lower average prediction error) than a comparable equilibrium σ if $ACD_\gamma(\sigma^*) < ACD_\gamma(\sigma)$. In particular, based on ACDC we can formulate the following selection criterion:

Definition 6.1 *An equilibrium σ^* survives ACDC relative to deviation theory γ if $ACD_\gamma(\sigma^*) \leq ACD_\gamma(\sigma)$ for all $\sigma \in \Sigma^*$*

The following results are immediate.

Proposition 6.2 *An equilibrium σ^* survives ACDC if $\gamma(\sigma^*) = \sigma^*$.*

If γ refers to credible neologisms, proposition 6.2 says that a neologism proof equilibrium survives ACDC.

Proposition 6.3 *If the number of equilibrium outcomes is finite, the cheap talk game has at least one equilibrium surviving ACDC relative to γ.*

Most cheap talk games have a finite set of equilibrium outcomes. All discrete games we have seen in the literature have a finite outcome set. All games in the general Crawford-Sobel setting have a finite number of equilibria under general conditions (Crawford and Sobel, 1982). Also the veto-threats game of Matthews (1989) has a finite number of equilibrium-outcomes. If there are an infinite number of equilibrium-outcomes, $\min_{\Sigma^*} ACD_\gamma(\sigma)$ need not exist However, even in this case there are rather mild conditions that guarantee existence, as the following proposition shows.

Definition 6.4 *Let T be an interval. An equilibrium is a partition equilibrium if the equilibrium outcome is such that*
1. The set of equilibrium actions is finite and, hence, can be written as $\{a_1, a_2, .., a_n\}$, with $a_i < a_{i+1}$;
2. A unique partition of the type space $T = [t_0, t_1] \cup (t_1, t_2] \cup \cdots \cup (t_{n-1}, t_n]$ exists, such that all types in (t_{i-1}, t_i) induce a_i for $1 \leq i \leq n$.

Hence, each equilibrium outcome is uniquely described by a vector $\overrightarrow{a} = (a_1, a_2, .., a_n) \in \mathbb{R}^n$. Let $\overrightarrow{A}$ be the set of all equilibrium-outcome vectors.

Define the set of size-n equilibrium outcomes $\overrightarrow{A}_n \equiv \overrightarrow{A} \cap \mathbb{R}^n$. For conventional cheap-talk games, $\overrightarrow{A}_n$ usually consists of a finite number of points. However, it could also be the case that $\overrightarrow{A}_n$ contains continua of equilibrium outcomes. Let $ACD_\gamma(\overrightarrow{a})$ be the ACD corresponding to equilibrium outcome $\overrightarrow{a} \in \overrightarrow{A}$.

PROPOSITION 6.5 *Let Σ^* consist only of partition equilibria. Furthermore, let there be a maximum $\overline{n}$ on the size equilibria can take on and let $\overrightarrow{A}_n$ be a finite union of compact sets for each $n = 1, ..., \overline{n}$. Finally, let $ACD_\gamma(\overrightarrow{a})$ be continuous in all $\overrightarrow{a}$ on all compact subsets of each $\overrightarrow{A}_n$. Then, at least one equilibrium survives ACDC with respect to γ.*

In all applications we have come across, a unique equilibrium outcome exists that survives ACDC. Of course, one can construct (highly symmetric) games with multiple equilibrium outcomes that survive ACDC. In such cases, we are content with the conclusion that both equilibrium outcomes are equally plausible.

7. OTHER APPLICATIONS

7.1. *Crawford and Sobel (1982)*

In De Groot Ruiz, Offerman, and Onderstal (2010b), we study the ACDC-properties of the popular uniform-quadratic case of the Crawford and Sobel (1982) game. In this (non-veto) Cheap Talk game, types are uniformly distributed on $[0, 1]$, the action space is $[0, 1]$, $U^R(a, t) = -(a - t)^2$ and $U^S(a, t) = -(a - (t + b))^2$, with $b > 0$ capturing the Sender bias. It is well known that the game only has partition equilibria, there exists maximum size $n(b)$ and it has a unique size-n equilibrium outcome for each $n \in \{1, ..., n(b)\}$. We derive the ACD with respect to credible neologisms. We have three main findings. First, we prove that the ACD of the size-n equilibrium is decreasing in n for any value of the bias parameter b. This provides support to the wide-spread idea that higher-size equilibria are more likely. Second, a direct corollary of the previous finding is that only the maximum size-$n(b)$ equilibrium survives ACDC. This is in line with NITS (Chen, Kartik, and Sobel, 2008), which also selects the size-$n(b)$ equilibrium. If the bias parameter is large, however, the maximum size equilibrium can still have a large ACD, so it may not be all that stable. Finally, we show that as the bias parameter b goes to zero, the ACD of the maximum size-$n(b)$ equilibrium goes to zero as well, and hence its hypothesized stability increases. The reason is the following: the mass of types that can send a neologism remains substantial, but the deviations from equilibrium each induces become very small. This intuitive result about the relationship between b and the stability of the maximum size equilibrium is not picked up by previous concepts or refinements. In particular, NITS does not pick this up as it assumes that only the lowest type can credibly seperate herself, and hence does not take into account possible credible deviations of other types.

We now turn to the (scarce) experimental work on the Crawford-Sobel game. Cai and Wang (2006) test a discrete version of the uniform-quadratic setting where the Sender's type is uniformly drawn from the State space $\{1, 3, 5, 7, 9\}$. They report the results of 4 treatments that differ in the disalignment between the Sender's and Receiver's preferences. The treatment with the smallest disalignment has the full range of equilibria from pooling to fully separating, while the treatment with the largest disalignment parameter only allows for the pooling equilibrium. In the two treatments in between, the most informative equilibrium is a size-2 equilibrium. Both NITS and ACDC select a most informative equilibrium in each treatment.[14] The experimental results are relatively closest to the most informative equilibrium.

[14] In their treatment with the disalignment parameter equal to 1.2 there is an additional most informative equilibrium $\{1\}$, $\{3579\}$, besides the reported most informative equilibrium $\{13\}$, $\{579\}$. Both equilibria are NITS, while ACDC selects the latter equilibrium. The data are not sufficiently informative to discriminate between these equilibria. (The ACDC equilibrium, however, is closer to the attractor of the neologism dynamic.)

Except in the case where complete separation is supported in equilibrium, subjects overcommunicate compared to the most informative equilibrium, and overcommunication increases as the bias parameter increases. Hence, in agreement with ACDC, behavior departs more from the the most informative equilibrium, as its ACD increases. Overcommunication with respect to the separating equilibrium is predicted by the neologism dynamic of this game.[15,16]

7.2. *Discrete Games*

Blume, DeJong, Kim, and Sprinkle (2001) provide an experimental analysis of 4 discrete Cheap Talk games, in which they compare the predictive power of equilibrium selection devices as neologism-proofness, influentiality and ex-ante efficiency with Partial Common Interest (PCI). Blume et al. find that PCI is a reliable predictor of when communication takes place and that the equilibrium refinements sometimes but not always improve on PCI. In their first three games, the predictions of PCI and neologism proofness (and hence ACDC) are very much aligned. The exception is their game 2 (see table V), where neologism proofness predicts complete separation while the finest partition consistent with PCI is partial separating. The data are in line with separation, as a clear majority of 88% of the outcomes are consistent with the separating equilibrium. One could argue that this result does not contradict PCI, because PCI allows multiple patterns including separation (see their footnote 10). As the authors note (in footnote 19), one needs to add neologism proofness to PCI to actually predict that separation happens.

[15] Their Table 5 shows that subjects overcommunicate the most for the treatment with disalignment parameter 4. This is the treatment with the largest ACD.

[16] Dickhaut et al.'s (1995) results on the Crawford Sobel game are qualitatively similar to the ones reported by Cai and Wang, although they do not interpret their results in terms of overcommunication.

TABLE V

REPRODUCTION OF GAMES 2 AND 4 OF BLUME ET AL. (2001).

	a_1	a_2	a_3	a_4	a_5
t_1	$800, 800$	$100, 100$	$0, 0$	$500, 500$	$0, 400$
t_2	$x, 100$	$y, 800$	$0, 0$	$500, 500$	$0, 400$
t_3	$0, 0$	$0, 0$	$500, 800$	$0, 0$	$0, 400$

Notes: All the three types $\{t_1, t_2, t_3\}$ of the Sender are equally likely and the Receiver can implement one of the actions $\{a_1, ..., a_5\}$. Entry i, j represents $U^S(t_i, a_j), U^R(t_i, a_j)$. Games 2 and 4 are identical, except that $x = 100, y = 300$ in game 2, whereas $x = 300, y = 100$ in game 4.

Their game 4 (see table V) is interesting because no equilibrium is neologism proof while PCI makes a prediction.This game has two equilibrium outcomes. Besides the pooling equilibrium where action a_5 is induced there is a partial separating equilibrium where types t_1 and t_2 send a common message that differs from the message of t_3. Types t_1 and t_2 induce a_4 while type t_3 induces a_3. Full separation is not an equilibrium because t_2 prefers to mimic t_1. The equilibrium outcomes do not satisfy neologism-proofness. [17] PCI predicts meaningful communication because the finest partition consistent with PCI is given by $\{t_1, t_2\}$, $\{t_3\}$. In the partial separating equilibrium, the only credible neologism is $\langle a_1, \{t_1\}\rangle$. Thus its ACD equals $\frac{1}{3}(800 - 500) = 100$. The pooling equilibrium admits the credible neologisms $\langle a_4, \{t_1, t_2\}\rangle$ and $\langle a_3, \{t_3\}\rangle$ and its ACD is $\frac{1}{3}(3(500 - 0)) = 500$. So ACDC predicts that the partial separating equilibrium will be the most observed equilibrium outcome but that it will not be completely stable.

In line with this prediction, Blume et al. find that 37% of the outcomes are consistent with the partial separating equilibrium but no outcome is consistent with the pooling equilibrium. So of the two equilibria the one with the

[17] Credible announcements and credible neologisms give the same result. Here, and in the remainder of the section, we will suppress 'with respect to' in the ACD whenever credible neologisms and credible announcements give equivalent results.

lowest ACD performs best. Consistent with the ACD measures, much fewer outcomes are in line with the equilibrium selected by ACDC in game 4 than in game 2. In line with the fact that types t_1 have a credible neologism, they turn out to be the ones that are able to credibly identify themselves. Our conclusion is that our ACDC concept improves the predictions of neologism-proofness and that it does at least as well as PCI in explaining the data of Blume et al. The extra mileage for ACDC comes from continuous games like the Crawford-Sobel game and the cheap-talk bargaining game, where PCI fails to predict any communication at all while, in accordance with ACDC, subjects are able to communicate meaningfully to a large extent.

One may be worried that ACDC predicts well because it always selects the most informative equilibrium. This is not the case, as two simple examples show. First consider Game A, which is a reproduction of game 2 in Farrell (1993) and example 2 in Matthews, Okuno-Fujiwara, and Postlewaite (1991) in table VI. In this game, the two types occur with equal probability. The game has a separating equilibrium outcome where type t_1 induces a_1 and type t_2 induces a_2. In addition, the game has a pooling equilibrium outcome where both types elicit a_3. Here, the separating equilibrium is not neologism proof because it allows the neologism "I am not going to tell you my type" In contrast, no type would want to send a neologism in a pooling equilibrium. The pooling equilibrium is neologism proof. We share Farrell's and Matthews et al.'s intuition that neologism proofness criterion (and hence ACDC) appropriately rejects the communication outcome.[18]

Game B (table VII) extends the previous game to three Sender types with a twist. For $\epsilon = 0$, the game gives an identical result as the previous game. It has a separating equilibrium, where t_i induces a_i and which admits the credible neologism $\langle a_4, \{t_1, t_2, t_3\}\rangle$. It also has a neologism proof pooling

[18]Note that the game has no lowest type and hence NITS does not make a prediction in this case.

