How fully do people exploit their bargaining position? The effects of bargaining institution and the 50–50 norm

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Abstract

A recurring puzzle in bargaining experiments is that individuals under–exploit their bargaining position, compared to theoretical predictions. We conduct an experiment using two institutions: Nash demand game (NDG) and unstructured bargaining game (UBG). Unlike most previous experiments, disagreement payoffs are *earned* rather than assigned, and about one–fourth of the time, one bargainer's disagreement payoff is more than half the cake size ("dominant bargaining power"), so that equal splits are not individually rational.

Subjects under–respond to their bargaining position most severely in the NDG without dominant bargaining power. Responsiveness increases in the UBG, but is still lower than predicted; the same is true for the NDG with dominant bargaining power. Only in the UBG with dominant bargaining power – the combination of a bargaining institution with low strategic uncertainty and elimination of the 50–50 "security blanket" – do subjects approximately fully exploit their bargaining position.

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1 Background

Bargaining is pervasive. Its role in determining prices is well known: even in Western societies, where haggling over small purchases has been de–emphasised, large goods (e.g., new and used cars, houses) are often sold by bargaining. Bargaining is frequently used to set employees' compensation packages and other working conditions, at either the group level (for unionised jobs) or the individual level (in many professional labour markets).[1] Collective decision making in politics is often modelled using a bargaining framework (e.g., Baron and Ferejohn (1989) use a multi–player version of the Nash demand game to investigate the behaviour of legislatures). Bargaining settings are also used to understand pre–trial behaviour in legal disputes (Daughety, 2000; Spier, 2007) and international treaty negotiations (see, e.g., Fisher and Ury's (1981) discussion of the role of bargaining during the 1973–1982 Third United Nations Conference on the Law of the Sea). Thomas Schelling was not exaggerating when he famously noted that "[t]o study the strategy of conflict is to take the view that most conflict situations are essentially bargaining situations" (Schelling, 1960, p. 5).

A fundamental principle of bargaining is that outcomes depend on bargaining power. Even before bargaining settings were thought of as leading to precise predictions, it was generally understood that the division of surplus would depend on the two parties' relative bargaining positions (Edgeworth, 1881). Later axiomatic bargaining solution concepts (e.g., Nash, 1950; Kalai and Smorodinsky, 1975) formalised this dependence and quantified it by specifying a precise outcome – the bargaining solution – based on the most important features of the environment. Even non–cooperative game–theoretic approaches, which may yield a multiplicity of theoretical predictions, can narrow these down to a unique prediction with minor additional assumptions. With a unique prediction comes a well–defined comparative–static relationship between specific features of the environment – in particular, the bargaining position of one player relative to the other – and that prediction.

Whether these theoretical implications are seen in real bargaining is an empirical question. Previous research (see Section 3) suggests that bargainers are actually less responsive to changes in bargaining position than predicted, and in particular, the social norm of 50–50 splits of the "cake" (the amount being bargained over) seems to exert a powerful pull on outcomes.[2] While the extent of this under–responsiveness varies widely across studies, there has been surprisingly little systematic examination of the factors associated with it: in what settings do people tend to exploit their bargaining power to a greater or lesser degree, how much impact do individual aspects of the bargaining setting have, and are there any settings where

[1] Indeed, many researchers have suggested that male–female wage gaps are at least partly due to sex differences in willingness or ability to bargain; see, e.g., Stuhlmacher and Walters (1999), Small et al. (2007) and Fortin (2008).

[2] In this paper, we are agnostic about the reasons behind deviations from the standard theoretical predictions. Two plausible, not mutually–exclusive, reasons are focal points and fairness preferences. Both have long been proposed as explanations for bargaining results, with the importance of focal points noted by Schelling (1960), and fairness explanations dating back at least to Hoffman and Spitzer (1982). Our own previous work has examined the ability of both of these to explain specifically under–responsiveness to changes in bargaining position (see Anbarci and Feltovich, 2013 and 2016 for fairness and focal points respectively).

theoretically predicted levels of exploitation should be expected?

The goal of the current paper is to improve understanding of how bargaining outcomes are shaped by players' bargaining positions. We use a laboratory experiment, allowing us to maintain, in two important ways, a high degree of control over the environment relative to observational studies from the field. First, we are able to standardise the rules under which bargaining takes place, in contrast to field studies that must aggregate bargaining outcomes from heterogeneous and perhaps imperfectly understood bargaining institutions. Second, we give the subjects complete information about the cake size and *disagreement payoffs* (the amounts they get if bargaining is unsuccessful), so that we know, and the subjects had enough information to compute, the theoretical prediction for any particular bargaining pair.

We implement differences in bargaining position via the disagreement outcome, so that it can vary nearly continuously over a wide range of possible levels, in contrast to many earlier studies that varied bargaining power in lumpier ways (e.g., first– versus second–mover, number of bargaining stages, endogenous versus random breakdown). Bargaining theory displays remarkable consensus regarding the predicted effect of the disagreement outcome. All of the most common axiomatic bargaining solutions – as well as those non–cooperative techniques that yield unique solutions – have exactly the same implication for this setting: a unit increase in one's own disagreement payoff implies a one–half unit *increase* in one's own payoff as a result of bargaining, while a unit increase in one's opponent's disagreement payoff implies a corresponding one–half unit *decrease*. We call these the *own–disagreement–payoff effect* and *opponent–disagreement–payoff effect*, and their sum – a measure of overall responsiveness to bargaining position – the *combined [disagreement–payoff] effect*.

Subjects in our experiment bargain under one of two bargaining institutions, both widespread in bargaining experiments and in theoretical modelling of the bargaining process. In the *Nash demand game* (NDG), bargaining consists of a single pair of simultaneous demands. If these total the cake size or less, then each bargainer receives the amount demanded; otherwise they receive their disagreement payoffs. In the *unstructured bargaining game* (UBG), bargainers are given a known time interval, during which either one can make proposals for splitting the cake. If no proposal is accepted before the time runs out, the bargainers receive their disagreement payoffs.

Although the distribution of bargaining power in our experiment is typically asymmetric due to the bargainers having different disagreement payoffs, the two institutions themselves are symmetric in the sense that neither bargainer is given a structural advantage (in contrast, for example, to the ultimatum game or Rubinstein (1982) bargaining, both of which favour the first mover). However, the two institutions have markedly different levels of strategic uncertainty, resulting in a much more severe coordination problem in the NDG than the UBG; previous research (Feltovich and Swierzbinski, 2011) has found this not only leads to fewer agreements in the NDG, but for agreements to gravitate toward 50–50 splits of the cake. Because of this, we hypothesise that subjects will be less responsive to changes in their bargaining power in that game than in the UBG. That is, disagreement–payoff effects should be *higher in the UBG than in the NDG*.

Our variation of the disagreement outcome gives rise to another set of hypotheses involving the 50–

50 split. About one–fourth of the time, one of the bargainers has a disagreement payoff more than half of the cake size; we call this *dominant bargaining power*. When an individual has dominant bargaining power, agreeing to a 50–50 split involves an actual monetary sacrifice, making it substantially less attractive compared to situations where neither bargainer has dominant bargaining power (in which case a 50–50 split may mean accepting a smaller gain relative to the disagreement payoff than one's co–bargainer, but not an outright money loss). With the focal power of the 50–50 split gone, subjects should be drawn toward alternative focal points like equal sharing *of the surplus* (the remainder of the cake after both disagreement payoffs are subtracted) that entail disagreement–payoff responsiveness equal to the theoretically predicted level. That is, disagreement–payoff effects are expected to be *higher with dominant bargaining power than without it*.

A notable feature of our experimental procedures is the use of *earned* bargaining power. Specifically, subjects' disagreement payoffs, rather than being exogenously selected and assigned by the experimenter, are based on performance on a simple but repetitive "real effort" task. Besides arguably being more realistic (a disagreement payoff in real bargaining – being the value of the best alternative to agreement – is often the result of past decisions, effort, and intrinsic abilities), making subjects earn their bargaining power ought to nudge them toward more fully exploiting it, whether this is due to taking their decisions more seriously in some general sense, or to the effort expended in the task changing perceptions of the bargainers' property rights over the cake. In either case, earned bargaining power should reduce the attraction of the 50–50 split and increase responsiveness to disagreement payoffs. Our experiment is novel, as there have been very few bargaining studies that vary bargaining power nearly continuously through a large range of levels, few in which bargaining power depends on skill and effort, extremely few that vary whether individually rational 50–50 splits can be ruled out, and to our knowledge, none with all of these features.

Our experimental results broadly confirm our conjectures regarding (1) the bargaining institution and (2) dominant bargaining power. When subjects bargain in the NDG and neither of them has dominant bargaining power, we observe severe under–responsiveness. In the UBG with no dominant bargaining power, subjects are substantially more responsive than in the NDG, but still less so than theory predicts. When one bargainer does have dominant bargaining power, by contrast, own– and opponent–disagreement–payoff effects are significantly larger. In the NDG, this increase still leaves responsiveness well below the theoretically predicted level. In the UBG, however, the increase leads to a level of responsiveness in line with the theory. Thus it takes the combination of a bargaining institution with low levels of strategic uncertainty and elimination of the 50–50 "security blanket" for bargaining behaviour to yield outcomes like those predicted by the theory.

2 The bargaining environment

There is a fixed sum of money (a *cake*) available to the players, which we normalise to one. Negative payments are not possible, so a feasible agreement is a non–negative pair totalling one or less. If bargaining is

unsuccessful, the players receive *disagreement payoffs*; the *favoured player* receives d_f and the *unfavoured player* receives d_u, with $d_f \geq d_u \geq 0$ and $d_f + d_u < 1$ (see Figure 1). The values of d_f and d_u (and the cake size of one) are assumed to be common knowledge.

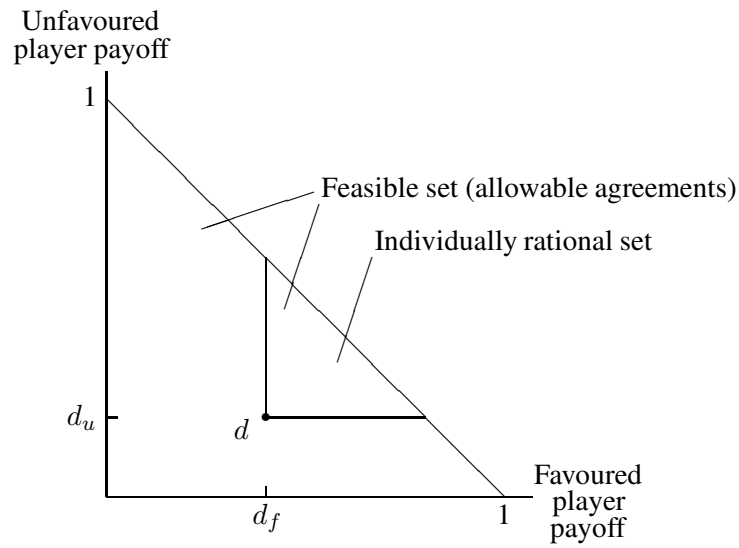

Figure 1: The bargaining environment

2.1 Nash demand game (NDG)

In the Nash (1953) demand game, bargaining consists of a single pair of simultaneously made demands x_f and x_u by the favoured and unfavoured players respectively. If the demands are compatible ($x_f + x_u \leq 1$), then each player receives the amount demanded (with any remainder left "on the table"). If the demands are incompatible ($x_f + x_u > 1$), then they receive their disagreement payoffs.

