CENTRE DE RECHERCHE SUR LES STRATÉGIES ÉCONOMIQUES

Gender and Peer Effects in Social Networks

Julie Beugnot, Bernard Fortin,

Guy lacroix and Marie-Claire Villeval

March 2017

Working paper No. 2017–3

CRESE
30, avenue de l'Observatoire
25009 Besançon
France
http://crese.univ-fcomte.fr/

UNIVERSITÉ DE FRANCHE-COMTÉ

Gender and Peer Effects in Social Networks[☆]

Julie Beugnot[a], Bernard Fortin[b], Guy Lacroix[c], Marie Claire Villeval[d]

[a] *CRESE EA3190, Univ. Bourgogne Franche-Comté, F-25000 Besançon, France.*
[b] *Department of economics, Université Laval, CRREP and CIRANO, Canada.*
[c] *Department of economics, Université Laval, CRREP, IZA and CIRANO, Canada.*
[d] *Univ. Lyon, CNRS, GATE UMR 5824, F-69130 Ecully, France.*

Abstract

We investigate whether peer effects at work differ by gender and whether the gender difference in peer effects –if any- depends on work organization, precisely the structure of social networks. We develop a social network model with gender heterogeneity that we test by means of a real-effort laboratory experiment. We compare sequential networks in which information on peers flows exclusively downward (from peers to the worker) and simultaneous networks where it disseminates bi-directionally along an undirected line (from peers to the worker and from the worker to peers). We identify strong gender differences in peer effects, as males' effort increases with peers' performance in both types of network, whereas females behave conditionally. While they are influenced by peers in sequential networks, females disregard their peers' performance when information flows in both directions. We reject that the difference between networks is driven by having one's performance observed by others or by the presence of peers in the same session in simultaneous networks. We interpret the gender difference in terms of perception of a higher competitiveness of the environment in simultaneous than in sequential networks because of the bi-directional flow of information.

Key words: Gender, peer effects, social networks, work effort, experiment.

JEL-codes: C91, J16, J24, J31, M52.

[☆]The authors thank C. Bellemare, L. Bissonnette, V. Boucher, M. Comola, D. Cooper, C. Eckel, N. Fortin, N. Jacquemet, T. Salmon, and especially Y. Bramoullé and R. Dieye for many helpful discussions and comments. They also thank participants at the Florence Workshop on Behavioural and Experimental Economics, at the European Workshop on Experimental and Behavioural Economics in Frankfurt, at seminars at UT Dallas, Southern Methodist University in Dallas, Texas A&M University, Florida State University, Nanyang Technology University in Singapore, Universidad de Sonora, Erasmus University in Rotterdam, University of Padova, University of Paris I, IZA Worshop on Behavioral Organizational Economics in Bonn, and GATE. They are grateful to Nathalie Viennot and Raphael Cautain for programming the experiment, and to Z. Dai for research assistance. Financial support from the French National Research Agency (ANR-09-BLAN-0321, "MINT" project) is gratefully acknowledged. This research was performed within the framework of the LABEX CORTEX (ANR-11-LABX-0042) of Université de Lyon, within the program Investissements d'Avenir (ANR-11-IDEX-007) operated by the French National Research Agency.

1. Introduction

The economics literature of the past decade has found that males and females respond differently to incentives. In particular, females, as opposed to males, appear to do worse when facing competitive incentive schemes (Gneezy et al., 2003; Gneezy and Rustichini, 2004); they tend to shy away from competitive schemes (Niederle and Vesterlund, 2007) and are more attracted by cooperative incentive schemes (Kuhn and Villeval, 2015). Some have argued that differences in preferences and confidence in one's own relative abilities (for surveys see Eckel and Grossman, 2008; Croson and Gneezy, 2009) are key in explaining such gender-specific responses. The latter has also been invoked to explain the puzzling persistence of inequalities between females and males' career paths (Goldin et al., 2006).