TABLE VI

Game A.

	a_1	a_2	a_3
t_1	$1, 3$	$0, 0$	$2, 2$
t_2	$0, 0$	$1, 3$	$2, 2$

Notes: Both types are equally likely.

TABLE VII

Game B.

	a_1	a_2	a_3	a_4	a_5
t_1	$1, 3$	$0, 0$	$0, 0$	$2, 2$	$2 + \epsilon, 2 + \epsilon$
t_2	$0, 0$	$1, 3$	$0, 0$	$2, 2$	$2 + \epsilon, 2 + \epsilon$
t_3	$0, 0$	$0, 0$	$1, 3$	$2, 2$	$2 - \epsilon, 0$

Notes: All three Sender types are equally likely.

equilibrium, where all types induce a_4. For small ϵ, the two equilibria remain intact, but now the pooling equilibrium also admits a credible neologism, namely $\langle a_5, \{t_1, t_2\}\rangle$. Hence, neologism proofness is silent here. Still, the ACD of the separating equilibrium is 1 and that of the pooling equilibrium $\frac{2}{3}\epsilon$, so that ACDC selects the pooling equilibrium.

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7.3. *A more general external veto threats game*

Finally, we turn to a more general class of external veto threats games, to which the game we analyze in this paper belongs to. De Groot Ruiz, Offerman, and Onderstal (2010a) analyze a class of external veto threats games allowing for more general forms of preferences and type-distributions (on a line). In this case, there can be a large set of partition equilibria. In particular, there can be a continuum of most influential equilibria. Furthermore, if $t = 0$ is selected as the lowest type, then often there will be

NITS equilibria of each size $2, 3, ..., N$, where N is the maximum size. Under some conditions, ACDC (with respect to credible neologisms) always selects a unique equilibrium, which is most informative. In an experiment, the ACDC concept organizes the data best.

8. CONCLUSION

This paper generalizes refinements based on credible deviations, such as neologism proofness and announcement proofness. It presents an intuition on why the frequency and size of credible deviations could affect equilibrium stability in a continuous rather than binary manner. The neologism dynamic illustrates this notion theoretically. The experimental results provide systematic support for ACDC: credible deviations matter and that they matter gradually. Finally, ACDC makes meaningful predictions across a wide range of previously studied settings and can organize the results of previous experiments well.

APPENDIX A: PROOFS OF PROPOSITIONS

PROOF OF PROPOSITION 2.1 First we show conditions on equilibrium actions. Let $0 < a < a'$ be two equilibrium actions the Receiver plays with positive probability. Let $\bar{t}(a)$ be the supremum of types that induce action a and accept a and $\underline{t}(a)$ the infimum of this set. Then $a \leq \max\{0, \bar{t}(a) - 60\}$, because otherwise the Receiver would do better by playing $\max\{0, \bar{t}(a) - 60\}$ instead of a. Furthermore, $a' \geq 2\bar{t}(a) - a$. If $a < a' < 2\bar{t} - a$, then type $\bar{t}(a)$ would prefer to induce a' than to induce a. Hence, $a' - a \geq 2\bar{t} - 2a \geq 120$. In particular, this means that in equilibrium a finite number of actions n will be played and we can define a_n as the maximum of such actions.

Note that if t and t' induce and accept a, then all $t \in (t, t')$ induce a. In particular, $t \in (\underline{t}(a), \bar{t}(a))$ induce a. Now, define $a^*[\underline{t}, \bar{t}]$, as the best response of the Receiver if Sender types are uniformly distributed in the interval $[\underline{t}, \bar{t}]$.

$a^*[\underline{t},\overline{t}] = \arg\max_{a\in A}\{U^R(a)\cdot \Pr\{|a-t| \leq 60 \mid t \in [\underline{t},\overline{t}]\}$. If $\underline{t} < 150$, $a^*[\underline{t},\overline{t}]$ is single-valued and equal to $\min\{\underline{t}+60, \overline{t}-60, 45+\frac{1}{2}\underline{t}\} = \min\{\overline{t}-60, 45+\frac{1}{2}\underline{t}\}$.

Consequently, we can characterize the equilibrium by a partition $t_0 = 0 < t_1 < ... < t_n = B$ and a set of equilibrium actions $a_1 < a_2 < .. < a_n$ such that all types in (t_{i-1}, t_i) induce a_i for $1 \leq i \leq n$. In equilibrium, Senders accept an induced action iff it gives them nonnegative payoff.[19] For it to be optimal for Senders to partition themselves in this way, t_i must be indifferent between a_i and a_{i+1}: $t_i = \frac{1}{2}(a_i + a_{i+1})$ for $i = 1, ..., n-1$. For it to be optimal for the Receiver to take action a_i, $a_i = a^*[t_{i-1}, t_i]$. This implies that $a^*[t_{i-1}, t_i] \in \arg\max_{a\in A} \int_0^B U^R(a)\nu(t,a)\beta^e(t|m)dt$ for all m that types in (t_{i-1}, t_i) send. Without loss of generality, we can thus assume that all types in (t_{i-1}, t_i) send the same message.

Note that, in equilibrium, all types below a_n+60 (with the exception of a zero mass of indifferent types) accept the a they induce. For a positive mass of types smaller than a_n+60 to reject a proposal, there must be some a with $a \geq \underline{t}(a) + 60$, because otherwise types just under $\underline{t}(a)$ would like to induce and accept a. However, to be optimal a must equal $a^*[\underline{t},\overline{t}] \leq 45 + \frac{1}{2}\underline{t}(a)$. This would imply that $\underline{t}(a_i) + 60 \leq a_i \leq 45 + \frac{1}{2}\underline{t}(a_i)$, which is not possible.

As in all cheap talk games, there are pooling equilibria, in which the Receiver always takes the same action and this action is induced by all players. In our game, this means that after any message the Receiver proposes action $a^*[0, B] = 45$ for all $B \geq 120$. Hence, $t_0 = 0, t_1 = B$ and $a_1 = 45$ is the unique pooling equilibrium outcome.

Let us now look at equilibria with $n \geq 2$. Note that if $a_i > 0$, then $a_{i+1} \geq 2\overline{t}(a_i) - a_i \geq a_i + 120$. Furthermore, if $a_{i+1} > a_i + 120$, types in $(a_i + 60, a_{i+1} - 60)$ would reject any proposal. This is not possible, as no set

[19] Strictly speaking, indifferent types can accept or reject. Since the set of indifferent types has measure zero in equilibrium, it essentially does not matter what they do.

of types smaller than $a_n + 60$ with positive measure reject an action. Thus, if $a_i > 0$, $a_{i+1} = a_i + 120$. Now, $a_n \leq 45 + \frac{1}{2}\underline{t}(a_n) = 45 + \frac{1}{2}(a_{n-1} + a_n)$ and $a_n \leq a_{n-1} + 90$. Hence, if $a_{n-1} > 0$, then $a_{n-1} + 120 \leq 90 + a_{n-1}$. This is not possible. As a consequence, $a_{n-1} = 0$. This rules out any equilibria with $n > 2$ or equilibria with $n = 2$ and $a_1 > 0$.

So a necessary condition for an equilibrium with $n = 2$, is $a_1 = 0$. Furthermore, another necessary condition is $a_2 = a^*[\frac{1}{2}a_2,\ B]$. Solving for a_2, yields $a_2 = 60$ for all $B \geq 120$. t_1 must then be $\frac{1}{2}a_2 = 30$. $a^*[0,\ 30]$ is indeed 0. Hence, $t_0 = 0, t_1 = 30, t_2 = B$, and $a_1 = 0, a_2 = 60$ is the unique separating equilibrium outcome. *Q.E.D.*

Proof of Proposition 2.2 Let $a(t)$ characterize the equilibrium outcome. In our game, $\langle \overline{a}, [\underline{\tau}, \overline{\tau}] \rangle$ is a credible neologism iff $U^S(t, \overline{a}) < U^S(t, a(t))$ $\forall t \notin [\underline{\tau}, \overline{\tau}]$, $U^S(t, \overline{a}) > U^S(t, a(t)) \forall t \in (\underline{\tau}, \overline{\tau})$ and $\overline{a} = a^*[\underline{\tau}, \overline{\tau}]$. Hence $\overline{a} < a_1$ implies $\underline{\tau} = 0$ and $\overline{a} > a_n$ implies $\underline{\tau} = B$.

First, let us look at pooling equilibrium outcome $a^P(t)$. Consider a low credible neologism $\overline{a}^L < a = 45$. Now, $\underline{\tau}^L = 0$. Furthermore, $\overline{\tau}^L = \frac{1}{2}(\overline{a}^L + 45) < 60$. Hence, $\overline{a}^L = a^*[0, \overline{\tau}] = 0$ and $\overline{\tau}^L$ must be 22.5. Next, consider a high credible neologism $\overline{a}^H > 45$. $\overline{\tau}^H = B$ and $\underline{\tau}^H = \frac{1}{2}(\overline{a}^H + 45)$. Solving $a^*[\frac{1}{2}(\overline{a}^H + 45),\ B] = \overline{a}^H$ yields $\overline{a}^H = \min\{\ B - 60, 75\} > 45$. Consequently, $\underline{\tau}^H = \min\{\frac{B-15}{2}, 60\}$.

Second, let us look at the separating equilibrium outcome $a^S(t)$. There can be no credible equilibrium $\overline{a} < a_1$ as $a_1 = 0$. Consider next a credible neologism $\overline{a} > 60$. $\overline{\tau} = B$ and $\underline{\tau} = \frac{1}{2}(d + 60)$. Solving $a^*[\frac{1}{2}(d + 60),\ B] = \overline{a}$ yields $\overline{a} = \min\{\ B - 60, 80\}$. Consequently, $\underline{\tau} = \min\{\frac{B}{2}, 70\}$. If $B = 120$, then $\overline{a} = 60$ and it is no neologism. If $B > 120$, it is a neologism. Finally, consider some neologism with $a_1 = 0 < \overline{a} < a_2 = 60$. Since $\overline{a} < 60$, it must be that $\overline{\tau} < 60$. However, if $\overline{\tau} < 60$, then $a^*[\underline{\tau}, \overline{\tau}] = 0$. Hence $\overline{a}$ can be no neologism. *Q.E.D.*

Proof of Proposition 3.1. Using the results from Propositions 2.1 and 2.2, we get for the pooling equilibrium that $ACD(\sigma^P) = \frac{1}{B}\int\limits_0^B U^S(t,\overline{a}^P(t)) - U^S(t,a^P(t))dt = \frac{1}{B}\int\limits_0^{45/2}\{(60-|t-0|)-(60-|t-45|)\}dt + \frac{1}{B}\int\limits_{45/2}^{B}\{(60-|t-(B-60)|)-(60-|t-45|)\}dt = \frac{1}{4B}(B^2+30B-12150)$ for $B < 135$. For $B > 135$, we get $ACD(\sigma^P) = \frac{1}{B}\int\limits_0^{45/2}\{(60-|t-0|)-(60-|t-45|)\}dt + \frac{1}{B}\int\limits_{60}^{B}\{(60-|t-75|)-(60-|t-45|)\}dt = \frac{15}{4B}(8B-405)$. For the separating equilibrium, we get $ACD(\sigma^S) = \frac{1}{B}\int\limits_{B/2}^{B}\{(60-|t-(B-60)|)-(60-|t-60|)\}dt = \frac{1}{4B}(B^2-14\,400)$ for $120 \leq B < 140$ and $ACD(\sigma^S) = \frac{1}{B}\int\limits_{70}^{B}\{(60-|t-80|)-(60-|t-60|)\}dt = \frac{20}{B}(B-75)$ for $B > 140$. *Q.E.D.*

Proof of Corollary 3.2. The proof follows immediately from comparing the numbers in Proposition 3.1. *Q.E.D.*

Proof of Proposition 6.5 If these conditions are met, $\overrightarrow{A}$ can be described as a finite union of compact subsets, such that $ACD_\gamma(\overrightarrow{a})$ is continuous in $\overrightarrow{a}$ on each subset. This means $ACD_\gamma(\overrightarrow{a})$ achieves a minimum on each subset and hence achieves a minimum on $\overrightarrow{A}$. As a consequence, also $\min_{\Sigma^*} ACD\gamma(\sigma)$ must exist so that at least one equilibrium survives ACD with respect to γ. *Q.E.D.*

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Appendix B (online): Experimental Instructions.