The NDG is simple enough to be analysed by standard non–cooperative techniques, but the result is not a unique prediction. If Nash equilibrium is the solution concept used, there are many solutions, including (a) efficient pure–strategy equilibria in which $x_f \geq d_f$, $x_u \geq d_u$ and $x_f + x_u = 1$, leading to payoffs (x_f, x_u); (b) inefficient pure–strategy equilibria in which $x_f > 1 - d_u$ and $x_u > 1 - d_f$, with resulting payoffs (d_f, d_u); and (c) inefficient mixed–strategy equilibria with expected payoffs totalling less than 1 but more than $d_f + d_u$.

Equilibrium selection criteria such as payoff dominance or efficiency can reduce the set of equilibria, eliminating the inefficient equilibria mentioned above. Harsanyi and Selten's (1988) criterion of *risk dominance* goes even further, making the unique prediction that players split the surplus (the remainder after disagreement payoffs are subtracted from the cake) evenly: $x_f = \frac{1}{2}(1 + d_f - d_u)$ and $x_u = \frac{1}{2}(1 - d_f + d_u)$. The same prediction is entailed by Harsanyi and Selten's (1988) general solution concept, or by combining payoff dominance (or efficiency) with a notion of symmetry defined relative to the individually rational set (rather than the entire bargaining set).

2.2 Unstructured bargaining game (UBG)

In the unstructured bargaining game, players have a fixed, known amount of time available to negotiate a mutually agreeable division of the cake. Either player can propose any feasible payoff pair. There is no constraint (other than the time available) on the number, ordering and timing of proposals that can be made, and the cake size remains the same until the time runs out. Either player can accept any opponent proposal; the first accepted proposal is implemented. (In case both players accept proposals at the same instant, each is implemented with probability one–half.) If no proposal is accepted before the time limit, the disagreement outcome is imposed.

The UBG is too complex to be analysed by standard non–cooperative game–theoretic methods without making additional assumptions (see, e.g., Simon and Stinchcombe, 1989; Perry and Reny, 1993, 1994; and de Groot Ruiz et al., 2016). Instead, we make use of techniques from cooperative game theory, which says little about the precise strategies used by the two players, but has implications about the bargaining outcome itself. The *core* predicts that the division of the cake corresponds to an efficient Nash equilibrium outcome ($x_f \geq d_f$, $x_u \geq d_u$ and $x_f + x_u = 1$), but makes no sharper prediction. Axiomatic bargaining solution concepts can refine this multiplicity of predicted outcomes to a unique one. If the bargainers are risk–neutral, then the outcome of every well–known axiomatic bargaining solution (including the Nash and Kalai–Smorodinsky solutions) coincides, with $x_f = \frac{1}{2}(1 + d_f - d_u)$ and $x_u = \frac{1}{2}(1 - d_f + d_u)$.

2.3 Disagreement–payoff effects

So, the prediction of Nash equilibrium (with the additional assumptions of either risk dominance or efficiency and symmetry) for the NDG, and the predictions of the well–known axiomatic bargaining solutions for both the NDG and the UBG, all imply the same outcome:

$$x_f = \frac{1}{2}(1 + d_f - d_u) \quad \text{and} \quad x_u = \frac{1}{2}(1 - d_f + d_u), \tag{1}$$

as noted in the last two sections.[3] This solution implies

$$x_f - x_u = d_f - d_u \tag{2}$$

(the difference in the bargainers' payoffs from bargaining is equal to the difference between their disagreement payoffs), or equivalently, $x_f - d_f = x_u - d_u$ (bargainers gain equal amounts over their disagreement

[3]Risk dominance applied to the NDG, and Nash's (1950) axiomatic bargaining solution applied to the UBG, yield identical predictions for general bargaining sets, as long as both settings use the same feasible set and disagreement outcome. This fact, pointed out by Harsanyi and Selten (1988), follows immediately from both concepts' maximisation of the same expression (the "Nash product"). Other ways of relating axiomatic bargaining solutions (often, but not always, Nash's solution) of unstructured bargaining settings to equilibrium play in a suitable structured bargaining setting involve uncertainty about whether incompatible demands could nonetheless be satisfied, or incomplete information about payoffs (e.g., Nash, 1953; Crawford, 1977, 1979; Moulin, 1984; Binmore, 1987; Carlsson, 1991; Carlsson and van Damme, 1993).

payoffs). Also, it implies a sharp theoretical prediction concerning the relationship between the individual disagreement payoffs and the bargaining outcome:

$$\frac{\partial x_f}{\partial d_f} = \frac{\partial x_u}{\partial d_u} = \frac{1}{2} \tag{3}$$

$$\frac{\partial x_f}{\partial d_u} = \frac{\partial x_u}{\partial d_f} = -\frac{1}{2}. \tag{4}$$

That is, both the "own–disagreement–payoff effect" and the "opponent–disagreement–payoff effect" have magnitudes of 0.5.

An obvious corollary is that the sum of these magnitudes (the "combined effect") is unity:

$$\left|\frac{\partial x_f}{\partial d_f}\right| + \left|\frac{\partial x_f}{\partial d_u}\right| = \left|\frac{\partial x_u}{\partial d_f}\right| + \left|\frac{\partial x_u}{\partial d_u}\right| = 1. \tag{5}$$

Indeed, even some bargaining solutions that do not imply own– and opponent–disagreement–payoff effects of one–half still imply that their combined effect is exactly one (e.g., the generalised Nash solution that maximises the expression $[x_f - d_f]^\theta [x_u - d_u]^{1-\theta}$ for given $\theta \in [0, 1]$). Also, Anbarci and Feltovich (2013) show that when bargainers are risk averse with (possibly different) constant absolute risk aversion preferences, both risk dominance and the Nash bargaining solution imply a combined effect of exactly one, and if either has constant relative risk aversion preferences instead, the combined effect is at least one.

3 Related literature

We will not go into detail regarding the huge literature on bargaining experiments in general (for surveys, see Roth, 1995 and Camerer, 2003, pp. 151–198). Despite this expansive literature, there has been very little research into the effects of disagreement outcomes in particular. What previous work there has been has usually varied disagreement outcomes as a "side–treatment", in conjunction with some other manipulation intended to address the primary research question. Hoffman and Spitzer (1982) examined unstructured bargaining games with (in essence) a fixed, known cake size and one of two randomly chosen disagreement outcomes. Disagreement outcomes were very asymmetric: approximately (0.79, 0) and (0, 0.83) in their "Decision 1" and (0.81, 0.08) and (0, 0.85) in their "Decision 2". Hoffman and Spitzer found a substantial frequency of equal splits of the cake, even though such splits require some bargainers to agree to payments well below their disagreement payoffs. Their results taken at face value would suggest that dominant bargaining power has little influence on bargaining outcomes; however, this may carry little implication for our experiment, due to the lack of anonymity in their procedures (not only did their experiment use face–to–face bargaining, but subjects reaching agreement were required to jointly sign a record sheet).

With equal splits frequently occurring even in settings like Hoffman and Spitzer's, it is perhaps not surprising that a strand of the literature has been devoted specifically to the focal nature of equal splits in bargaining. Besides the well–known phenomena of 50–50 splits in ultimatum and dictator games (Roth, 1995, pp. 254–292; Camerer, 2003, pp. 48–59) and in symmetric bargaining (see footnote 6), there have

been several experiments showing large differences in behaviour according to whether 50–50 splits are available. Güth et al. (2001) considered binary ultimatum games where proposers have only two pure strategies: a demand of 85% of the cake and, depending on the treatment, 45%, 50% or 55%. They found that demands of 85% were substantially less frequent when the alternative was 50% (a proposal of an equal split) than when the alternative was either of the other two demands. Falk et al. (2003), also looking at binary ultimatum games, found that responders reject demands of 80% of the cake much more often when the proposer's alternative was a 50% demand than when the alternative was a 100% demand, a 20% demand or a duplicate 80% demand. Levati et al. (2014) elicit preference orderings over outcomes for second movers in a trust game, and dictators in a dictator game, and find that when 50–50 splits are an available option, these subjects are much more likely to submit preferences that are non–single–peaked (and thus inconsistent with own–monetary–payoff maximisation as well as nearly all standard models of other–regarding preferences). Janssen (2006) discusses 50–50 splits as a focal point in both the ultimatum game and the Nash demand game, while Andreoni and Bernheim (2009) present examples of the 50–50 norm in the field and report experimental results suggesting that subjects conform to this norm more closely when deviations can be attributed to themselves (rather than luck).

The first experiment with earned bargaining power was from Hoffman and Spitzer (1985). In some of their cells, favourable bargaining position was assigned randomly, while in others, it was assigned based on performance in a game of skill. Perhaps surprisingly, the way favoured status was assigned had only a minor effect; rather, their data indicate that in order for subjects to exploit their bargaining position, it must be that both (1) bargaining power is perceived by subjects to be earned (their "game trigger" treatment), and (2) instructions make clear that exploiting bargaining power is acceptable behaviour (their "moral authority" treatment), with the latter more important than the former. However, even with *both* a game trigger and moral authority, the favoured player's average payoff from bargaining was still less than her disagreement payoff, though as in their 1982 study, this may be due to a lack of subject anonymity.

Several more recent papers have used effort and/or skill to allocate bargaining roles, typically for ultimatum or dictator games (Hoffman et al., 1994; Schurter and Wilson, 2007; Bolton and Karagözoğlu, 2016; Rodriguez-Lara, 2016). In these settings, under–responsiveness to changes in bargaining position arises naturally from theoretical predictions being on opposite endpoints of the outcome space, but even so, the evidence is fairly mixed about the impact of earned bargaining power. For example, Schurter and Wilson (2007) found dictator–game offers were *lower* when the dictator position is assigned via a quiz than via a die roll, but they were lower still when it was assigned on the basis of seniority (number of credit hours completed or attempted). Other experiments have used effort and/or skill for reasons other than allocating bargaining power: e.g., to determine the cake size (Ruffle, 1998; Konow, 2000; Cherry et al., 2002; Parrett, 2006; Oxoby and Spraggon, 2008; Karagözoğlu and Riedl, 2015; Birkeland, 2011; Corgnet et al., 2011) or to give one bargainer "moral authority" to receive a larger share of the cake (Gächter and Riedl, 2005; Rode and Le Menestrel, 2011; Karagözoğlu and Riedl, 2015; Bolton and Karagözoğlu, 2016). Most of these studies did not explicitly test tasks versus luck (as we also do not). Rather, at this point the consensus

seems fairly well established that subjects take their decisions more seriously when some aspect of the setting has been "earned", and real–effort tasks (and related devices like quizzes) have now become part of the experimental economist's tool–box, without the need to re–evaluate them in every new setting.