However, the literature has so far focused largely on monetary schemes, such as piece-rates and tournaments, and has paid limited attention to non-monetary incentives such as information feedback on peer performances and work organization. Many papers have restricted the role of information to a minimum in an attempt to measure the impact of beliefs about relative abilities. Papers that do allow such information feedback usually aim at investigating the gender-specific willingness to enter a competition (Cason et al., 2010; Wozniak, 2012; Wozniak et al., 2015)[1] or, at times, the relative performance in competitive settings with or without monetary prizes (*e.g.*, Delfgaauw et al., 2009). Due to their focus on competition, however, the latter are not designed to separately identify the pure effect of information from its strategic dimension.

The aim of this paper is twofold. First, we investigate whether information on peer performance and characteristics affects males and females' work effort differently. Everyday life offers many examples whereby individual labor supply and performance not only depend on a worker's wage and characteristics but also on those of a reference group. Since Kandel and Lazear (1992)'s seminal theoretical contribution, several empirical studies have found positive peer effects in settings as varied as tournaments, piece-rates (Azmat and Iriberri, 2010; Blanes i Vidal and Nossol, 2011) and fixed compensation schemes (Falk and Ichino, 2006; Mas and Moretti, 2009; Kuhnen and Tymula, 2012).[2] Others, in contrast,

[1] For example, Wozniak et al. (2015) show that females are much more responsive to feedback on relative ability than males, thus eliminating the gender gap in competitiveness for high-ability subjects when feedback is costless. But females are also less likely than males to pay to obtain this information.

[2] For example, in Falk and Ichino (2006), subjects had to wrap envelopes either alone in a room, or alongside a co-worker. Working in pairs induced a higher output level. In a large grocery chain, Mas and Moretti (2009) found positive peer effects on productivity when cashiers could be observed by coworkers. No such effect was found when they could only observe others' output without being observed themselves. Kuhnen and Tymula (2012), in contrast, conducted a lab experiment that insured feedback was private and anonymous; they found that learning about one's own rank increased work effort presumably out of concern for self-esteem.

have found either a null or a weak positive effect (Guryan et al., 2009; Bellemare et al., 2010; Eriksson et al., 2009; Van Veldhuizen et al., 2014). Some have even found a negative peer effect amongst the lowest-performing (Barankay, 2012) and the disappointment-averse workers (Gill and Prowse, 2012). Surprisingly, the literature has seldom addressed gender-specific peer effects on work effort. This paper provides one of the first contributions in this direction.

Concern for strategic complementarity, social learning (*e.g.*, monitoring), competitiveness and conformity, or any combination of these mechanisms are potential candidates to explain the relationship between individual and peer performances. Our empirical framework excludes strategic complementarity and social learning, and thus allows us to focus on mechanisms such as competitiveness and conformity. Moreover, in our approach, workers are paid under a piece-rate scheme. Therefore, tournament incentives are left out from our design.

Workers usually interact directly or indirectly with coworkers so that individual performance is oftentimes common knowledge. The information flows through a "social network" that is specific to each work environment. The second aim of the paper is thus to investigate the extent to which various work organizations impact male and female peer effects differently, if at all. Yet, despite the pervasiveness of such social networks (Jackson, 2010, 2011), most studies of peer effects at work assume that individuals interact within groups. This is akin to assuming that individual performance depends upon that of each member of the group, however defined, with equal weight.[3] More realistically, each worker may have his own reference group. His performance will thus be influenced directly by his peers, but also indirectly through their own peers. While peer effects in social networks have been studied in various contexts,[4] their analysis on the labor market has focused for the most part on the transmission of information about job opportunities (Laschever, 2011; Calvó-Armengol et al., 2009) and the role of referrals (Topa, 2011). The role of social networks on work effort has seldom been investigated.[5]

[3]More precisely, in a group, all individuals interact with each others but with none outside of it.

[4]See Bertrand et al. (2000) on welfare participation, De Weerdt and Dercon (2006) on the provision of informal health insurance in developing countries, Cassar (2007) on coordination and cooperation, Patacchini and Zenou (2008) on criminal activity, Calvó-Armengol et al. (2009) on education, Karlan et al. (2009) on risk-sharing, Munshi (2010) on labor and credit networks on economic activity in developing countries, Waldinger (2012) in science, and Fortin and Yazbeck (2015) on obesity.