We include the experimental instructions (including check questions) of the B-120 treatment for both the “Chooser” (Sender) and “Proposer” (Receiver) roles. The instructions of the B-130 and B-210 treatments are very similar and are made available upon request.

A. Instructions Chooser

INSTRUCTIONS

Welcome to this decision-making experiment. Please read these instructions carefully. We will first provide you with an outline of the instructions and then we will proceed with a detailed description of the instructions.

OUTLINE

Experiment

- At the start of the experiment you will receive a starting capital of 100 points. In addition, you can earn points with your decisions.
- At the end of the experiment, you receive 1,5 (one-and-a-half) euro for each 100 points earned.
- The experiment consists of around 50 periods.
- Your role in the whole experiment is: **CHOOSER**.
- In each period, you will be randomly paired with a different participant who performs the role of Proposer.

Sequence of events

- In each period, you and the Proposer will bargain over an outcome, which can be any number between 0 and 120.
- Your preferred outcome is a number between 0 and 120. Any number between 0 and 120 is equally likely. The Proposer's preferred outcome is always 0.
- Each period you will receive a new (random) preferred outcome. You are the only one who is informed about your preferred outcome.
- After learning your preferred outcome, you will send a SUGGESTION for a proposal (between 0 and 120) to the Proposer.
- The Proposer is informed of your suggestion and makes a PROPOSAL (between 0 and 120) for the outcome.
- After you have been informed of the proposal, you accept or reject it.
- At the end of a period, you are informed of the points you earned (your payoff).

Payoffs

- When you accept a proposal, your payoff is 60 minus the distance between your preferred outcome and the proposal.
- The Proposer's payoff is 60 minus 0.4 times the proposal in this case.
- When you reject a proposal, you receive 0 points and the Proposer receives 0 points.

History Overview

When making a decision, you may use the History Overview, which provides an overview of the results of five Chooser/Proposer pairs (including your own pair) in the 15 most recent periods. The left part of the overview is a Table with four columns SUGGESTION, PROPOSAL, ACCEPTANCE and PREFERRED OUTCOME. In a row, you will find a particular pair’s suggestion, the corresponding proposal, whether the Chooser accepted or rejected the proposal and the preferred outcome of that Chooser. On the right, you find a Graph where the most recent results are represented by blue squares. On the horizontal axis you can read the value of the suggestion and on the vertical axis the value of the corresponding proposal.

DETAILED INSTRUCTIONS

Now we will describe the experiment in detail. At the start of the experiment you will receive a starting capital of 100 points. During the experiment you will be asked to make a number of decisions. Your decisions and the decisions of the participants you will be paired with will determine how much money you earn. The experiment consists of around 50 periods. In each period, your earnings will be denoted in points. Your final earnings in the experiment will be equal to the starting capital plus the sum of your earnings in all periods. At the end of the experiment, your earnings in points will be transferred to money. For each 100 points you earn, you will receive 1,5 (one-and-a-half) euro. Your earnings will be privately paid to you in cash.

In each period, all participants are paired in couples. One participant within a pair has the role of CHOOSER, the other participant performs the role of PROPOSER. In all periods you keep the same role.

Your role is: CHOOSER.

MATCHING PROCEDURE

For the duration of the experiment, you will be in a fixed matching group of five Proposers and five Choosers (hence 10 participants in total, including yourself). In each period you are randomly matched to another participant in this matching group with the role of Proposer. You will never learn with whom you are matched.

BARGAINING AND PREFERRED OUTCOMES

In each period, you and the Proposer with whom you are coupled will bargain over an outcome. The Proposer's preferred outcome is always 0. Your preferred outcome is a number between (and including) 0 and 120. Any number between 0 and 120 is equally likely. Each period you will receive a new preferred outcome that does not depend on your preferred outcome of any previous period. You are the only one who is informed about your preferred outcome. The Proposer only knows that your preferred outcome is a number between 0 and 120 (and that each such number is equally likely).

SEQUENCE OF EVENTS IN A PERIOD

After you have learned your preferred outcome in a period, you will send a SUGGESTION for a proposal to the Proposer. You may send any suggestion between (and including) 0 and 120. It is up to you to decide whether and how you let your suggestion depend on your preferred outcome. Then, the Proposer with whom you are coupled is informed of your suggestion (but not of your preferred outcome). Subsequently, the Proposer makes a PROPOSAL for the outcome. A proposal is any number between (and including) 0 and 120. Finally, you will choose to accept or reject the proposal.

At the end of a period, you are informed of the payoff (points you earned) that you made. This payoff is automatically added to your total earnings (or in case that you make a loss, it is subtracted from your total earnings). The Proposer is informed of the outcome, your preferred outcome and her or his own payoff.

Please note that the experiment will only continue from one phase to another after *everybody* has pressed OK/PROCEED. For this reason, please press OK/PROCEED as soon as you have made your decision.

PAYOFFS WHEN YOU ACCEPT THE PROPOSAL
When you accept the proposal, you will receive a payoff of 60 minus the distance between your preferred outcome and the proposal:

Your payoff = 60 – distance(your preferred outcome and proposal).

When you accept the proposal, the Proposer's payoff is 60 minus 0.4 times the proposal:

Payoff Proposer = 60 – 0.4 * proposal.

It is possible to reject a proposal.

PAYOFFS WHEN YOU REJECT THE PROPOSAL
When you reject a proposal, then the outcome is the status quo. In this case, you will receive 0 points and the Proposer will receive 0 points.

Notice that accepting an offer gives you a higher payoff than rejecting it if and only if the distance between the proposal and your preferred outcome is smaller than 60. The Proposer's payoff is higher when you accept than when you reject in all cases.

EXAMPLE 1. Suppose your preferred outcome is 80 and you receive a proposal of 100. Then, the distance between your preferred outcome and proposal is 100 - 80 = 20.

- If you accept, your payoff is 60 - 20 = 40. The Proposer's payoff in this case is 60 – 0.4*100 = 20.
- If you reject, your payoff is 0 and the Proposer's payoff is 0.

EXAMPLE 2. Suppose your preferred outcome is 80 and you receive a proposal of 10. Then, the distance between your preferred outcome and the proposal is 80 - 10 = 70.

- If you accept, your payoff is 60 - 70 = -10. The Proposer's payoff in this case is 60 – 0.4*10 = 56.
- If you reject, your payoff is 0 and the Proposer's payoff is 0.

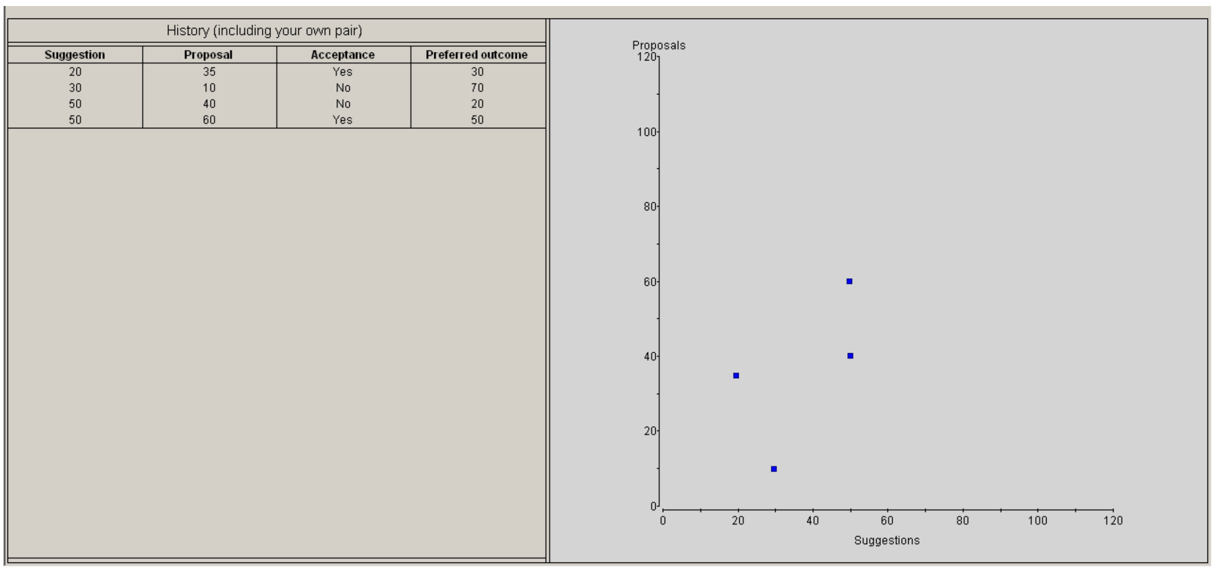
HISTORY OVERVIEW
When making a decision, you may use the History Overview, which fills the lower part of the screen. The History Overview summarizes the results of the most recent 15 periods. (If less than 15 periods have been completed, this history overview contains results of all completed periods.)

Apart from your own results in the previous periods, the History Overview also contains the results of the other Chooser/Proposer pairs in your matching group. In total you are thus informed about the past results of the same matching group of five

Chooser/Proposer pairs. All other Choosers and Proposers in your matching group will have the same information. The presentation of information for Proposers is different than for Choosers.

TABLE

Below you see an example of the history overview. THE NUMBERS IN THE HISTORY OVERVIEW DO NOT INDICATE WHAT YOU SHOULD DO IN THE EXPERIMENT. The left part of the history overview is a Table with four columns. The first column labelled SUGGESTION contains the suggestions made by the Choosers in the recent previous periods. The second column labelled PROPOSAL gives the proposal that was made by the Proposer as a response to the suggestion in the same row. The third column labelled ACCEPTANCE shows whether the Chooser accepted or rejected the proposal. The fourth column labelled PREFERRED OUTCOME shows the preferred outcome of the Chooser.