The first study to vary predicted bargaining outcomes over multiple values covering a large range was Kahn and Murnighan's (1993) alternating–offer bargaining experiment. They varied five treatment variables – discount factor, breakdown probability, second mover's outside option, availability of a unilateral opt–out, and who was the first mover – through two values each in a factorial design, with the resulting 32 cells yielding 16 distinct equilibrium predictions. Depending on which outcome measure was used (first mover's payoff, second mover's payoff, first mover's initial demand, second mover's initial demand), actual responsiveness to changes in bargaining power varied from 48 percent to 88 percent of predicted responsiveness.

The studies most closely related to ours have induced variation in bargaining position via a single variable – disagreement payoffs – varied systematically through multiple values. Fischer et al. (2007) examine a variant of the NDG, where players simultaneously submit an ambitious demand x_i and a fallback demand g_i. They receive their ambitious demands if they are compatible; if not, they each get their fallback demand if these are compatible, or disagreement payoffs d_i if not. Their main research question was whether behaviour differed between this game and an ultimatum game, but they used eleven disagreement outcomes with perfect negative correlation between own and opponent disagreement payoffs, allowing computation of a combined disagreement–payoff effect. (The perfect correlation prevents separate measurement of own– and opponent–disagreement–payoff effects.) On average, their results imply that $|\partial x_i/\partial d_i|+|\partial x_i/\partial d_{-i}| \approx 0.71$ and $|\partial g_i/\partial d_i|+|\partial g_i/\partial d_{-i}| \approx 0.78$: that is, observed responsiveness to disagreement outcomes was roughly three–fourths of the theoretical prediction.[4]

Finally, Anbarci and Feltovich (2013) had subjects bargaining in either the NDG or the UBG, with disagreement payoffs varying from 5% to 45% of the cake, and drawn randomly in each round. They found that in the NDG, the own–disagreement–payoff effect $|\partial x_i/\partial d_i|$ was about 0.2 and the opponent–disagreement–payoff effect $|\partial x_i/\partial d_{-i}|$ was slightly lower, yielding a combined effect roughly 40% of the predicted level. In the UBG, both effects were about 0.3 – significantly more than in the NDG, but still only about 60% of the predicted level.

Our paper contributes to this literature in two ways. First, our use of earned – rather than assigned – bargaining position allows us a test of the robustness of previous under–responsiveness results. One might expect that subjects dismiss advantaged status that they consider to have been allocated arbitrarily or unfairly; such a view would push bargaining outcomes toward 50–50 splits, decreasing responsiveness to variation in bargaining position.[5] If so, we would expect to find higher disagreement–payoff responsiveness

[4]Their results for the ultimatum game were similar, with proposers' demands responding 76 percent as much to changes in the disagreement outcome as theoretically predicted. A more recent ultimatum game experiment by Hennig-Schmidt et al. (2013) found lower responsiveness: 45 percent for proposers' offers and 55 percent for responders' minimum acceptable offers.

[5]Ball and Eckel (1998) find some evidence that subjects in an ultimatum–game experiment behave more in line with theoretical predictions when the proposer (who is structurally favoured in that game) had been given a symbol of status based on a high quiz score, and the (unfavoured) responder had not been given the status symbol. See also Ball et al. (2001) for a similar result in a

than previous studies did.

Second, the particulars of our design makes it likely that in a significant fraction of bargaining pairs, one of the bargainers will have a disagreement payoff more than 50% of the cake ("dominant bargaining power"). In such cases, equal splits are not individually rational, and hence not consistent with equilibrium; by contrast, when neither player has dominant bargaining power, equal splits are always consistent with equilibrium. If under–responsiveness to bargaining position is the result of equal splits providing a powerful focal point in bargaining, then removing this focal point ought to lead to higher responsiveness. Previous experiments that varied bargaining position either did not present situations with such "dominant bargaining power" (e.g., Anbarci and Feltovich, 2013), had them in too few cases to allow rigorous comparisons to situations without dominant bargaining power (e.g., Fischer et al., 2007), or had few or no cases *without* dominant bargaining power (e.g., Hoffman and Spitzer, 1982), again preventing comparisons.

4 The experiment

The real–effort task used to determine bargaining position was adapted from the one used by Erkal et al. (2011). A sample screen–shot is shown in the supplementary materials. The basic unit of the task was the encoding of a sequence of 2–9 letters (a "word") into numerals, based on a key displayed on the computer screen for the entirety of the task. Below each letter was a blank space; to encode the word, the subject needed to type the numeral corresponding to each letter in the space below it, then click a button once the word was finished. If the word was encoded correctly, it was accepted and the word was replaced by a new word. If the word was encoded incorrectly, an error message stated the incorrectly–encoded letter (or the first, if there were multiple errors), and the subject could go back and make changes as desired.

At the beginning of a round, a sequence of 400 letters was randomly drawn (with replacement); each letter had an equal chance of being chosen for any given place in the sequence. At the same time, the key – a permutation of $(1, 2, ..., 26)$ – was randomly chosen from the set of all such permutations. Thus, both the key and the sequence of letters changed from round to round, though both were common to all subjects within a round of a session. Our use of a random sequence of letters means that the vast majority of our "words" were not actual words (in contrast with Erkal et al.'s task, which used a deterministic list of English words); this was done in order that subjects would not be privileged based on their ability to read English. Drawing a new key and sequence of letters in each round of each session was done in order to minimise differences across rounds due to memorisation.

Variation in task difficulty was accomplished by varying the lengths of the words. Each subject in each round was given words of changing lengths, drawn i.i.d. from a distribution that was fixed for that subject and round. At the beginning of a session, each subject was assigned a type (*advantaged* or *disadvantaged*) that remained fixed throughout the session. Both types of subject faced an *easy* and a *hard* version of the task; the four distributions are shown in Table 1. Note that for each type, the hard version of the task

double–auction market.

Table 1: Real–effort task – distributions of word lengths

Type	Task version	Probability of word length								Expected word length
		2	3	4	5	6	7	8	9	
Advantaged	Easy	0.2	0.4	0.2	0.1	0.1	0	0	0	3.5
	Hard	0	0.2	0.4	0.2	0.1	0.1	0	0	4.5
Disadvantaged	Easy	0	0	0.1	0.1	0.2	0.4	0.2	0	6.5
	Hard	0	0	0	0.1	0.1	0.2	0.4	0.2	7.5

contained longer words, in the sense of first–order stochastic dominance, than the easier version. However, the advantaged player was always advantaged; even the disadvantaged/easy distribution contained longer words than the advantaged/hard distribution.

Assigning an easier version of the task to one subject in a pair than the other serves two important functions in the experiment. First, it decreases the likelihood that the subjects will have equal or nearly equal disagreement payoffs. This matters because many previous experiments have shown symmetric bargaining games to have an extremely strong tendency toward 50–50 splits of the cake, and even with some asymmetry, the 50–50 norm provides a powerful focal point that can affect what outcome the pair does reach.[6] Second, it allows the difficulty of the task to be set so that one member of a bargaining pair has a reasonable chance of earning dominant bargaining power without a corresponding risk that both bargainers will do so. When exactly one bargainer has dominant bargaining power, 50–50 splits are ruled out as an equilibrium outcome, but other agreements are still possible; if both bargainers had dominant bargaining power, there would be no gains to agreement, making the bargaining problem trivial.

Except for a one–minute practice round, subjects were allotted five minutes in each round for the task. At the beginning of this time, a word length k_i^1 was drawn randomly from the relevant distribution for subject i. That subject's first word would be made up of letters 1 through k_i^1 of the sequence that had been drawn for that round. When that word was correctly encoded, a new word length k_i^2 was drawn, independently of the previous word length, and the subject's second word would comprise letters $k_i^1 + 1$ through $k_i^1 + k_i^2$ of the sequence. In a similar way, the subject's j–th word was made up of the first k_i^j letters that had not been used yet. Thus, all subjects in a session faced the same sequence of letters; it was only the way the sequence was broken up into words that varied across subjects.

We would like to remark that implementing disagreement outcomes via real–effort tasks rather than exogenously – while possibly having the advantage that subjects internalise them to a greater extent – is not costless. One obvious cost of having disagreement payoffs depend on performance in the task is that the experimenter loses a modicum of control over these disagreement payoffs. Fischer, Güth and Pull (2007)

[6] See Nydegger and Owen (1975) and Roth and Malouf (1979) for experimental comparisons of symmetric and asymmetric bargaining.

and Anbarci and Feltovich (2013) were able to specify the exact disagreement outcomes subjects faced (in the former paper) or the exact distribution from which these outcomes were drawn (in the latter). In the current paper, we are unable to do so, since the outcomes depend on subjects' behaviour. Indeed, even with the substantial difference in difficulty between the advantaged player's and disadvantaged player's tasks, we cannot guarantee that within a bargaining pair, the advantaged player will have the favoured bargaining position.

A second disadvantage concerns the time subjects spend on the real–effort task, which is time they are not spending on the bargaining game. The five minutes in each round allocated to the task itself, along with another half–minute for related aspects such as feedback, carry an opportunity cost of two to three rounds of bargaining in the UBG, or four to five rounds in the NDG. This has two negative implications: fewer data points of bargaining for a given length of session (and thus, roughly speaking, for a given budget for subject payments), and less opportunity for subjects to acquire experience in the bargaining task, leading to a higher variance in the data and more outliers (though on the plus side, the smaller number of rounds in our experiment implies higher stakes per bargaining round, so that subjects might be expected to take their decisions more seriously). Both of these implications complicate comparisons to previous studies that used endowed bargaining power.

Finally, there is no guarantee that our use of a real–effort task will succeed in getting subjects to view their bargaining power as earned. As we will discuss in the next section, we made the differences in task difficulty (within and between subjects) as opaque as possible, in an attempt to get subjects to view their bargaining power as arising from skill and effort rather than luck. However, it is possible that especially clever subjects could infer the role that luck played in determining their disagreement payoffs. It is also possible that some subjects may have considered the task itself to be sufficiently contrived that bargaining power based on performance on it would never be viewed as being earned. However, since we do not vary whether disagreement payoffs are earned, neither of these potential issues would result in a loss of control. At worst, our experiment would reduce to a test of bargaining institution and dominant bargaining power with *endowed* rather than earned bargaining power. In that case, if earned bargaining power leads to higher responsiveness than endowed bargaining power, then our results would under–state responsiveness under truly earned bargaining power.

4.1 Experimental design and procedures

Sessions consisted of ten rounds, plus an initial practice round with no bargaining and no effect on subjects' payments. Rounds 1–10 were split into five two–round blocks; within each block, one round comprised task followed by bargaining, while the other consisted of the task only. In half of the sessions, bargaining took place in the even–numbered rounds, and in the other half of sessions, bargaining took place in the odd–numbered rounds (see Table 2).[7] The cake size was always £10, and a subject's disagreement payoff in all

[7]Within a block, the rounds were identical except for whether bargaining took place. In an earlier working paper (Anbarci and Feltovich, 2016), we compare task performance with and without a subsequent bargaining round. Since the bargaining round

bargaining rounds was £0.15 for each word correctly encoded in that round. (In rounds with no bargaining, this amount was the subject's payoff for the round.)

Table 2: Experimental design and session information

Cell	Bargaining game	Rounds in which bargaining took place	Matching–group sizes	Subjects
NDG–odd	NDG	1, 3, 5, 7, 9	6, 6, 6, 6, 8, 8	40
NDG–even		2, 4, 6, 8, 10	6, 6, 6, 8, 10, 12	48
UBG–odd	UBG	1, 3, 5, 7, 9	6, 6, 8, 8, 8, 10	46
UBG–even		2, 4, 6, 8, 10	6, 6, 6, 8, 8, 8	42

Each session comprised one or more *matching groups* that were closed with respect to interaction (advantaged subjects in a particular group interacted only with disadvantaged subjects in the same group), so that data from different matching groups can be considered statistically independent of each other. Subjects were not given any information about the partitioning into matching groups; combined with the small number of bargaining rounds (5 per session), this makes repeated–game effects unlikely. Random assignment to roles (advantaged/disadvantaged) and matching groups took place before the practice round; these were fixed for the entire session.

Sessions took place at University of Aberdeen; subjects were primarily undergraduate and masters–level students, and were recruited using ORSEE (Greiner, 2015) from a database of people expressing interest in participating in economics experiments. No one took part more than once. The experiment was run on networked personal computers, and was programmed using z–Tree (Fischbacher, 2007). Subjects were asked not to communicate with other subjects except via the computer program.

At the beginning of a session, subjects were seated in a single room and given written instructions, which were also read aloud in an attempt to make the rules common knowledge. Once the instructions were read and questions answered, subjects were given a few demographic questions to answer.[8] After all subjects had submitted their answers, the practice round began.

Subjects were randomly paired in each bargaining round, with each opposite–type subject in the same matching group equally likely (a two–population protocol). No identifying information was given about opponents, in an attempt to minimise incentives for reputation building and other supergame effects. Also,

reduces by half the marginal return to completing a unit of the task – and this is reduced still further by under–responsiveness to the disagreement payoff – one might expect lower task performance in bargaining rounds. We found evidence of such an effect, but it was weak. See Appendix A of that earlier working paper, or contact the corresponding author, for details.

[8]Sample instructions and screen–shots are shown in the supplementary materials. The remaining sets of instructions, as well as the raw data from the experiment, are available from the corresponding author upon request. The demographic questions asked for subjects' age, sex, number of economics units completed at university (with "4 or more" as the top category), and number of years resident in the United Kingdom (with categories 0–1, 1–2, 2–5, 5–10, and 10 or more).

to reduce demand effects, rather than using terms like "opponent" or "partner" for the other player, we used neutral terms like "player matched to you".

Each round began with a screen displaying instructions for the real–effort task, which were also shown during the task itself. After a few seconds, the task would begin. The task difficulties in each round are shown in Table 3. Notably, while we used no deception in the experiment, we did not provide specific

Table 3: Real–effort task difficulty by round

Round(s)	Task difficulty		Time allotted
	Advantaged player	Disadvantaged player	(seconds)
0 (practice)	Hard	Hard	60
1–2	Hard	Hard	300
3–4	Hard	Easy	300
5–6	Easy	Easy	300
7–8	Easy	Hard	300
9–10	Hard	Easy	300

information to subjects about how task difficulty varied within– or between–subjects. The only information they received was the sequence of words they faced in each round, and in bargaining rounds, the opponent's number of words encoded (from which clever subjects might have been able to infer some information about others' task difficulty).

Rounds without bargaining ended after the time allotted for the task had run out. In rounds with bargaining, after the task finished, subjects were informed of the number of words they and their opponent had encoded, and the corresponding disagreement payoffs; they were also reminded of the £10 cake size. After viewing their disagreement outcome, subjects in the NDG treatment were prompted to choose their demands. Demands could be any whole–number multiple of £0.01 between zero and the cake size inclusive. End–of–round feedback comprised own and opponent words encoded and disagreement payoffs, own and opponent demands, whether agreement was reached, and own and opponent payoffs. After all subjects clicked a button on the screen to continue, the session proceeded to the next round.

In the UBG cells, subjects were given a 120–second "negotiation stage" (130 seconds in the first bargaining round) to reach agreement on a division of the cake.[9] A proposal consisted of a nonnegative multiple

[9]Two minutes for bargaining may seem short compared to typical deadlines of 5–10 minutes in the unstructured bargaining literature. Indeed, our deadline is comparable to the "high time pressure" setting of Karagözoğlu and Kocher (2017), who set a deadline of 90 seconds (in contrast to their 10–minute deadline under "low time pressure"). However, the differences they observe between low and high time pressure are mainly confined to the frequency of disagreement and that of last–moment agreements, while agreed splits of the cake are not substantially different between their treatments. Since our focus is on splits of the cake rather than if or when agreement takes place, their results suggest our two–minute deadline should not be a problem. In fact, we observe that of those bargainers in our UBG treatment not reaching agreement, 66.4 percent made no proposal in the last 30 seconds, and

of £0.01 for the sender and one for the receiver, adding up to the cake size or less. Proposals could not be withdrawn once made, and no messages were possible apart from the proposals ("tacit", rather than "explicit", bargaining). Both own and opponent proposals were displayed on the subject's screen. A subject could choose to accept any of the opponent's proposals, which were listed in order of increasing own payoff, making it trivial to determine the most favourable one (though subjects could accept less favourable proposals if they wished). The negotiation stage ended if a proposal was accepted, if either subject in a pair chose to end it (by clicking a button on the screen), or if the time had expired without an accepted proposal; in these latter two cases, the disagreement outcome was imposed. End–of–round feedback comprised own and opponent words encoded and disagreement payoffs, whether agreement was reached, and own and opponent payoffs.

At the end of round 10, the session ended and subjects were paid, privately and individually. For each subject, two bargaining rounds and two task–only rounds were randomly chosen, and the subject was paid his/her earnings in those four rounds. There was no show–up fee. Total earnings averaged £19.40 for advantaged subjects (with a standard deviation of £2.96) and £13.34 for disadvantaged subjects (with a standard deviation of £2.17), for a session that typically lasted about 90–100 minutes (including about 10 minutes devoted to instructions, and another 10 minutes for other administration such as collecting consent forms).

4.2 Hypotheses

Here, we list three null hypotheses, each an implication of standard bargaining theory. Along with each, we include a corresponding conjecture about how observed behaviour might deviate from the standard theory.

As described in Section 2.3, standard theory predicts own– and opponent–disagreement–payoff effects of one–half, and a combined effect of unity. This yields our first hypothesis:

Hypothesis 1 *For both games, and irrespective of the distribution of bargaining power between the players, demands and payoffs respond fully (to the predicted extent) to changes in the disagreement outcome.*

While this null hypothesis could be rejected in two ways – either from observed responsiveness being higher or lower than predicted – the literature has been consistent in reporting only under–responsiveness. We therefore have

Conjecture 1 *For both games, and irrespective of the distribution of bargaining power between the players, demands and payoffs* under–respond *to changes in the disagreement outcome.*

Some researchers (e.g., Skyrms, 1996; Binmore, 2007) have argued that the NDG already captures the important features of bargaining environments, which would imply that the more complex structure of the UBG adds nothing of strategic importance, so that outcomes ought to be similar under the two institutions.

81.4 percent made no proposal in the last 15 seconds. So, it seems that for the majority of bargainers, time pressure is a secondary concern.

On the other hand, Feltovich and Swierzbinski (2011) argued that the higher level of strategic uncertainty in the NDG should lead to different outcomes compared to the UBG, and in their experiment they find some differences in the types of agreements reached, with more agreements close to the 50–50 split in their analogue to the NDG than in their analogue to the UBG. This result implies the following hypothesis and conjecture for the current study:

Hypothesis 2 *Responsiveness to changes in the disagreement outcome will be the same in both games.*

Conjecture 2 *Responsiveness to changes in the disagreement outcome will be* higher *in the UBG than in the NDG.*

Finally, we conjecture that while the attraction of the 50–50 split tends to be strong in bargaining experiments, this attraction will be reduced when there is dominant bargaining power. In this case, the 50–50 split is no longer an equilibrium outcome, and is therefore lost as a potential focal point. As a result, the power of alternative focal points – most notably, the theoretical prediction – should increase correspondingly. This gives rise to our last hypothesis and conjecture:

Hypothesis 3 *Responsiveness to changes in the disagreement outcome will be the same irrespective of whether or not the favoured player has dominant bargaining power.*

Conjecture 3 *Responsiveness to changes in the disagreement outcome will be* higher *when the favoured player has dominant bargaining power than when neither player does.*

5 Experimental results

In our analysis, we express quantities like demands, payoffs, and disagreement outcomes as fractions or percents of the cake size. We concentrate on four sub–samples of the experimental data–set. In the NDG, each subject makes a single demand, which may or may not lead to agreement. Our first sub–sample will comprise all bargaining pairs in the NDG (we will often call this "NDG–all") – giving us one demand for each member of the pair, for all NDG pairs over all rounds. Our second sub–sample is a subset of the first, comprising only the demands of those pairs reaching agreement; this is our "NDG–agreements" sub–sample. (Note that in both NDG and UBG, demand conditional on agreement is by definition equal to payoff conditional on agreement.)

In the UBG, each subject may make a single proposal, multiple proposals, or no proposals at all. Each proposal made by a subject could be interpreted as a demand by that subject. Moreover, a subject's acceptance of an opponent proposal, and even failure to accept a proposal, can be construed as carrying information about demands. Inferring a single demand from all of a subject's behaviour in a UBG round thus necessarily carries a big subjective element. To minimise this subjectivity, we classify UBG demands based on unambiguous rules. Our "UBG–agreements" sub–sample is straightforward. We interpret each accepted

proposal in the UBG as a pair of compatible demands; if a pair does not reach an agreement, it is left out of this sub–sample. Our "UBG–all" sub–sample includes these demands, but additionally, in cases where agreement was not reached, we examine the sequence of proposals and counter–proposals to find the *lowest* amount each bargainer proposed for him/herself. If this lowest amount exists (i.e., if the subject made at least one proposal), this was taken to be the demand. If a subject made no proposals and did not accept an opponent proposal, that subject was left out of this subsample. (This happened only once in 440 UBG observations.)

5.1 Preliminaries

Table 4 shows that in about 5.5% of bargaining pairs, the advantaged player (the subject with the easier task) becomes the unfavoured player (the one with the lower disagreement payoff) by encoding fewer words than the disadvantaged player. In another 2.2%, bargaining is symmetric (disagreement payoffs are equal). In

Table 4: Real–effort task statistics (bargaining rounds)

		Task difficulties (advantaged/disadvantaged player)				
		Easy/Easy	Easy/Hard	Hard/Easy	Hard/Hard	Total
Number of pairs	in total	88	88	176	88	440
	with d_i lower for advantaged player	3 (3.4%)	1 (1.1%)	15 (8.5%)	5 (5.7%)	24 (5.5%)
	with d_i lower or equal for advantaged player	3 (3.4%)	1 (1.1%)	22 (12.5%)	8 (9.1%)	34 (7.7%)
	with $d_f > 0.5$	43 (48.9%)	47 (53.4%)	12 (6.8%)	3 (3.4%)	105 (23.9%)
	with $d_f + d_u \geq 1$	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

just under one–quarter of pairs, the advantaged player encodes enough words in a bargaining round to earn dominant bargaining power. Finally, bargainers' disagreement payoffs never totalled the cake size or more, so there were always gains to be made from agreement.