The results shown in the history overview will be sorted on the basis of suggestion in ascending order. (The lower the suggestion, the higher the place in the table.) When the suggestion is the same for two or more different results, these observations will be sorted on the basis of proposal, again in ascending order. In the example above, this applies to the third and the fourth row, where two Choosers chose the same suggestion but the corresponding Proposers chose different proposals. More generally, observations have been sorted first on suggestion, then on proposal, then on acceptance or rejection and finally on preferred outcome.

GRAPH

On the right of the history overview, the most recent results are represented in a graph. The horizontal axis presents the suggestion and the vertical axis presents the proposal. Each previous observation is represented by a blue square. On the horizontal axis you can read the value of the suggestion for a particular result and on the vertical axis you can read the value of the corresponding proposal. (Proposers will see preferred outcomes on the vertical axis, rather than proposals.)

EXAMPLE. Consider the square that is displayed in the lower left corner of the Graph shown above. Here, the Chooser made a suggestion of 30. The Proposer responded with a proposal of 10.

You have now reached the end of the instructions. The next page contains some questions concerning the experiment. When all participants have answered all questions correctly, we will proceed with the experiment.

QUESTIONS

Please answer the following questions. THE VALUES USED IN SOME QUESTIONS DO NOT INDICATE WHAT YOU SHOULD DO IN THE EXPERIMENT. RATHER, THEY HAVE BEEN CHOSEN TO FACILITATE CALCULATIONS.

1. Is the following statement correct? ‘In each period I am coupled with the same Proposer.’

2. Is the following statement correct? ‘My preferred position will be observed by the Proposer before (s)he makes her or his proposal.’

3.
(A) What is the highest value your preferred outcome can take on?
(B) What is the highest value a suggestion of yours can take on?
(C) What is the highest value a proposal can take on?

4. Consider a period in which your preferred outcome is 50. You chose to send a suggestion of 40. The Proposer made a proposal of 20, which was accepted by you.
(A) What are your own earnings in this period?
(B) How much does the Proposer to whom you are paired earn?

5. Consider a period in which your preferred outcome is 90. You chose to send a suggestion of 100. The Proposer made a proposal of 0, which was accepted by you.
(A) What are your own earnings in this period?
(B) How much does the Proposer to whom you are paired earn?

6. Consider a period in which your preferred outcome is 30. You chose to send a suggestion of 40. The Proposer made a proposal of 10, which was rejected by you.
(A) What are your own earnings in this period?
(B) How much does the Proposer to whom you are paired earn?

When you are ready answering the questions, please raise your hand.

B. Instructions Proposer

INSTRUCTIONS

Welcome to this decision-making experiment. Please read these instructions carefully. We will first provide you with an outline of the instructions and then we will proceed with a detailed description of the instructions.

OUTLINE

Experiment

- At the start of the experiment you will receive a starting capital of 100 points. In addition, you can earn points with your decisions.
- At the end of the experiment, you receive 1,5 (one-and-a-half) euro for each 100 points earned.
- The experiment consists of around 50 periods.
- Your role in the whole experiment is: **PROPOSER**.
- In each period, you will be randomly paired with a different participant who performs the role of Chooser.

Sequence of events

- In each period, you and the Chooser will bargain over an outcome, which can be any number between 0 and 120.
- Your preferred outcome is always 0.
- The Chooser’s preferred outcome is a number between 0 and 120. Any number between 0 and 120 is equally likely.
- Each period, each Chooser will receive a new (random) preferred outcome. The Chooser is the only one who is informed about her or his preferred outcome.
- After learning her or his preferred outcome, the Chooser with whom you are matched will send a SUGGESTION for a proposal (between 0 and 120) to you.
- You are informed of the Chooser’s suggestion and make a PROPOSAL (between 0 and 120) for the outcome.
- After the Chooser has been informed of the proposal, she or he accepts or rejects it.
- At the end of a period, you are informed of the points you earned (your payoff).

Payoffs

- When the Chooser accepts your proposal, your payoff is 60 minus 0.4 times the proposal.
- The Chooser’s payoff is in this case 60 minus the distance between her or his preferred outcome and the proposal.
- When the Chooser rejects your proposal, you receive 0 points and the Chooser 0 points.

History Overview

When making a decision, you may use the History Overview, which provides an overview of the results of five Chooser/Proposer pairs (including your own pair) in the 15 most recent periods. The left part of the overview is a Table with four columns SUGGESTION, PREFERRED OUTCOME, PROPOSAL and ACCEPTANCE. In a row, you will find a particular pair's suggestion, the preferred outcome of the Chooser, the proposal made by the Proposer and whether the Chooser accepted or rejected the proposal. On the right, you find a Graph where the most recent results are represented by blue squares. On the horizontal axis you can read the value of the suggestion and on the vertical axis the value of the corresponding preferred outcome of the Chooser.

DETAILED INSTRUCTIONS

Now we will describe the experiment in detail. At the start of the experiment you will receive a starting capital of 100 points. During the experiment you will be asked to make a number of decisions. Your decisions and the decisions of the participants you will be paired with will determine how much money you earn. The experiment consists of around 50 periods. In each period, your earnings will be denoted in points. Your final earnings in the experiment will be equal to the starting capital plus the sum of your earnings in all periods. At the end of the experiment, your earnings in points will be transferred to money. For each 100 points you earn, you will receive 1,5 (one-and-a-half) euro. Your earnings will be privately paid to you in cash.

In each period, all participants are paired in couples. One participant within a pair has the role of CHOOSER, the other participant performs the role of PROPOSER. In all periods you keep the same role.

Your role is: PROPOSER.

MATCHING PROCEDURE

For the duration of the experiment, you will be in a fixed matching group of five Proposers and five Choosers (hence 10 participants in total, including yourself). In each period you are randomly matched to another participant with the role of Chooser. You will never learn with whom you are matched.

BARGAINING AND PREFERRED OUTCOMES

In each period, you and the Chooser with whom you are coupled will bargain over an outcome. Your preferred outcome is always 0. The Chooser's preferred outcome is a number between (and including) 0 and 120. Any number between 0 and 120 is equally likely. Each period, each Chooser will receive a new preferred outcome that does not depend on a preferred outcome of any previous period. The Chooser is the only one who is informed about her or his preferred outcome. You only know that the Chooser's preferred outcome is a number between 0 and 120 (and that each such number is equally likely).

SEQUENCE OF EVENTS IN A PERIOD

After the Chooser with whom you are matched has learned her or his preferred outcome in a period, she or he will send a SUGGESTION for a proposal to you. The Chooser may send any suggestion between (and including) 0 and 120. It is up to the Chooser to decide whether and how she or he lets her or his suggestion depend on her or his preferred outcome. Then, you are informed of the Chooser's suggestion (but not of her or his preferred outcome). Subsequently, you make a PROPOSAL for the outcome. A proposal is any number between (and including) 0 and 120. Finally, the Chooser will choose to accept or reject the proposal.

At the end of a period, you are informed of the outcome of the period and the preferred outcome of the Chooser you were paired with. Finally, you are informed of the payoff (points you earned) that you made. This payoff is automatically added to your total earnings (or in case that you make a loss, it is subtracted from your total earnings).

Please note that the experiment will only continue from one phase to another after *everybody* has pressed OK/PROCEED. For this reason, please press OK/PROCEED as soon as you have made your decision.

PAYOFFS WHEN THE CHOOSER ACCEPTS THE PROPOSAL

When the Chooser accepts your proposal, your payoff is 60 minus 0.4 times the proposal:

Your payoff = 60 – 0.4 * proposal.

When the Chooser accepts your proposal, the Chooser will receive a payoff of 60 minus the distance between her or his preferred outcome and the proposal:

Payoff Chooser = 60 – distance(her or his preferred outcome and proposal).

It is possible for a Chooser to reject a proposal.

PAYOFFS WHEN THE CHOOSER REJECTS THE PROPOSAL

When the Chooser rejects a proposal, then the outcome is the status quo. In this case, you will receive 0 points and the Chooser will receive 0 points.

Notice that accepting an offer gives the Chooser a higher payoff than rejecting it if and only if the distance between the proposal and her preferred outcome is smaller than 60. Your payoff is higher when the Chooser accepts than when she or he rejects in all cases.

EXAMPLE 1. Suppose the Chooser's preferred outcome turns out to be 80 (which you cannot know) and you make a proposal of 100. Then, the distance between her preferred outcome and your proposal is 100 - 80 = 20.

- If the Chooser accepts, your payoff is 60 – 0.4*100 = 20. The Chooser's payoff in this case is 60 - 20 = 40.
- If the Chooser rejects, your payoff is 0 and the Chooser's payoff is 0.

EXAMPLE 2. Suppose the Chooser's preferred outcome turns out to be 80 and you make a proposal of 10. Then, the distance between her preferred outcome and your proposal is 80 - 10 = 70.

- If the Chooser accepts, your payoff is 60 – 0.4*10 = 56. The Chooser's payoff in this case is 60 - 70 = -10.
- If the Chooser rejects, your payoff is 0 and the Chooser's payoff is 0.

HISTORY OVERVIEW

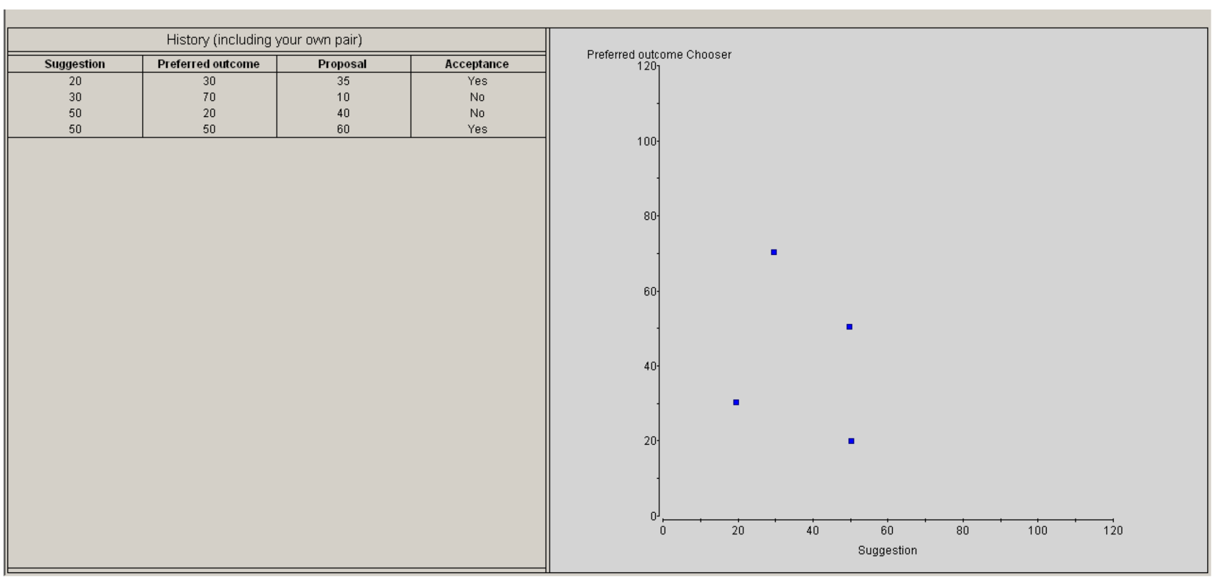
When making a decision, you may use the History Overview, which fills the lower part of the screen. The History Overview summarizes the results of the most recent 15 periods.

(If less than 15 periods have been completed, this history overview contains results of all completed periods.)

Apart from your own results in the previous periods, the history overview also contains the results of the other Chooser/Proposer pairs in your matching group. In total you are thus informed about the past results of the same group of five Chooser/Proposer pairs. All Choosers and Proposers in your matching group will have the same information. The presentation of information is different for Choosers than for Proposers.

TABLE

Below you see an example of the history overview. THE NUMBERS IN THE HISTORY OVERVIEW DO NOT INDICATE WHAT YOU SHOULD DO IN THE EXPERIMENT. The left part of the history overview is a Table with four columns. The first column labelled SUGGESTION contains the suggestions made by the Choosers in the recent previous periods. The second column labelled PREFERRED OUTCOME shows the preferred outcome of the Chooser. The third column labelled PROPOSAL gives the proposal that was made by the Proposer as a response to the suggestion in the same row. The fourth column labelled ACCEPTANCE shows whether the Chooser accepted or rejected the proposal.


History (including your own pair)

Suggestion	Preferred outcome	Proposal	Acceptance
20	30	35	Yes
30	70	10	No
50	20	40	No
50	50	60	Yes

The results shown in the history overview will be sorted on the basis of suggestion in ascending order. (The lower the suggestion, the higher the place in the table.) When the suggestion is the same for two or more different results, these observations will be sorted on the basis of preferred outcome, again in ascending order. In the example above, this applies to the third and the fourth row, where two Choosers chose the same suggestion but had different preferred outcomes. More generally, observations have been sorted first on suggestion, then on preferred outcome, then on proposal and finally on acceptance or rejection.

GRAPH

On the right of the history overview, the most recent results are represented in a graph. The horizontal axis presents the suggestion and the vertical axis presents the proposal. Each previous observation is represented by a square. On the horizontal axis you can read the value of the suggestion for a particular result and on the vertical axis you can read the value of the corresponding proposal. If the square is green, the particular proposal was accepted and if the square is red with white inside, the particular proposal was rejected. (Choosers will see proposals on the vertical axis.)

EXAMPLE 1. Consider the square that is displayed in the lower left corner of the Graph shown above. Here, the Chooser made a suggestion of 20. This Chooser's preferred outcome was 30.

You have now reached the end of the instructions. The next page contains some questions concerning the experiment. When all participants have answered all questions correctly, we will proceed with the experiment.

QUESTIONS

Please answer the following questions. THE VALUES USED IN SOME QUESTIONS DO NOT INDICATE WHAT YOU SHOULD DO IN THE EXPERIMENT. RATHER, THEY HAVE BEEN CHOSEN TO FACILITATE CALCULATIONS.

1. Is the following statement correct? ‘In each period I am coupled with the same Chooser.’

2. Is the following statement correct? ‘I will observe the Chooser’s preferred position before I make my proposal.’

3.
(A) What is the highest value the preferred outcome of a Chooser can take on?
(B) What is the highest value a suggestion of a Chooser can take on?
(C) What is the highest value a proposal of yours can take on?

4. Consider a period in which the Chooser’s preferred outcome is 50. The Chooser chose to send a suggestion of 40. You made a proposal of 20, which was accepted by the Chooser.
(A) What are your own earnings in this period?
(B) How much does the Chooser to whom you are paired earn?

5. Consider a period in which the Chooser’s preferred outcome is 90. The Chooser chose to send a suggestion of 100. You made a proposal of 0, which was accepted by the Chooser.
(A) What are your own earnings in this period?
(B) How much does the Chooser to whom you are paired earn?

6. Consider a period in which the Chooser’s preferred outcome is 30. The Chooser chose to send a suggestion of 40. You made a proposal of 10, which was rejected by the Chooser.
(A) What are your own earnings in this period?
(B) How much does the Chooser to whom you are paired earn?

When you are ready answering the questions, please raise your hand.

Appendix C (online): Neologism Dynamic.

1 Neologism Dynamic

We first describe the standard, simple, best response dynamic. In each period all Sender types and the Receiver choose a strategy. We assume that the Sender in the acceptance stage accepts all actions that yield her nonnegative payoff: $\nu(t,a) = 1$ if $U^S(t,a) \geq 0$ and $\nu(t,a) = 0$ otherwise. The strategy of the Sender in period r is then given by $\mu_r : T \rightarrow \Delta M$ and that of the Receiver by $\alpha_r : M \rightarrow A$. Let $m_r(t)$ denote the message Sender type t sends (which may be a random variable) and $a_r(m)$ denote the Receiver's action after receiving message m. Both players best respond to the strategy of the other player in the previous round. First, the support of $\mu_r(t)$ is equal to $\arg\max_{m\in M} U^S(t, a_{r-1}(m))$. In particular, we assume the Sender randomizes uniformly over the set of best responses. Second, $a_r(m) = \arg\max_{a\in A} U^R(t,a)E_t[\nu(t,a)|\beta^r(m)]$, where $\beta^r(m)$ is derived from $\mu_{r-1}$by Bayes rule whenever possible.[1] If β^r cannot be derived from μ_{r-1}, then $\beta^r = \beta^r(m)$ for some randomly chosen $m \in \cup_{t\in T}\text{supp}\mu_{r-1}(t)$.

The neologism dynamic differs from the best response dynamic on one crucial aspect: Senders can send credible neologisms, which will be believed. We define $\langle \overline{a}, N\rangle$ as a credible neologism with respect to Receiver strategy α_r if (i) $U^S(t,\overline{a}) > \arg\max_{m\in M} U^S(t, a_r(m))\cdot\nu(t, a_r(m))$ for all $t \in N$, (ii) $U^S(t,\overline{a}) \leq \arg\max_{m\in M} U^S(t, a_r(m)) \cdot \nu(t, a_r(m))$ for all $t \notin N$ and (iii) $\overline{a} = \arg\max_{a\in A} U^R(t,a)E_t[\nu(t,a)|t \in N]$.[2].

[1] We assume that there is one unique best response for the Receiver, which is generically the case. Theoretically, if there are more optimal actions, one could take, for instance, the minimum.

[2] We need to point out the following subtlety. If a credible neologism was used in the previous period, it becomes just a message (which may have acquired a new 'meaning'). If the same credible neologism has to be made in the following period, it cannot be the same literal message, as then it would not be a neologism. Hence, the Sender can add for instance Really! or Really, Really! etc. to make it a neologism and distinguish it from the old message.

Now, in the neologism dynamic all Senders that can send a credible neologism in round r with respect to α_{r-1}, will do so and such credible neologisms will be believed by the Receivers in round r. In all other cases, the dynamic is identical to a best response dynamic.We call the neologism dynamic $f(\mu_r, a_r)$.

This best reponse dynamic bears similarities to a level-k analysis. The difference is that in level-k, in each iteration just one player (Sender or Receiver) changes her strategy. In the best response dynamic, both players change their strategy each period. Still, the best response dynamic converges in all cases below to very similar outcomes as the outcomes a level-k analysis would converge to.

Before analyzing the dynamic, we characterize the best responses and neologisms. The Sender's best response is simply to induce the action closest to her type. We call the Receiver's best response $a^*[\underline{t}, \overline{t}]$ if Sender types are uniformly distributed in the interval $[\underline{t}, \overline{t}]$. $a^*[\underline{t}, \overline{t}]$ is single-valued and equal to $\min\{\overline{t} - 60, 45 + \frac{1}{2}\underline{t}\}$. Let $\widetilde{a} = \max_{m \in M}\{a_r(m)\}$ be the highest action of a Receiver's strategy. Then, for $B = 120, 130$, there exists a high credible neologism with respect to a_r if and only if $\widetilde{a} < B - 60$. In particular, it is equal to $\left\langle B - 60, (\frac{B-60+\widetilde{a}}{2}, 130]\right\rangle$ if $3(B - 120) \leq \widetilde{a} < B - 60$ and $\left\langle 60 + \widetilde{a}/3, (\frac{2}{3}(45 + \widetilde{a}), 130]\right\rangle$ if $\widetilde{a} < 3(B - 120)$. For $B = 210$, there exists a high credible neologism if and only if $\widetilde{a} < 90$, and in this case it is equal to $\left\langle 60 + \frac{1}{3}\widetilde{a}, (\frac{2}{3}(45 + \widetilde{a}), 130]\right\rangle$.

We restrict our analysis to two natural initial strategy profiles: babbling (where no information is transmitted) and naive (where all possible information is transmitted).

For each $B \in \{120, 130, 210\}$, we (i) give the attractor[3], (ii) show that both the babbling and naive initial profiles lie in its basis of attraction and (iii) calculate the average prediction error of the pooling and separating equilibria for the attractor.

2 B=120

For $B = 120$. It is easy to check that the equilibrium profile is a steady state of the neologism dynamic: $m_r(t) = m^1$ for $t \in [0, 30]$ and $m_r(t) = m^2 \neq m^1$ for $t \in [30, 120]$, and $a_r(m^1) = 0$ and $a_r(m^2) = 60$. It is a steady state of the best response dynamic and no neologism relative

[3] An attractor is roughly speaking a set in the phase-space the neighboorhood of which the dynamic evolves to after sufficient time. This can be, for instance, a steady state or a a higer n-cycle.

to a_r exists.

If we start with a babbling profile in period 1, the neologism dynamic proceeds as follows:

Strategy Sender period 1 (Babbling)	Strategy Receiver period 1 (Babbling)
$m_1(t) \sim U[0,120]$ if $t \in [0,120]$	$a_1(m) = 45$ for all $m \in [0,120]$

where all Senders randomize uniformly over the interval $[1,120]$

Strategy Sender period 2 (Babbling)	Strategy Receiver period 2 (Babbling)
$m_2(t) = n^1$ if $t \in [0,45/2)$	$a_2(m) = 0$ if $m = n^1$
$m_2(t) \sim U[0,120]$ if $t \in [45/2,105/2]$	$a_2(m) = 45$ if $m \in [0,120]$
$m_2(t) = n^2$ if $t \in (105/2,120]$	$a_2(m) = 60$ if $m = n^2$

where $n^1 = \langle 0, [0,45/2) \rangle$ and $n^2 = \langle 60, [105/2,120) \rangle$

Strategy Sender period 3 (Babbling)	Strategy Receiver period 3 (Babbling)
$m_3(t) = n^1$ if $t \in [0,45/2)$	$a_3(m) = 0$ if $m \in [0,120] \cup \{n^1\}$
$m_3(t) \sim U[0,120]$ if $t \in [45/2,105/2)$	$a_3(m) = 60$ if $m = n^2$
$m_3(t) = n^2$ if $t \in [105/2,120]$	

Strategy Sender period 4 (Babbling)	Strategy Receiver period 4 (Babbling)
$m_4(t) \sim U[0,120] \cup \{n^1\}$ if $t \in [0,30)$	$a_4(m) = 0$ if $m \in [0,120] \cup \{n^1\}$
$m_4(t) = n^2$ if $t \in [30,120]$	$a_4(m) = 60$ if $m = n^2$

Hence, from period 4, the dynamic is and stays in the separating equilibrium.