5.2 Aggregate behaviour

The first row of Table 5 shows that agreements (compatible demands in the NDG, accepted proposals in the UBG) are more frequent in the UBG – unsurprisingly given its lower strategic uncertainty. A non–parametric robust rank–order test confirms this difference is significant (two–sided test, matching–group–level data, $p < 0.001$).[10] The next rows show that 50–50 splits are substantially more likely when there is no

[10] See Siegel and Castellan (1988) for descriptions of the non–parametric statistical tests used in this paper, as well as for tables of critical values. Some critical values for the robust rank–order test are from Feltovich (2005).

dominant bargaining power – comprising about a third of all outcomes in both NDG and UBG when there is no dominant bargaining power, but only about five percent of outcomes when there is dominant bargaining power – consistent with our conjecture that equal splits are focal if and only if they are individually rational. These differences are also significant (two–sided Wilcoxon signed–ranks test, matching–group–level data, $p \approx 0.003$ for NDG, $p \approx 0.002$ for UBG, $p < 0.001$ for both games pooled).

Table 5: Aggregate statistics – bargaining outcomes (all rounds)

Game:	NDG		UBG	
Subject type:	advantaged/ disadvantaged	favoured/ unfavoured	advantaged/ disadvantaged	favoured/ unfavoured
Agreement frequency	0.618		0.800	
Frequency of equal splits conditional on agreement....				
...when $d_f > 0.5$	0.053		0.077	
...when $d_f < 0.5$	0.538		0.423	
Mean disagreement payoff (d_i)	0.426/0.258	0.433/0.253	0.424/0.263	0.430/0.259
Frequency of $d_i > 0.5$	0.241/0.000	0.241/0.000	0.236/0.000	0.236/0.000
Mean demand, unconditional	0.563/0.482	0.563/0.483	0.562/0.453	0.569/0.446
Mean demand, given agreement	0.504/0.442	0.507/0.440	0.553/0.447	0.560/0.439

The remainder of the table shows, for both games, the mean disagreement payoff for both advantaged and disadvantaged subjects; the fraction of observations with dominant bargaining power; and both types' mean demands, both unconditional and conditional on agreement. The table also shows the corresponding statistics for favoured and unfavoured subjects. As results are not extremely sensitive to whether we categorise by disadvantaged/advantaged or favoured/unfavoured status, we will concentrate on the latter.

One result suggested by Table 5 is that the favoured player makes some, but only limited, use of her better bargaining position. In the NDG, favoured subjects' disagreement payoffs are higher than their opponents' by an average of 17% of the cake (i.e., 17 percentage points), but overall, they demand only 8% more of the cake, and conditional on agreement, the difference is only about 6% of the cake. This under–exploitation of bargaining power is less stark in the UBG, but still present: on average, despite having a higher disagreement payoff by over 16% of the cake, the favoured player demands only 11% more of the cake, and the difference is the same in agreements.

Table 6 reports corresponding non–parametric test results. The first row shows that favoured subjects do take account of their stronger bargaining power, demanding significantly more than unfavoured subjects do. On the other hand, the second row shows that they significantly under–exploit their bargaining power; the difference is demands between favoured and unfavoured players is significantly smaller than the difference in their disagreement payoffs. Finally, the bottom row gives evidence of systematic differences between the UBG and NDG treatments. Specifically, the difference $(x_f - x_u) - (d_f - d_u)$, the extent to which subjects

Table 6: p–values from non–parametric tests on matching–group–level data (all rounds)

Within–game tests	NDG (all)	NDG (agreements)	UBG (all)	UBG (agreements)
$x_f > x_u$	$p \approx 0.001$	$p \approx 0.005$	$p < 0.001$	$p < 0.001$
$x_f - x_u < d_f - d_u$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p \approx 0.002$
Between–game tests	NDG (all) vs. UBG (all)		NDG (agreements) vs. UBG (agreements)	
$(x_f - x_u) - (d_f - d_u)$ smaller in NDG	$p < 0.01$		$p \approx 0.02$	

Wilcoxon signed–ranks test used for within–game tests, robust rank–order test used for between–game tests. Both use two–tailed rejection regions.

exploit their bargaining power, is significantly less in the NDG than in the UBG. This means that while favoured subjects do not fully exploit their status in either game, they exploit it *more* in the UBG than in the NDG.

5.3 Parametric statistical analysis

We next use panel regressions to disentangle the effect of the disagreement outcome from various other factors that might influence bargaining outcomes. We estimate specifications with demands as the dependent variable, separately for all bargaining pairs and agreements only, and leaving out the observations with a symmetric bargaining game (since in that case there is no favoured player). For each sub–sample, we estimate three Tobit models: one for each game (NDG or UBG) separately, and a third with the games pooled. The main explanatory variables are the own and opponent disagreement payoffs (d_i and d_{-i}), a UBG indicator (for the specifications that use both games) and an indicator for dominant bargaining power. We also include all of the two– and three–way interactions among disagreement payoff, the UBG indicator when it is included, and the dominant–bargaining–power indicator, as well as several control variables, a constant term, and subject random effects.[11]

[11] See the supplementary materials for the Stata commands and output corresponding to these models. The control variables include demographics, an indicator for bargaining taking place in odd–numbered rounds, an indicator for favoured–player status, the block number and its products with the disagreement payoffs, and both own and opponent performance on the real–effort task. These last two variables – the number of *letters* in the words successfully encoded – measure raw ability of the two bargainers, unaffected by whether they are advantaged or disadvantaged, or whether they are facing the harder or easier version of the task. Since we view all of these additional variables as "nuisance" variables, we will not devote much discussion to results concerning them. In particular, the demographic variables did not yield any significant effects. However, we do note that the estimated marginal effects of the own– and opponent–disagreement–payoff variables are *higher* in block 5 than in block 1. While these differences are either weakly significant or insignificant, they do imply that if disagreement–payoff responsiveness does change over time, it increases rather than decreasing. Finally, we mention that besides the models described in this section, we estimated a number of related models (available from the corresponding author upon request) as robustness checks, none of which affects the main results in any important way. These include a Tobit including only those observations with dominant bargaining power, Tobits on the entire sample but with only the main explanatory variables (with or without the block number, which turns out to be significant),

Table 7 presents estimated average marginal effects and standard errors for each variable (estimated by Stata, version 12). Three aspects of these results are worth mentioning here. First, all twelve of the estimated

Table 7: Regression results: average marginal effects, standard errors in parentheses

Dependent variable: demand (x_i)	NDG/UBG (all)			NDG/UBG (agreements)		
	[1]	[2]	[3]	[4]	[5]	[6]
Own disagr. payoff (d_i)	0.362^{***}	0.409^{***}	0.284^{***}	0.258^{***}	0.223^{**}	0.271^{***}
	(0.095)	(0.161)	(0.092)	(0.071)	(0.107)	(0.088)
Opp. disagr. payoff (d_{-i})	-0.182^{*}	–0.104	-0.332^{***}	-0.289^{***}	-0.182^{*}	-0.325^{***}
	(0.096)	(0.161)	(0.094)	(0.071)	(0.106)	(0.089)
UBG	-0.016^{*}			0.032^{***}		
	(0.008)			(0.009)		
Dominant barg. power (dbp)	–0.008	–0.017	–0.003	–0.004	–0.014	0.007
	(0.019)	(0.033)	(0.018)	(0.016)	(0.029)	(0.017)
block number	-0.006^{**}	-0.010^{**}	–0.002	0.003	0.005	–0.000
	(0.003)	(0.005)	(0.003)	(0.002)	(0.003)	(0.003)
barg. in odd–numbered rounds	0.007	0.011	–0.002	–0.002	0.000	–0.003
	(0.008)	(0.013)	(0.010)	(0.009)	(0.015)	(0.010)
favoured player	–0.001	–0.016	0.007	0.000	–0.007	0.012
	(0.018)	(0.031)	(0.018)	(0.013)	(0.020)	(0.017)
letters encoded (hundreds)	–0.008	–0.034	0.040	0.012	0.013	0.028
	(0.028)	(0.046)	(0.031)	(0.023)	(0.034)	(0.030)
opp. letters encoded (hundreds)	0.026	0.043	0.002	–0.003	0.017	–0.034
	(0.027)	(0.045)	(0.028)	(0.021)	(0.030)	(0.027)
Bargaining game	Both	NDG	UBG	Both	NDG	UBG
Demographic variables?	Yes	Yes	Yes	Yes	Yes	Yes
N	859	428	431	606	262	344
$\|ln(L)\|$	692.65	247.54	532.47	765.08	310.93	478.47

* (**,***): *Coefficient significantly different from zero at the 10% (5%, 1%) level.*

marginal effects for own– and opponent–disagreement–payoff effects have magnitudes less than one–half, consistent with the earlier evidence of under–responsiveness we have seen.[12] However, these are average marginals; we will see results for marginals conditional on the game and presence of dominant bargaining power in Table 8 below. Second, while there appear to be differences in absolute size between own– and opponent–disagreement–payoff effects in some of the specifications – as large as 30 percentage points in Model 2 – none of these differences are significant, meaning we cannot reject any null hypothesis that these effects are equal. Third, neither own nor opponent letters encoded has a significant effect in any of the

and linear models with either bootstrapped standard errors or clustering by matching group.

[12]The differences from one–half are usually, but not always, significant. Of the twelve marginal effects reported in the table, ten (all but the own–disagreement–payoff effects in [1] and [2]) are significantly less than one–half at the 10 percent level, with two of these (the opponent–disagreement–payoff effects in [3] and [6]) are significantly less than one–half at the 10 percent level but not the 5 percent level.

Table 8: Point estimates and confidence intervals for combined disagreement–payoff effects, from Models 1 and 4 in Table 7

		All bargaining pairs			Agreements		
		NDG	UBG	sig. diff.?	NDG	UBG	sig. diff.?
No dbp	Point est.	0.271	0.674	$p < 0.001$	0.254	0.675	$p < 0.001$
	95% CI	(0.010, 0.531)	(0.403, 0.944)		(0.053, 0.455)	(0.466, 0.884)	
dbp	Point est.	0.700	0.820	$p \approx 0.21$	0.723	0.870	$p \approx 0.11$
	95% CI	(0.514, 0.886)	(0.630, 1.011)		(0.554, 0.891)	(0.721, 1.020)	
Point est's sig. diff.?		$p < 0.001$	$p \approx 0.20$		$p < 0.001$	$p \approx 0.02$	

Notes: dbp = dominant bargaining power; CI = confidence interval; est. = estimate; sig. diff. = significantly different.

specifications, and the point estimates for these variables are tiny in magnitude (the interquartile range of 29 letters represents at most a change of about 1 percent of the cake). This suggests that ability to perform the real–effort task has little impact on bargaining outcomes other than via its effect on disagreement payoffs.