If we start with a naive profile in period 1, the neologism dynamic proceeds as follows:

Strategy Sender period 1 (Naive)	Strategy Receiver period 1 (Naive)
$m_1(t) = t$ if $t \in [0,120]$	$a_1(m) = 0$ if $m \in [0,60]$
	$a_1(m) = m - 60$ if $m \in [60,120]$

where all Senders randomize uniformly over the interval $[1,120]$

Strategy Sender period 2 (Naive)	Strategy Receiver period 2 (Naive)
$m_2(t) \sim U[0,60]$ if $t = 0$	$a_2(m) = 0$ for all $m \in [0,60]$
$m_2(t) = t + 60$ if $t \in (0,60)$	$a_2(m) = m - 60$ for all $m \in [60,120]$
$m_2(t) = 120$ if $t \in [60,120]$	

Strategy Sender period 3 (Naive)	Strategy Receiver period 3 (Naive)
$m_3(t) \sim U[0,60]$ if $t = 0$	$a_3(m) = 0$ if $m \in [0,120)$
$m_3(t) = t + 60$ if $t \in [0,60)$	$a_3(m) = 60$ if $m = 120$
$m_3(t) = 120$ if $t \in [60,120]$	

Strategy Sender period 4 (Naive)	Strategy Receiver period 4 (Naive)
$m_4(t) \sim U[0,120)$ if $t \in [0,30)$	$a_4(m) = 0$ if $m \in [0,120)$
$m_4(t) = 120$ if $t \in [30,120]$	$a_4(m) = 60$ if $m = 120$

Hence, from period 4, the dynamic is and stays in the separating equilibrium.

Now we turn to the prediction error. Let the equilibrium profile be σ^e and the attracting profile σ^a. Then, the average (or expected) prediction error of an equilibrium for the attracting profile is $E\left[|a^e(m^e(t)) - a^a(m^a(t))|\right]$. The average prediction error of the separating equilibrium is obviously 0. The prediction error of the pooling equilibrium is $\frac{1}{120}\left(\int_0^{30} |45-0|\,dt + \int_{30}^{120} |45-60|\,dt\right) = 45/2$.

3 B=130

For $B = 130$, consider the following state r':

Strategy Sender period r'	Strategy Receiver period r'
$m_{r'}(t) = m^1$ if $t \in [0, t^1)$	$a_{r'}(m) = 0$ if $m \in \{m^1, m^2\}$
$m_{r'}(t) = m^2$ if $t \in [t^1, t^2)$	$a_{r'}(m) = a^1$ if $m = m^3$
$m_{r'}(t) = m^3$ if $t \in [t^2, 130]$	

with the restriction that $0 \leq t^1 < t^2 < 50$ and $50 < a1 < 70$. m^1, m^2, m^3 can be any three messages.

Then, by straightforwardly applying the neologism dynamic, we get the following for rounds $r'+1, r'+2, r'+3$ and $r'+4$

Strategy Sender period $r'+1$	Strategy Receiver period $r'+1$
$m_{r'+1}(t) \sim U\{m^1, m^2\}$ if $t \in [0, a^1/2)$	$a_{r'+1}(m) = 0$ if $m \in \{m^1, m^2\}$
$m_{r'+1}(t) = m^3$ if $t \in [a^1/2, 35 + a^1/2]$	$a_{r'+1}(m) = 45 + t^2/4$ if $m = m^3$
$m_{r'+1}(t) = n^1$ if $t \in (35 + a^1/2, 130]$	$a_{r'+1}(m) = 70$ if $m = n^1$

where n^1 is the credible neologism $\langle 70, (35 + a^1/2, 130] \rangle$. Furthermore, a Sender in $[0, a^1/2)$, will randomize uniformly over m^1 and m^2.

Strategy Sender period $r'+2$	Strategy Receiver period $r'+2$
$m_{r'+2}(t) \sim U\{m^1, m^2\}$ if $t \in [0, 45/2 + t^2/4)$	$a_{r'+1}(m) = 0$ if $m \in \{m^1, m^2\}$
$m_{r'+2}(t) = m^3$ if $t \in [45/2 + t^2/4, 115/2 + t^2/4)$	$a_{r'+1}(m) = a^1/2 - 25$ if $m = m^3$
$m_{r'+2}(t) = n^1$ if $t \in [115/2 + t^2/4, 130]$	$a_{r'+1}(m) = 70$ if $m = n^1$

Hence, if player type is in $[0, a^1/2)$, then she will randomize uniformly over m^1 and m^2.

Strategy Sender period $r'+3$	Strategy Receiver period $r'+3$
$m_{r'+3}(t) \sim U\{m^1, m^2\}$ if $t \in [0, a^1/4 - 25/2)$	$a_{r'+3}(m) = 0$ if $m \in \{m^1, m^2\}$
$m_{r'+3}(t) = m^3$ if $t \in [a^1/4 - 25/2, a^1/4 + 45/2)$	$a_{r'+3}(m) = t^2/4 - 5/2$ if $m = m^3$
$m_{r'+3}(t) = n^1$ if $t \in [a^1/4 + 45/2, 130]$	$a_{r'+3}(m) = 70$ if $m = n^1$

Strategy Sender period $r'+4$	Strategy Receiver period $r'+4$
$m_{r'+4}(t) \sim U\{m^1, m^2\}$ if $t \in [0, t^2/8 - 5/4)$	$a_{r'+4}(m) = 0$ if $m \in \{m^1, m^2, m^3\}$
$m_{r'+4}(t) = m^3$ if $t \in [t^2/8 - 5/4, t^2/8 + 135/4)$	$a_{r'+4}(m) = a^1/8 + 225/4$ if $m = n^1$
$m_{r'+4}(t) = n^1$ if $t \in [t^2/8 + 135/4, 130]$	

Hence, starting at period r',we can characterize f^4 by $a^1_{p+1} = a^1_p/8 + 225/4$, t^1_p, $t^1_{p+1} = t^2_p/8 - 5/4$ and $t^2_{p+1} = 135/4 + t^2_{p+1}/8$ (as long as $0 \leq t^1_p < t^2_p < 50$ and $50 < a^1_p < 70$).

$a^1_p = 450/7, t^2_p = 270/7$ and $t^1_p = 25/7$ is a steady state and attractor to which the dynamic converges monotonically. Hence, if in some period the strategy profile meets the conditions in r', then f converges to the 4-cycle characterized by above values.

We proceed to give the first periods of the neologism dynamic for the babbling and naive initial conditions. We end as soon as the dynamic meets the sufficient conditions for their respective attractors specified above.

If we start with a babbling profile in period 1, the neologism dynamic proceeds as follows:

Strategy Sender period 1 (Babbling)	Strategy Receiver period 1 (Babbling)
$m_1(t) \sim U[0,130]$ if $t \in [0,130]$	$a_1(m) = 45$ for all $m \in [0,130]$

Strategy Sender period 2 (Babbling)	Strategy Receiver period 2 (Babbling)
$m_2(t) = n^1$ if $t \in [0,45/2)$	$a_2(m) = 0$ if $m = n^1$
$m_2(t) \sim U[0,130]$ if $t \in [45/2,115/2]$	$a_2(m) = 45$ if $m \in [0,130]$
$m_2(t) = n^2$ if $t \in (115/2,130]$	$a_2(m) = 70$ if $m = n^2$

where $n^1 = \langle 0, [0,45/2) \rangle$ and $n^2 = \langle 70, (115/2,130] \rangle$

Strategy Sender period 3 (Babbling)	Strategy Receiver period 3 (Babbling)
$m_3(t) = n^1$ if $t \in [0,45/2)$	$a_3(m) = 0$ if $m \in [0,130] \cup \{n^1\}$
$m_3(t) \sim U[0,130]$ if $t \in [45/2,115/2)$	$a_3(m) = 70$ if $m = n^2$
$m_3(t) = n^2$ if $t \in [115/2,130]$	

Strategy Sender period 4 (Babbling)	Strategy Receiver period 4 (Babbling)
$m_4(t) \sim U[0,130] \cup \{n^1\}$ if $t \in [0,35)$	$a_4(m) = 0$ if $m \in [0,130] \cup \{n^1\}$
$m_4(t) = n^2$ if $t \in [35,130]$	$a_4(m) = 70$ if $m = n^2$

Strategy Sender period 5 (Babbling)	Strategy Receiver period 5 (Babbling)
$m_5(t) \sim U[0,130] \cup \{n^1\}$ if $t \in [0,35)$	$a_5(m) = 0$ if $m \in [0,130] \cup \{n^1\}$
$m_5(t) = n^2$ if $t \in [35,130]$	$a_5(m) = 125/2$ if $m = n^2$

Strategy Sender period 6 (Babbling)	Strategy Receiver period 6 (Babbling)
$m_6(t) \sim U[0,130] \cup \{n^1\}$ if $t \in [0,125/4)$	$a_6(m) = 0$ if $m \in [0,130] \cup \{n^1\}$
$m_6(t) = n^2$ if $t \in (125/4,265/4]$	$a_6(m) = 125/2$ if $m = n^2$
$m_6(t) = n^3$ if $t \in (265/4,130]$	$a_6(m) = 70$ if $m = n^3$

where $n^3 = \langle 70, (265/4,130] \rangle$

Strategy Sender period 7 (Babbling)	Strategy Receiver period 7 (Babbling)
$m_7(t) \sim U[0,130] \cup \{n^1\}$ if $t \in [0, 125/4)$	$a_7(m) = 0$ if $m \in [0,130] \cup \{n^1\}$
$m_7(t) = n^2$ if $t \in [125/4, 265/4)$	$a_7(m) = 25/4$ if $m = n^2$
$m_7(t) = n^3$ if $t \in [265/4, 130]$	$a_7(m) = 70$ if $m = n^3$

Strategy Sender period 8 (Babbling)	Strategy Receiver period 8 (Babbling)
$m_8(t) \sim U[0,130] \cup \{n^1\}$ if $t \in [0, 25/8)$	$a_8(m) = 0$ if $m \in [0,130] \cup \{n^1, n^2\}$
$m_8(t) = n^2$ if $t \in [25/8, 305/8)$	$a_8(m) = 25/4$ if $m = n^2$
$m_8(t) = n^3$ if $t \in [305/8, 130]$	$a_8(m) = 70$ if $m = n^3$

Strategy Sender period 9 (Babbling)	Strategy Receiver period 9 (Babbling)
$m_9(t) \sim U[0,130] \cup \{n^1, n^2\}$ if $t \in [0, 25/8)$	$a_9(m) = 0$ if $m \in [0,130] \cup \{n^1, n^2\}$
$m_9(t) = n^2$ if $t \in [25/8, 585/16]$	$a_9(m) = 1025/16$ if $m = n^3$
$m_9(t) = n^3$ if $t \in [585/16, 130]$	

Strategy Sender period 10 (Babbling)	Strategy Receiver period 10 (Babbling)
$m_{10}(t) \sim U[0,130] \cup \{n^1, n^2\}$ if $t \in [0, 1025/32)$	$a_{10}(m) = 0$ if $m \in [0,130] \cup \{n^1, n^2\}$
$m_{10}(t) = n^3$ if $t \in [1025/32, 2145/32]$	$a_{10}(m) = 125/2$ if $m = n^3$
$m_{10}(t) = n^4$ if $t \in (2145/32, 130]$	$a_{10}(m) = 70$ if $m = n^4$

where $n^4 = \langle 70, (2145/32, 130] \rangle$

Strategy Sender period 11 (Babbling)	Strategy Receiver period 11 (Babbling)
$m_{11}(t) \sim U[0,130] \cup \{n^1, n^2\}$ if $t \in [0, 125/4)$	$a_{11}(m) = 0$ if $m \in [0,130] \cup \{n^1, n^2\}$
$m_{11}(t) = n^3$ if $t \in [125/4, 265/4)$	$a_{11}(m) = 225/32$ if $m = n^3$
$m_{11}(t) = n^4$ if $t \in [265/4, 130]$	$a_{11}(m) = 70$ if $m = n^4$

Strategy Sender period 12 (Babbling)	Strategy Receiver period 12 (Babbling)
$m_{12}(t) \sim U[0,130] \cup \{n^1, n^2\}$ if $t \in [0, 225/64)$	$a_{12}(m) = 0$ if $m \in [0,130] \cup \{n^1, n^2\}$
$m_{12}(t) = n^3$ if $t \in [225/64, 2465/64)$	$a_{12}(m) = 25/4$ if $m = n^3$
$m_{12}(t) = n^4$ if $t \in [2465/64, 130]$	$a_{12}(m) = 70$ if $m = n^4$

Strategy Sender period 13 (Babbling)	Strategy Receiver period 13 (Babbling)
$m_{13}(t) \sim U[0,130] \cup \{n^1, n^2\}$ if $t \in [0, 25/8)$	$a_{13}(m) = 0$ if $m \in [0,130] \cup \{n^1, n^2, n^3\}$
$m_{13}(t) = n^3$ if $t \in [25/8, 305/8)$	$a_{13}(m) = 8225/128$ if $m = n^4$
$m_{13}(t) = n^4$ if $t \in [305/8, 130]$	

Now, $t^1_{13} = 25/8 < t^2_{13} = 305/8 < 50$ and $50 < a^1_{13} = 8225/128 < 70$ Hence, period 13 meets the requirements of round r' and the dynamic converges to the attracting four-cycle.