The main results from these Tobits are summarised in Table 8: point estimates and 95% confidence intervals for the combined disagreement–payoff effect (the sum of the absolute values of the marginal effects of d_i and d_{-i}), based on Model 1 for all demands and Model 4 for agreements only, and taken at values of 0 and 1 for the UBG and dominant–bargaining–power indicators. This gives us the effects for all four combinations of NDG vs. UBG and with vs. without dominant bargaining power. Chi–square tests strongly reject the null hypothesis of equal effects across the four combinations ($\chi^2_3 \approx 25.66$ for all observations and 45.38 for agreements, $p < 0.001$ in both); therefore we also report p–values for the corresponding ceteris paribus pair–wise comparisons. These show that subjects are least responsive to their bargaining power in the NDG with no dominant bargaining power; the combined effect of 0.271 (all bargaining pairs) or 0.254 (agreements only) is far below the theoretical prediction of one, and indeed one is well outside either of the corresponding confidence intervals. Responsiveness is much higher – and significantly so – in the UBG without dominant bargaining power, with point estimates of 0.674 and 0.675. However, these are still well below the theoretical prediction of one, which again lies outside both of the corresponding confidence intervals.

With dominant bargaining power, responsiveness to bargaining power increases, sometimes drastically. In the NDG, the difference is especially striking – a rise from 0.271 to 0.700 (over all observations) or from 0.254 to 0.723 (over agreements) of the theoretically–predicted level – and is significant, though even so, this leaves disagreement–payoff responsiveness still well below one. In the UBG, responsiveness increases from 0.674 to 0.820 (all observations), or from 0.675 to 0.870 (agreements), under dominant bargaining power compared to without it; these differences are significant for agreements (though not for the case of all observations). Also in the UBG with dominant bargaining power, the corresponding confidence interval contains one, meaning that in this case, we cannot reject the null hypothesis that subjects respond to changes

in their bargaining power to the extent predicted by theory.

6 Discussion and concluding remarks

In the NDG without dominant bargaining power, we observe low responsiveness to changes in bargaining position, consistent with previous studies where bargaining position was manipulated via disagreement outcomes (Fischer et al., 2007; Anbarci and Feltovich, 2013). Since disagreement payoffs were earned in our experiment and assigned in those previous experiments, this suggests that making subjects earn their bargaining position may not have a substantial effect on subsequent bargaining outcomes. Clearly this is not a controlled comparison, however, and such interpretations should be made with caution. Future research into the effects of earned versus assigned bargaining position is welcome.[13]

Both the bargaining institution and the existence of equilibrium equal splits have profound effects on bargaining outcomes, as hypothesised. Responsiveness to disagreement payoffs increases as we move from the NDG to the UBG, likely due to the lower amount of strategic uncertainty and resultant less severe coordination problem in the latter, which reduces the attractiveness of the 50–50 split. Responsiveness is also higher with dominant bargaining power than without, as when 50–50 splits are no longer individually rational, they are no longer focal, so that bargainers have to rely on alternative focal points. These treatment effects are not only statistically significant, but large in magnitude. Starting from the NDG without dominant bargaining power, either changing the game to the UBG or adding dominant bargaining power (i.e., moving from the top–left corner either rightward or downward within either panel of Table 8) increases disagreement–payoff responsiveness by roughly 40–45 percentage points. From there, adding the other (i.e., moving to the bottom–right corner in either panel of Table 8) increases responsiveness by a further 12–20 percentage points. In the UBG with dominant bargaining power, responsiveness approaches the theoretically predicted level (100 percent), and indeed the corresponding 95% confidence interval includes this point prediction, meaning that we could not reject the null hypothesis that subjects fully exploit their bargaining position. Caution should always be taken when drawing conclusions based on failure to reject a null hypothesis, but even with this caveat, our result is noteworthy, as we are unaware of any other finding of approximately full exploitation of bargaining power in the literature.

Two of the design choices we made for the experiment are worth re–stating here, as each implies a possible future experiment aimed at replicating, or assessing the robustness of, our results. First, as noted at the beginning of Section 4, subjects' bargaining power is earned via task performance, but the difficulty

[13] Two recent studies find that real effort does matter. Franco-Watkins et al. (2013) use a set of unincentivised experiments to compare bargaining when the surplus was earned versus when it was a "windfall", and report that fairness considerations are more important in the latter case. A recent working paper by Feltovich (2017) finds a similar result in an incentivised experiment that exogenously varies whether disagreement payoffs are earned via a real–effort task (as in the current paper), assigned randomly without a real–effort task (as in Anbarci and Feltovich, 2013), or – as an intermediate case – assigned randomly but with the real–effort task used as a hurdle to reaching the bargaining stage. Comparison between the first treatment and the other two suggests a small but significant increase in responsiveness to bargaining position when this position is earned compared to when it is assigned.

of the task is exogenously assigned, meaning that bargaining power still carries an unearned component. Second, as noted in Section 4.1, neither of our bargaining institutions allow communication except through the proposals themselves ("cheap talk" is not possible). Future experiments may alter one or both of these design choices. Intuitively, it is unclear how this might affect the results. If responsiveness to changes in bargaining position is actually greater when bargaining position is fully earned compared to when it is partially earned and partially assigned, then clearly, making bargaining position fully earned ought to increase responsiveness, while keeping the task as it is but calling attention to the assigned component could decrease it – though as mentioned at the beginning of this section, our current results suggest that the extent to which bargaining position is earned might not matter as much as conjectured. Similarly, adding cheap talk to the bargaining environment could increase responsiveness by allowing favoured bargainers to argue for the "standard" bargaining–theory prediction, but on the other hand, it could also push outcomes toward the 50–50 split by reducing the social distance between bargainers. Further research in these and related areas is very welcome.

We close with some implications for applied theorists and experimenters. First, our finding of a general under–responsiveness to disagreement payoffs, and the sensitivity of this responsiveness to the presence or absence of dominant bargaining power, highlight the importance of framing in bargaining experiments. We conjecture that our results would have been quite different if our experiment had involved bargainers (a) being given their disagreement payoffs immediately, and (b) bargaining over the remainder. This setting is nearly isomorphic to ours (the only difference is that we allow individually irrational agreements), but we would expect outcomes in such a hypothetical experiment to cluster around 50–50 splits of the *remainder*, which would correspond to 100% responsiveness to disagreement payoffs in our actual experiment. If this is true, then the standard modelling technique of normalising the bargaining problem so that the disagreement outcome is (0, 0) is clearly not innocuous: absolute payoff amounts matter, not just payoffs relative to the disagreement point.

Second, the differences we find between NDG and UBG suggest that the way bargaining is modelled matters. Applications of bargaining in applied–theoretical models tend to assume a bargaining process similar to our UBG (typically applying the Nash solution or a generalisation thereof), while experimental tests of such models tend to use more highly abstracted bargaining games like the NDG. Implementing bargaining this way carries the risk that the experimental results will not be generalisable back to the original strategic setting, above and beyond any other concerns about the external validity of lab experiments. This may actually be good news for theorists, since experimental results that seem inconsistent with standard theory may be at least partly an artifact of how the theory was implemented in the experiment, rather than owing to any intrinsic weakness of the theory itself.

Third, our results cast some light on how a *descriptive* theory of bargaining might look. Normative solution concepts that assume *translation invariance*, such as Nash's (1950) and Kalai and Smorodinsky's (1975), will have difficulty explaining the under–responsiveness that we have observed. Anbarci and Feltovich (2013) showed that this kind of under–responsiveness is consistent with some models of

other–regarding preferences. However, the differing results for NDG and UBG in the current study suggest that other–regarding preferences are at best only part of the explanation, as we can see no plausible reason for individuals' distastes for inequality to differ according to the bargaining institution. If other–regarding preferences are to have an impact, it may be an indirect one, via their influence on focal points.[14]

[14] An earlier version of this paper presented a simple focal–point–based model that explains our main results, along with some secondary results such as higher agreement frequency in UBG than in NDG. For space reasons we do not include it here; however it is available from the corresponding author upon request.

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A.1 Instructions from the experiment

Below is the text of instructions for our UBG treatment with bargaining in even-numbered rounds, followed by the text of instructions for our NDG treatment with bargaining in odd-numbered rounds. The instructions for the other two treatments are analogous, and available from the corresponding author upon request.

[UBG instructions]

You are about to participate in a study of decision making. Please read these instructions carefully, as your payment may depend on how well you understand them. If you have any questions, please feel free to ask the experimenter. We ask that you not talk with the other participants – or anyone else – during the experiment.

The main part of this experiment consists of ***ten*** rounds. In each round, you will perform an ***encoding task***. Your computer screen will display a "word" – a sequence of 1-10 letters of the alphabet – along with a key showing the number that corresponds to each letter. Below each letter on your screen will be a blank space. ***Inside each space, you should type the number that corresponds to the letter above it.*** Once you have encoded the entire word, click the "OK" button. If you have encoded the word correctly, the computer will accept it and display a new word. The key will stay the same for all words during a round, but may change from round to round.

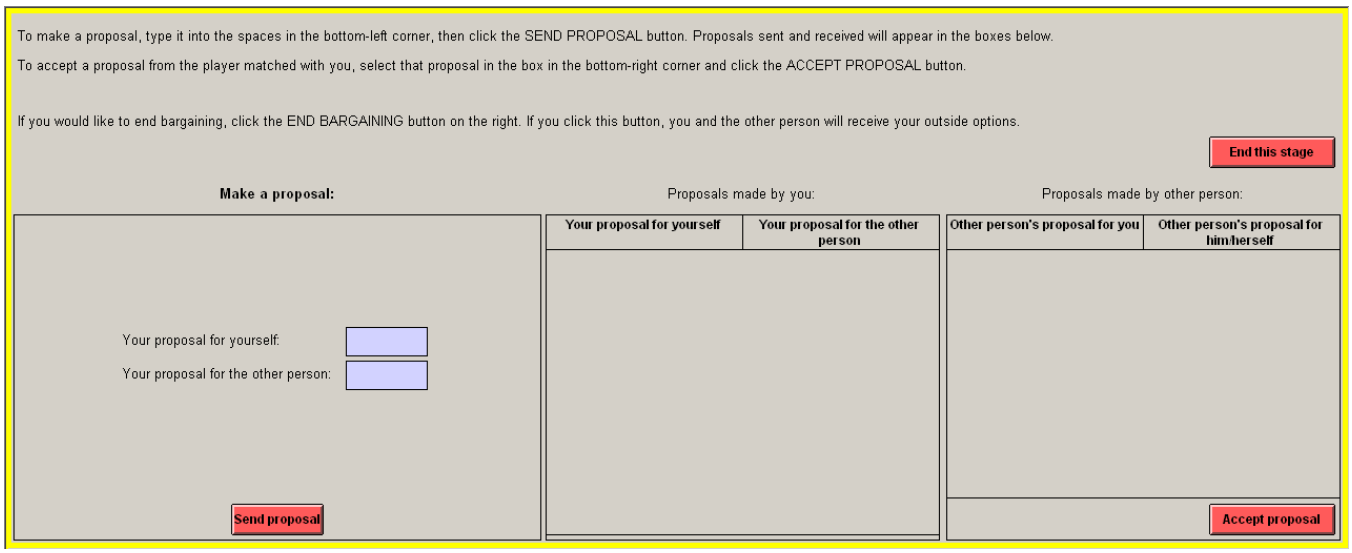
Example: Suppose the key is as follows (this is just an example; the actual key might be different):

A	B	C	D	E	F	G	H	I	J
1	9	5	4	10	6	7	3	8	2

Suppose the word you are given is G – A – J – F – J. The code for G is 7 (below G in the table), and the codes for A, J, F and J are 1, 2, 6 and 2. So, you would encode this word as 7 – 1 – 2 – 6 – 2, then click "OK".

In each round of the experiment, you will have ***five minutes*** to encode as many words as you wish. In ***rounds 1, 3, 5, 7 and 9***, the round ends after the five minutes have finished, and your profit is *15p (£0.15)* for each word you correctly encoded.

In ***rounds 2, 4, 6, 8 and 10***, there is another stage after the encoding task is over. ***In this stage, you have the opportunity to bargain with a randomly chosen participant, over a prize of £10***. The way you bargain is by ***sending and receiving proposals*** for dividing the £10. Below is an example of how the bottom portion of your computer screen will look during this bargaining stage.



To send a proposal to the other person, type the amounts for yourself and the other person in the "Make a proposal" box, then click "Send proposal". ***The amounts you enter must be between 0 and 10 (inclusive), and can have 0, 1 or 2 decimal places.*** The two amounts together must add up to £10 or less. All of your proposals will appear in the box in the bottom-centre of your screen, and all of the proposals made by the other person will appear in the box in the bottom-right. The person paired with you will see these proposals as well, but no one else will be able to see your proposals, nor will you be able to see theirs.

You may accept ***any one*** of the proposals from the person paired with you, ***or none*** of them. To accept a proposal, highlight the one you wish to accept and click "Accept proposal". ***If either you or the other person accepts a proposal, then you have reached an agreement, and the prize is divided according to the accepted proposal.***

The bargaining stage lasts for up to ***2 minutes***; you may send as many or as few proposals as you wish during that time. You may end the bargaining stage before the 2 minutes are over, by clicking on the button labelled "End this stage" on the right of your screen. ***Once you or the person matched with you has clicked this button, it is not possible to send or accept proposals.***

If you or the other person ends the bargaining stage early, or if the time available for proposals ends without you reaching an agreement, then you receive an ***outside option*** equal to ***15p*** for each word you had encoded, and the other person receives an ***outside option*** equal to 15p for each word he/she had encoded. Both you and the person paired with you are informed of ***both*** outside options at the beginning of the bargaining stage.

Organisation of the experiment: This experimental session has three parts.
(1) We will begin with a short questionnaire, where you will answer some demographic questions.
(2) Next, there will be a ***one-minute practice round***, so that you can familiarise yourself with the encoding task. After the one minute has ended, the computer screen will show the number of words you correctly encoded. The results of this practice round will ***not*** affect the amount you are paid.
(3) Then, the main part of the experiment will begin. Each round proceeds as follows:
(a) You perform the encoding task. In odd-numbered rounds, you earn 15p for each word correctly encoded. In even-numbered rounds, this amount becomes your outside option for the bargaining stage.
(b) If it is an even-numbered round, the computer randomly pairs you with another participant, and your screen displays both of your outside options. You can send proposals for dividing the £10.00 prize. The other person can also send proposals for dividing the £10.00 prize; you can accept one of these proposals or none of them.
(c) The round ends. Your computer screen displays the number of words you encoded and your profit. In even-numbered rounds, it also displays whether or not you reached an agreement, and the other person's profit.

Payments: The amount you are paid will depend on the results of the experiment. The computer will randomly select ***four rounds*** out of the ten you played. You will be paid the total of your profits from those selected rounds. Payments are made privately and in cash at the end of the session.

[NDG instructions]

You are about to participate in a study of decision making. Please read these instructions carefully, as your payment may depend on how well you understand them. If you have any questions, please feel free to ask the experimenter. We ask that you not talk with the other participants – or anyone else – during the experiment.

The main part of this experiment consists of ***ten*** rounds. In each round, you will perform an ***encoding task***. Your computer screen will display a "word" – a sequence of 1-10 letters of the alphabet – along with a key showing the number that corresponds to each letter. Below each letter on your screen will be a blank space. ***Inside each space, you should type the number that corresponds to the letter above it.*** Once you have encoded the entire word, click the "OK" button. If you have encoded the word correctly, the computer will accept it and display a new word. The key will stay the same for all words during a round, but may change

from round to round.

Example: Suppose the key is as follows (this is just an example; the actual key might be different):

A	B	C	D	E	F	G	H	I	J
1	9	5	4	10	6	7	3	8	2

Suppose the word you are given is G – A – J – F – J. The code for G is 7 (below G in the table), and the codes for A, J, F and J are 1, 2, 6 and 2. So, you would encode this word as 7 – 1 – 2 – 6 – 2, then click "OK".

In each round of the experiment, you will have ***five minutes*** to encode as many words as you wish. In ***rounds 2, 4, 6, 8 and 10***, the round ends after the five minutes have finished, and your profit is *15p (£0.15)* for each word you correctly encoded.

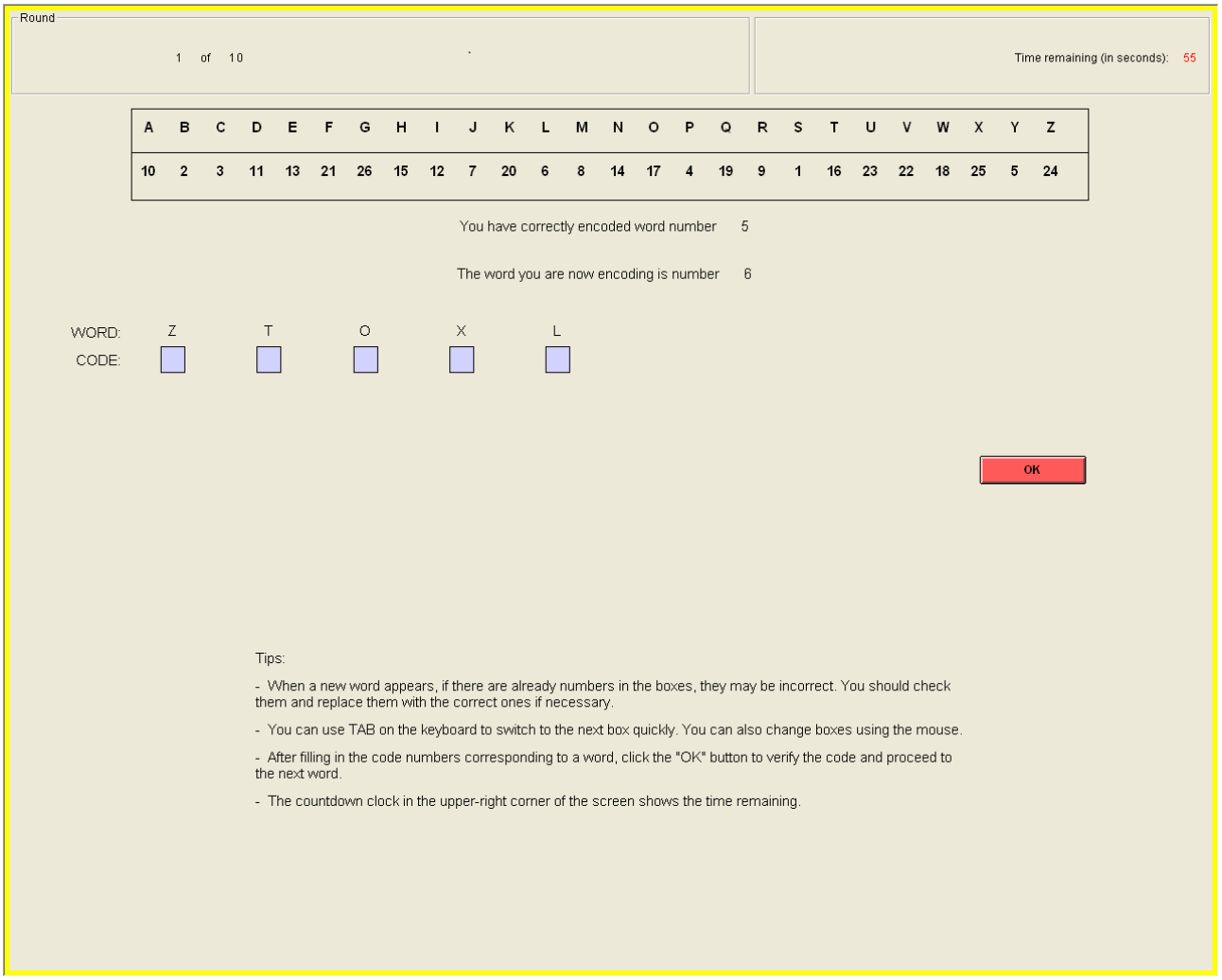
In ***rounds 1, 3, 5, 7 and 9***, there is another stage after the encoding task is over. ***In this stage, you have the opportunity to bargain with a randomly chosen participant, over a prize of £10.*** The way you bargain is by each making ***simultaneous*** claims for shares of the £10.
- If your claim and the other person's claim add up to ***£10 or less***, you receive your claim, and the other person receives his/her claim.
- If the claims add up to ***more than £10***, you receive an ***outside option*** equal to ***15p*** for each word you had encoded, and the other person receives an outside option equal to 15p for each word he/she had encoded.
Both you and the person paired with you are informed of ***both*** outside options before choosing your claims.

Organisation of the experiment: This experimental session has three parts.
(1) We will begin with a short questionnaire, where you will answer some demographic questions.
(2) Next, there will be a ***one-minute practice round***, so that you can familiarise yourself with the encoding task. After the one minute has ended, the computer screen will show the number of words you correctly encoded. The results of this practice round will ***not*** affect the amount you are paid.
(3) Then, the main part of the experiment will begin. Each round proceeds as follows:
(a) You perform the encoding task. In even-numbered rounds, you earn 15p for each word correctly encoded. In odd-numbered rounds, this amount becomes your outside option for the bargaining stage.
(b) If it is an odd-numbered round, the computer randomly pairs you with another participant, and your screen displays both of your outside options. You choose a claim for your share of the £10.00 prize. The other person chooses a claim for his/her share. ***Your claim can be any multiple of 0.01, between 0.00 and 10.00 inclusive.*** Be sure to enter your claim before the allotted time runs out, or the computer will enter a claim of zero for you.
(c) The round ends. Your computer screen displays the number of words you encoded and your profit. In odd-numbered rounds, it also displays your claim, the claim made by the person paired with you, and the other person's profit.