If we start with a naive profile in period 1, the neologism dynamic proceeds as follows:

Strategy Sender period 1 (Naive)	Strategy Receiver period 1 (Naive)
$m_1(t) = t$ if $t \in [0, 130]$	$a_1(m) = 0$ if $m \in [0, 60]$
	$a_1(m) = m - 60$ if $m \in [60, 130]$

Strategy Sender period 2 (Naive)	Strategy Receiver period 2 (Naive)
$m_2(t) \sim U[0,60]$ if $t = 0$	$a_1(m) = 0$ if $m \in [0,60]$
$m_2(t) = t + 60$ if $t \in (0,70)$	$a_1(m) = m - 60$ if $m \in [60,130]$
$m_2(t) = 130$ if $t \in [70,130]$	

Strategy Sender period 3 (Naive)	Strategy Receiver period 3 (Naive)
$m_3(t) \sim U[0,60]$ if $t = 0$	$a_3(m) = 0$ if $m \in [0,120)$
$m_3(t) = t + 60$ if $t \in [0,70)$	$a_3(m) = m - 120$ if $m \in [120,130)$
$m_3(t) = 120$ if $t \in [70,130]$	$a_3(m) = 70$ if $m = 130$

Strategy Sender period 4 (Naive)	Strategy Receiver period 4 (Naive)
$m_4(t) \sim U[0,120]$ if $t = 0$	$a_4(m) = 0$ if $m \in [0,120)$
$m_4(t) = t + 120$ if $t \in [0,10)$	$a_4(m) = m - 120$ if $m \in [120,130)$
$m_4(t) = 130 - \epsilon$ if $t \in [10,40)$	$a_4(m) = 70$ if $m = 130$
$m_4(t) = 130$ if $t \in [40,130]$	

Strategy Sender period 5 (Naive)	Strategy Receiver period 5 (Naive)
$m_5(t) \sim U[0,120]$ if $t = 0$	$a_5(m) = 0$ if $m \in [0,130)$
$m_5(t) = t + 120$ if $t \in [0,10)$	$a_5(m) = 65$ if $m = 130$
$m_5(t) = 130 - \epsilon$ if $t \in [10,40)$	
$m_5(t) = 130$ if $t \in [40,130]$	

Strategy Sender period 6 (Naive)	Strategy Receiver period 6 (Naive)
$m_6(t) \sim U[0,130)$ if $t \in [0,65/2)$	$a_6(m) = 0$ if $m \in [0,130)$
$m_6(t) = 130$ if $t \in [65/2,135/2]$	$a_6(m) = 65$ if $m = 130$
$m_6(t) = n_1$ if $t \in (135/2,130]$	$a_6(m) = 70$ if $m = n_1$

where $n_1 = \langle 70, (135/2, 130] \rangle$.

Strategy Sender period 7 (Naive)	Strategy Receiver period 7 (Naive)
$m_7(t) \sim U[0,130)$ if $t \in [0,65/2)$	$a_7(m) = 0$ if $m \in [0,130)$
$m_7(t) = 130$ if $t \in [65/2,135/2]$	$a_7(m) = 15/2$ if $m = 130$
$m_7(t) = n_1$ if $t \in (135/2,130]$	$a_7(m) = 70$ if $m = n_1$

Strategy Sender period 8 (Naive)	Strategy Receiver period 8 (Naive)
$m_8(t) \sim U[0,130)$ if $t \in [0,15/4)$	$a_8(m) = 0$ if $m \in [0,130)$
$m_8(t) = 130$ if $t \in [15/4,155/4]$	$a_8(m) = 15/2$ if $m = 130$
$m_8(t) = n_1$ if $t \in (155/4,130]$	$a_8(m) = 70$ if $m = n_1$

Strategy Sender period 9 (Naive)	Strategy Receiver period 9 (Naive)
$m_9(t) \sim U[0,130)$ if $t \in [0,15/4)$	$a_9(m) = 0$ if $m \in [0,130]$
$m_9(t) = 130$ if $t \in [15/4,155/4]$	$a_9(m) = 515/8$ if $m = n_1$
$m_9(t) = n_1$ if $t \in (155/4,130]$	

Now, $t_9^1 = 15/4 < t_9^2 = 155/4 < 50$ and $50 < a_9^1 = 515/8 < 70$ Hence, period 9 meets the requirements of round r' and the dynamic converges to the attracting four-cycle.

Finally, we turn to the prediction errors for the attracting four-cycle. First the pooling equilibrium. In the same way as above, it can be straightforwardly calculated that prediction error of the pooling equilibirum in periods r',$r'+1$, $r'+2$, $r'+3$ is respectively equal to $\frac{17145}{637}$, $\frac{2585}{91}$, $\frac{304}{91}$, $\frac{2640}{91}$. Hence, the average prediction error of the pooling equilibrium over the four cycle is $\frac{18750}{637} \simeq 29.4$. The prediction error of the separating equilibrium in periods r',$r'+1$, $r'+2$, $r'+3$ is respectively equal to $\frac{4440}{637}$, $\frac{635}{91}$, $\frac{1825}{91}$, $\frac{7625}{91}$. Hence, the average prediction error over the four cycle is $\frac{18750}{637} \simeq 29.4$.Hence, the average prediction error of the separating equilibrium over the four cycle is $\frac{29285}{2548} \simeq 11.5$.

4 B=210

We continue with $B = 210$. Consider the following state r':

Strategy Sender period r'	Strategy Receiver period r'
$m_{r'}(t) = m^1$ if $t \in [0, t^1)$	$a_{r'}(m) = 0$ if $m \in \{m^1, m^2\}$
$m_{r'}(t) = m^2$ if $t \in [t^1, t^2)$	$a_{r'}(m) = a^1$ if $m = m^3$
$m_{r'}(t) = m^3$ if $t \in [t^2, t^3)$	$a_{r'}(m) = a^2$ if $m = m^4$
$m_{r'}(t) = m^4$ if $t \in [t^3, t^4)$	$a_{r'}(m) = a^3$ if $m = m^5$
$m_{r'}(t) = m^5$ if $t \in [t^4, t^5]$	$a_{r'}(m) = a^4$ if $m = n^1$
$m_{r'}(t) = n^1$ if $t \in (t^5, 210]$	

where $t^1 < t^2 < t^3 < t^4 < t^5$ with $0 < t^1 < 15$, $t^3 < 60$ and $t^5 < 90$; $0 < a^1 < a^2 < a^3 < a^4$ with $a^2 < 30$ and $a^4 < 90$ and $n^1 = \langle a^4, [t^5, 210] \rangle$.

Then, by straightforwardly applying the neologism dynamic, we get for round $r'+1$:

Strategy Sender period $r'+1$	Strategy Receiver period $r'+1$
$m_{r'+1}(t) = m^1$ if $t \in [0, a^1/2)$	$a_{r'+1}(m) = 0$ if $m \in \{m^1, m^2, m^3\}$
$m_{r'+1}(t) = m^3$ if $t \in [a^1/2, (a^1+a^2)/2)$	$a_{r'+1}(m) = t^4 - 60$ if $m = m^4$
$m_{r'+1}(t) = m^4$ if $t \in [(a^1+a^2)/2, (a^2+a^3)/2)$	$a_{r'+1}(m) = t^5 - 60$ if $m = m^5$
$m_{r'+1}(t) = m^5$ if $t \in [(a^2+a^3)/2, (a^3+a^4)/2)$	$a_{r'+1}(m) = 45 + t^5/2$ if $m = n^1$
$m_{r'+1}(t) = n^1$ if $t \in [(a^3+a^4)/2, \frac{2}{3}(45+a^4)]$	$a_{r'+1}(m) = 60 + a^4/3$ if $m = n^2$
$m_{r'+1}(t) = n^2$ if $t \in (\frac{2}{3}(45+a^4), 210]$	

where $n^2 = \left\langle 60 + a^4/3, (\frac{2}{3}(45+a^4), 210] \right\rangle$.

Hence,for period $r \geq r'$we can describe f by $a^4_{r+1} = 60 + a^4_r/3$, $t^5_{r+1} = \frac{2}{3}(45 + a^4_r/3)$, $a^3_{r+1} = 45 + t^5_r/2$, $t^4_{r+1} = \frac{1}{2}(a^3_r + a^4_r)$, $a^2_{r+1} = t^5_r - 60$, $t^3_{r+1} = \frac{1}{2}(a^2_r + a^3_r)$, $a^1_{r+1} = t^4_r - 60$, $t^2_{r+1} = \frac{1}{2}(a^1_r + a^2_r)$, $t^1_{r+1} = \frac{1}{2}a^1_r$ (as long as $a^1_r, ..., a^5_r$ and $t^1_r, ..., t^5_r$ meet the above conditions).

Since $a^4_{r+1} = 60 + a^4_r/3$, a^4_r converges monotonically to 90. Consequently, it follows that

$a_r^4 = 90, t_r^5 = 90,\ a_r^3 = 90,\ \ t_r^4 = 90,\ a_r^2 = 30,\ \ t_r^3 = 60, a_r^1 = 30,\ \ t_r^2 = 30$ and $t_r^1 = 15$ is an attractor for this dynamic to which converges.(It is not a steady state, as if $a_r^4 = 90$, then no neologism could be made. Nonetheless, the profile is never reached and all points in its neighboorhood converge to it.)

We now proceed to give the first periods of the neologism dynamic for the babbling and naive initial conditions.