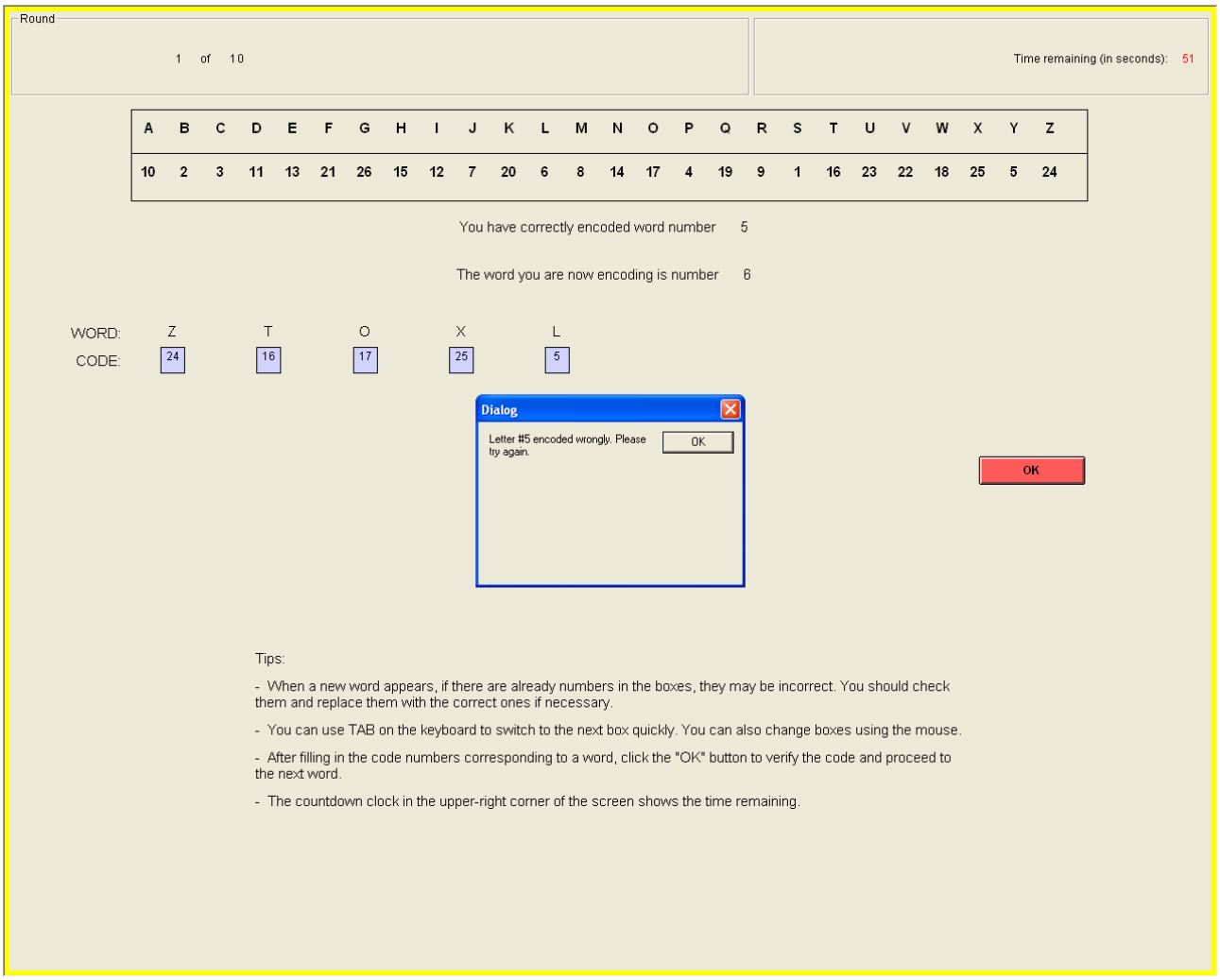
Payments: The amount you are paid will depend on the results of the experiment. The computer will randomly select ***four rounds*** out of the ten you played. You will be paid the total of your profits from those selected rounds. Payments are made privately and in cash at the end of the session.

A.2 Sample screenshots from experiment

Real-effort task:



Error screen from real-effort task:



Decision screen, NDG treatment:

Round

1 of 10

Remaining time [sec]: 90

History of your past outcomes:

Round	Your words encoded	Your outside option (£)	Other person's words encoded	Other person's outside option (£)	Your claim (£)	Other person's claim (£)	Your profit (£)	Other person's profit (£)
0	0	---	---	---	---	---	0.00	---
1	8	1.20	3	0.45	---	---	---	---

You have been randomly matched to another participant.

You correctly encoded **8** words, so your outside option is **£1.20**.

The person matched to you correctly encoded **3** words, so his/her outside option is **£0.45**.

You and the other person can now bargain over **£10.00**.

If you reach an agreement (your claims total less than or equal to **£10.00**), you and the other person will receive the amounts you and he/she claimed.

If you do not reach an agreement, you will each receive your outside options.

Please choose your claim, in pounds. Your claim must be a multiple of 0.01, and must be at least 0.00 and at most 10.00. ***Do not type the £ sign in the box.*** Your claim can have zero, one or two decimal places. For example, a (hypothetical) claim of one thousand pounds could be written as 1000, 1000.0 or 1000.00.

Be sure to enter your claim before the clock at the top-right corner of your screen reaches zero. If you don't, the computer will enter a claim of 0.00 for you.

OK

Feedback screen, NDG treatment:

Round

1 of 10

Remaining time [sec]: 18

History of your past outcomes:

Round	Your words encoded	Your outside option (£)	Other person's words encoded	Other person's outside option (£)	Your claim (£)	Other person's claim (£)	Your profit (£)	Other person's profit (£)
0	0	---	---	---	---	---	0.00	---
1	8	1.20	3	0.45	6.00	3.50	6.00	3.50

THIS ROUND'S RESULTS:

You correctly encoded **8** words.

Your outside option was **£1.20**, and your claim was **£6.00**.

The other person's outside option was **£0.45**, and his/her claim was **£3.50**.

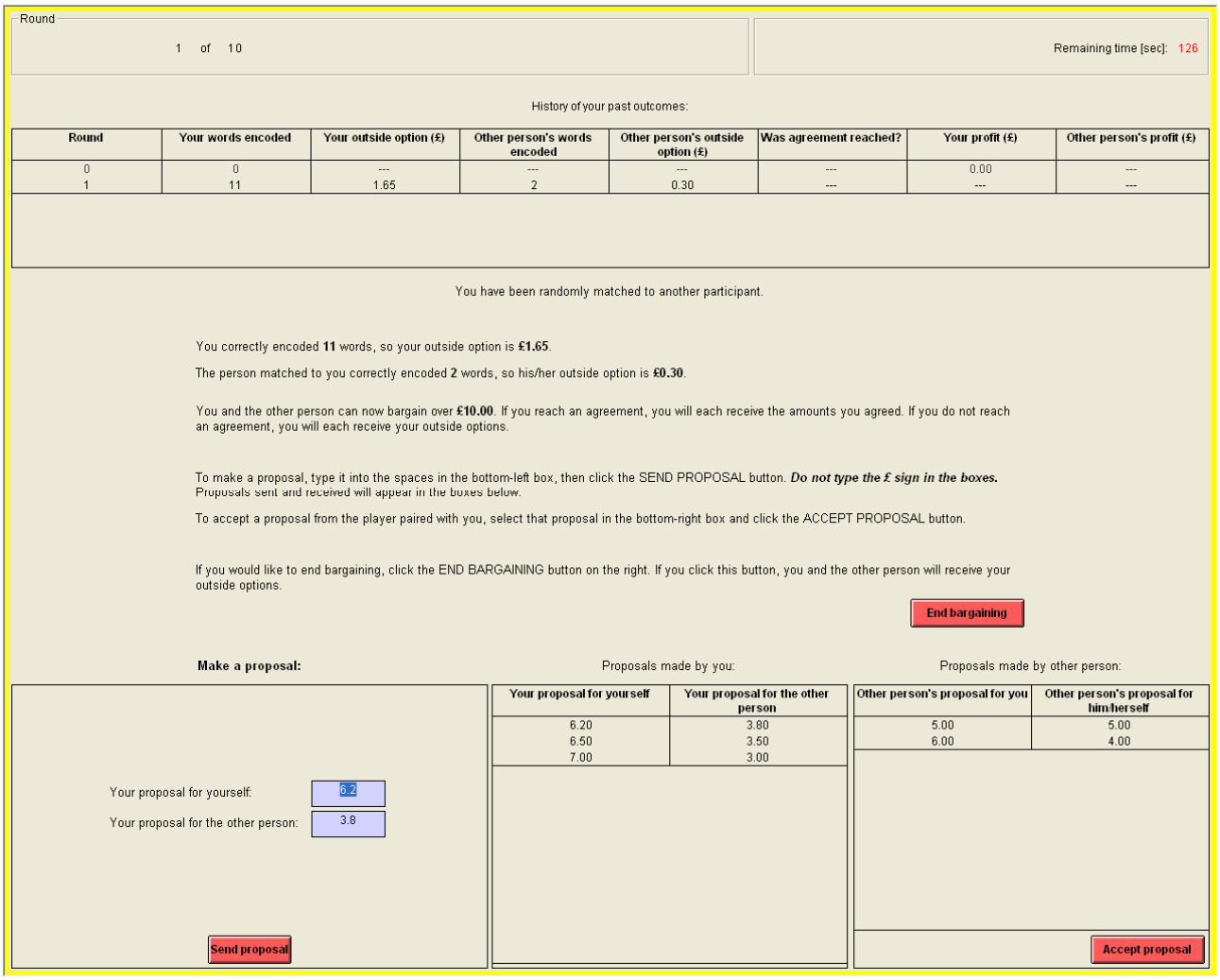
Your combined claims were **LESS THAN OR EQUAL TO** the amount you were bargaining over, so you each receive your claims.

Your profit is **£6.00**.

The other person's profit is **£3.50**.

OK

Bargaining stage screen, UBG treatment:



Round

1 of 10

Remaining time [sec]: 126

History of your past outcomes:

Round	Your words encoded	Your outside option (£)	Other person's words encoded	Other person's outside option (£)	Was agreement reached?	Your profit (£)	Other person's profit (£)
0	0	---	---	---	---	0.00	---
1	11	1.65	2	0.30	---	---	---

You have been randomly matched to another participant.

You correctly encoded **11** words, so your outside option is **£1.65**.

The person matched to you correctly encoded **2** words, so his/her outside option is **£0.30**.

You and the other person can now bargain over **£10.00**. If you reach an agreement, you will each receive the amounts you agreed. If you do not reach an agreement, you will each receive your outside options.

To make a proposal, type it into the spaces in the bottom-left box, then click the SEND PROPOSAL button. ***Do not type the £ sign in the boxes.*** Proposals sent and received will appear in the boxes below.

To accept a proposal from the player paired with you, select that proposal in the bottom-right box and click the ACCEPT PROPOSAL button.

If you would like to end bargaining, click the END BARGAINING button on the right. If you click this button, you and the other person will receive your outside options.

End bargaining

Make a proposal:

Your proposal for yourself: 6.2

Your proposal for the other person: 3.8

Send proposal

Proposals made by you:

Your proposal for yourself	Your proposal for the other person
6.20	3.80
6.50	3.50
7.00	3.00

Proposals made by other person:

Other person's proposal for you	Other person's proposal for him/herself
5.00	5.00
6.00	4.00

Accept proposal

Feedback screen, UBG treatment:

Round

1 of 10

Remaining time [sec]: 15

History of your past outcomes:

Round	Your words encoded	Your outside option (£)	Other person's words encoded	Other person's outside option (£)	Was agreement reached?	Your profit (£)	Other person's profit (£)
0	0	---	---	---	---	0.00	---
1	11	1.65	2	0.30	YES	6.20	3.80

THIS ROUND'S RESULTS:

You correctly encoded **11** words.

Your outside option was **£1.65**, and the other person's outside option was **£0.30**.

You and the other person **DID** reach an agreement.

Your profit is **£6.20**.

The other person's profit is **£3.80**.

OK