If we start with a babbling profile in period 1, the neologism dynamic proceeds as follows:

Strategy Sender period 1 (Babbling)	Strategy Receiver period 1 (Babbling)
$m_1(t) \sim U[0,210]$ if $t \in [0,210]$	$a_1(m) = 45$ for all $m \in [0,210]$

Strategy Sender period 2 (Babbling)	Strategy Receiver period 2 (Babbling)
$m_2(t) = n^1$ if $t \in [0,45/2)$	$a_2(m) = 0$ if $m = n^1$
$m_2(t) \sim U[0,210]$ if $t \in [45/2,60]$	$a_2(m) = 45$ if $m \in [0,210]$
$m_2(t) = n^2$ if $t \in (60,210]$	$a_2(m) = 75$ if $m = n^2$

where $n^1 = \langle 0, [0,45/2) \rangle$ and $n^2 = \langle 75, (60,210] \rangle$

Strategy Sender period 3 (Babbling)	Strategy Receiver period 3 (Babbling)
$m_3(t) = n^1$ if $t \in [0,45/2)$	$a_3(m) = 0$ if $m \in [0,210] \cup \{n^1\}$
$m_3(t) \sim U[0,210]$ if $t \in [45/2,60)$	$a_3(m) = 75$ if $m = n^2$
$m_3(t) = n^2$ if $t \in [60,80]$	$a_3(m) = 85$ if $m = n^3$
$m_3(t) = n^3$ if $t \in (80,210]$	

where $n^3 = \langle 85, (80,210] \rangle$

Strategy Sender period 4 (Babbling)	Strategy Receiver period 4 (Babbling)
$m_4(t) \sim U[0,210] \cup \{n^1\}$ if $t \in [0,75/2)$	$a_4(m) = 0$ if $m \in [0,210] \cup \{n^1\}$
$m_4(t) = n^2$ if $t \in [75/2,80)$	$a_4(m) = 20$ if $m = n^2$
$m_4(t) = n^3$ if $t \in [80,260/3]$	$a_4(m) = 85$ if $m = n^3$
$m_4(t) = n^4$ if $t \in (260/3,210]$	$a_4(m) = 265/3$ if $m = n^4$

where $n^4 = \langle 265/3, (260/3,210] \rangle$

Strategy Sender period 5 (Babbling)	Strategy Receiver period 5 (Babbling)
$m_5(t) \sim U[0,210] \cup \{n^1\}$ if $t \in [0,10)$	$a_5(m) = 0$ if $m \in [0,210] \cup \{n^1\}$
$m_5(t) = n^2$ if $t \in [10,105/2)$	$a_5(m) = 20$ if $m = n^2$
$m_5(t) = n^3$ if $t \in [105/2,260/3)$	$a_5(m) = 80/3$ if $m = n^3$
$m_5(t) = n^4$ if $t \in [260/3,800/9]$	$a_5(m) = 265/3$ if $m = n^4$
$m_5(t) = n^5$ if $t \in (800/9,210]$	$a_5(m) = 805/9$ if $m = n^5$

where $n^5 = \langle 805/9, (800/9,210] \rangle$

Strategy Sender period 6 (Babbling)	Strategy Receiver period 6 (Babbling)
$m_6(t) \sim U[0,210] \cup \{n^1\}$ if $t \in [0,10)$	$a_6(m) = 0$ if $m \in [0,210] \cup \{n^1, n^2\}$
$m_6(t) = n^2$ if $t \in [10, 70/3)$	$a_6(m) = 80/3$ if $m = n^3$
$m_6(t) = n^3$ if $t \in [70/3, 115/2)$	$a_6(m) = 260/9$ if $m = n^4$
$m_6(t) = n^4$ if $t \in [115/2, 800/9)$	$a_6(m) = 805/9$ if $m = n^5$
$m_6(t) = n^5$ if $t \in [800/9, 2420/5]$	$a_6(m) = 2425/27$ if $m = n^6$
$m_6(t) = n^6$ if $t \in (2420/27, 210]$	

where $n^6 = \langle 2425/27, (2420/27, 210] \rangle$

Now, $0 < t_6^1 = 10 < 15$, $t_6^3 = 115/2 < 60$, $t_6^5 = 2420/27 < 90$, $a_6^2 = 260/9 < 30$ and $a_6^4 = 2425/27 < 90$ Hence, period 6 meets the requirements of round r' and the dynamic converges to the attractor.

If we start with a naive profile in period 1, the neologism dynamic proceeds as follows:

Strategy Sender period 1 (Naive)	Strategy Receiver period 1 (Naive)
$m_1(t) \ = t$ if $t \in [0, 210]$	$a_1(m) = 0$ if $m \in [0, 60]$
	$a_1(m) = m - 60$ if $m \in [60, 210]$

Strategy Sender period 2 (Naive)	Strategy Receiver period 2 (Naive)
$m_2(t) \sim U[0, 60]$ if $t = 0$	$a_2(m) = 0$ for all $m \in [0, 60]$
$m_2(t) = t + 60$ if $t \in (0, 150)$	$a_2(m) = m - 60$ for all $m \in [60, 210]$
$m_2(t) = 210$ if $t \in [150, 210]$	

Strategy Sender period 3 (Naive)	Strategy Receiver period 3 (Naive)
$m_3(t) \sim U[0, 60]$ if $t = 0$	$a_3(m) = 0$ if $m \in [0, 120)$
$m_3(t) = t + 60$ if $t \in (0, 150)$	$a_3(m) = m - 120$ if $m \in [120, 210)$
$m_3(t) = 210$ if $t \in [150, 210]$	$a_3(m) = 120$ if $m = 210$

Strategy Sender period 4 (Naive)	Strategy Receiver period 4 (Naive)
$m_4(t) \sim U[0, 120]$ if $t = 0$	$a_4(m) = 0$ if $m \in [0, 120)$
$m_4(t) = t + 120$ if $t \in (0, 90)$	$a_4(m) = m - 120$ if $m \in [120, 210)$
$m_4(t) = 210 - \epsilon$ if $t \in [90, 105)$	$a_4(m) = 120$ if $m = 210$
$m_4(t) = 210$ if $t \in [105, 210]$	

Strategy Sender period 5 (Naive)	Strategy Receiver period 5 (Naive)
$m_5(t) \sim U[0, 120]$ if $t = 0$	$a_5(m) = 0$ if $m \in [0, 180)$
$m_5(t) = t + 120$ if $t \in (0, 90)$	$a_5(m) = m - 180$ if $m \in [180, 210 - \epsilon)$
$m_5(t) = 210 - \epsilon$ if $t \in [90, 105)$	$a_5(m) = 45$ if $m = 210 - \epsilon$
$m_5(t) = 210$ if $t \in [105, 210]$	$a_5(m) = 195/2$ if $m = 210$

Strategy Sender period 6 (Naive)	Strategy Receiver period 6 (Naive)
$m_6(t) \sim U[0,180]$ if $t=0$	$a_6(m)=0$ if $m\in[0,180)$
$m_6(t)=t+180$ if $t\in(0,30)$	$a_6(m)=m-180$ if $m\in[180,210-\epsilon)$
$m_6(t)=210-2\epsilon$ if $t\in[30,75/2)$	$a_6(m)=45$ if $m=210-\epsilon$
$m_6(t)=210-\epsilon$ if $t\in[75/2,285/4)$	$a_6(m)=195/2$ if $m=210$
$m_6(t)=210$ if $t\in[285/4,210]$	

Strategy Sender period 7 (Naive)	Strategy Receiver period 7 (Naive)
$m_6(t) \sim U[0,180]$ if $t=0$	$a_7(m)=0$ if $m\in[0,210-2\epsilon)$
$m_7(t)=t+180$ if $t\in(0,30)$	$a_7(m)=45/4$ if $m=210-\epsilon$
$m_7(t)=210-2\epsilon$ if $t\in[30,75/2)$	$a_7(m)=645/8$ if $m=210$
$m_7(t)=210-\epsilon$ if $t\in[75/2,285/4)$	
$m_7(t)=210$ if $t\in[285/4,210]$	

Strategy Sender period 8 (Naive)	Strategy Receiver period 8 (Naive)
$m_8(t) \sim U[0,210-2\epsilon)$ if $t\in[0,45/8)$	$a_8(m)=0$ if $m\in[180,210-2\epsilon)$
$m_8(t)=210-\epsilon$ if $t\in[45/8,735/16)$	$a_8(m)=45/4$ if $m=210-\epsilon$
$m_8(t)=210$ if $t\in[735/16,335/4)$	$a_8(m)=645/8$ if $m=210$
$m_8(t)=n^1$ if $t\in[335/4,210]$	$a_8(m)=695/8$ if $m=n^1$

where $n^1=\langle 695/8\ ,(335/4,210]\rangle$

Strategy Sender period 9 (Naive)	Strategy Receiver period 9 (Naive)
$m_9(t) \sim U[0,210-2\epsilon)$ if $t\in[0,45/8)$	$a_9(m)=0$ if $m\in[0,210-\epsilon)$
$m_9(t)=210-\epsilon$ if $t\in[45/8,735/16)$	$a_9(m)=95/4$ if $m=210$
$m_9(t)=210$ if $t\in[735/16,335/4)$	$a_9(m)=695/8$ if f $m=n^1$
$m_9(t)=n^1$ if $t\in[335/4,1055/12]$	$a_9(m)=2135/24$ if $m=n^2$
$m_9(t)=n^2$ if $t\in(1055/12,210]$	

where $n^2=\langle 2135/24\ ,(1055/12,210]\rangle$

Strategy Sender period 10 (Naive)	Strategy Receiver period 10 (Naive)
$m_{10}(t) \sim U[0,210-\epsilon)$ if $t\in[0,95/8)$	$a_{10}(m)=0$ if $m\in[0,210-\epsilon)$
$m_{10}(t)=210$ if $t\in[95/8,885/16)$	$a_{10}(m)=95/4$ if $m=210$
$m_{10}(t)=n^1$ if $t\in[885/16,1055/12)$	$a_{10}(m)=335/12$ if $m=n^1$
$m_{10}(t)=n^2$if $t\in[1055/12,3215/36]$	$a_{10}(m)=2135/24$ if $m=n^2$
$m_{10}(t)=n^3$if $t\in(3215/36,210]$	$a_{10}(m)=6455/72$if $m=n^3$

where $n^3=\langle 6455/72\ ,(3215/36,210]\rangle$

Strategy Sender period 11 (Naive)	Strategy Receiver period 11 (Naive)
$m_{11}(t) \sim U[0,210-\epsilon)$ if $t\in[0,95/8)$	$a_{11}(m)=0$ if $m\in[0,210]$
$m_{11}(t)=210$ if $t\in[95/8,155/6)$	$a_{11}(m)=335/12$ if $m=n^1$
$m_{11}(t)=n^1$ if $t\in[155/6,935/16)$	$a_{11}(m)=1055/36$ if f $m=n^2$
$m_{11}(t)=n^2$if $t\in[935/16,3215/36)$	$a_{11}(m)=6455/72$ if $m=n^3$
$m_{11}(t)=n^3$if $t\in[3215/36,9695/108]$	$a_{11}(m)=19415/216$ if $m=n^4$
$m_{11}(t)=n^4$if $t\in(9695/108,210]$	

where $n^4=\langle 19415/216\ ,(9695/108,210]\rangle$

Now, $t^1_{11} = 95/8 < 15$, $t^3_{11} = 935/16 < 60$, $t^5_{11} = 9695/108 < 90$, $a^2_{11} = 1055/36 < 30$ and $a^4_{11} = 19415/216 < 90$ Hence, period 11 meets the requirements of round r' and the dynamic converges to the attractor.

Finally, we turn to the prediction errors for of the equilibria with respect to the attractor. The average prediction error of the pooling equilibrium is equal to $\frac{285}{7} \simeq 40.7$. The average prediction error of the separating equilibrium is equal to $\frac{195}{7} \simeq 27.9$.