[5]Using field experiments, Bandiera et al. (2005, 2009, 2010) show how friendship at work modulates the impact of incentive schemes on productivity. More closely related to our approach, Lindquist et al. (2015) use data from the call center of a mobile network operator and a field experiment; they find evidence of both a local average network effect on productivity, attributed to conformism and peer pressure, and a local aggregate effect that results from knowledge spillovers.

We investigate peer effects on effort at work by developing a social network model with gender heterogeneity. More precisely, our theoretical framework generalizes the standard linear-in-means approach (e.g., see Manski, 1993; Bramoullé et al., 2009; Blume et al., 2015) to allow both the performance and the contextual peers effects to vary across gender. Our model is inspired by Arduini et al. (2016) and Dieye and Fortin (2017).

To estimate the model, we design laboratory experiments in which subjects are paid according to a piece-rate scheme to perform a real effort task repeatedly. Two work organizations (treatments) are considered: *sequential* networks and *simultaneous* networks. In the sequential treatments, subjects are randomly assigned to peers who participated in a previous baseline treatment in which they performed the exact same tasks in isolation. Subjects are informed about the mean performance, wage and individual characteristics of their peers. Thus, in this directed bipartite lines network, information flows one-way from peers to subjects. This more or less mimics a situation whereby workers learn about the output level of their peers in a previous work shift.[6] In the simultaneous treatments, subjects are also randomly assigned to peers but interact in real-time. In these undirected line networks, information flows in two directions: from peers to subjects and from subjects to peers. This arrangement mimics that of a cashier in a large retail store who can observe the performances of her co-workers located nearby, and *vice versa*. Workers interact in a non-cooperative way and each game is played until (quasi-)convergence to a Nash equilibrium.

Designing exogenous networks in the lab eases the identification of peer effects for at least three reasons. First, by randomly assigning subjects across networks, it ensures the absence of endogeneity biases arising for instance from the fact that individuals with similar characteristics or behavior self-select in their reference group (*i.e.*, no correlated effects due to homophily). Second, it guarantees knowledge of the true reference group (by the researcher), that is, we know who interacts with whom with no measurement errors. Third, it has been known since Manski (1993) and Lee (2007) that the simultaneity between a subject's and his peers' behavior may make separate identification of the endogenous and contextual peer effects difficult when individuals interact in groups and especially so when the number of groups is small or when the average group size is large.[7] Manski calls this *the reflection problem*. However, Bramoullé et al. (2009) and Blume et al. (2015), among others, have proved that, in the absence of correlated effects, the linear-in-means homogenous model is *generically* identified when interactions are structured through social networks. Thus, by forming properly designed exogenous networks in the lab, our approach allows to

[6] In our experiment, subjects do not learn from their peers (no social learning or knowledge spillover). Also we ignore the presence of technical complementarity in labor inputs.

[7] See de Paula (2015) for a detailed discussion on social network identification when individuals interact in groups.

identify peer effects. In particular, peer effects in our sequential treatments are identified since by construction the reference groups' behavior is predetermined. Peer effects in our simultaneous networks are also identified since we show that our model satisfies Arduini et al. (2016)'s conditions for identification under group heterogeneity.

Our empirical strategy consists in estimating the gender-specific sequential model using a clustered random effects panel approach and the simultaneous model using a panel spatial pseudo-maximum likelihood method. Our results show that peer effects strongly differ between males and females. We find that males' performances are positively linked to that of their peers in both treatments. Females, on the other hand, respond positively to their peers' performances in the sequential treatment, but not so in the simultaneous case. Thus, when information flows in both directions, females behave as though their peers' performance and characteristics were irrelevant, which is in stark contrast to their male counterparts. Variants of the informational content of the baseline and sequential treatments are used to investigate the sensitivity of the estimates of the sequential treatment. These variants aim at replicating the information that is available to the subjects and their peers in the simultaneous treatment. Because both female and male performances are the same as in the initial sequential treatment, we conclude that it is the simultaneity and the bi-directionality of the flow of information in the simultaneous treatment that determine how females react to their peers' performances.

We conjecture that females perceive the simultaneous networks as being somewhat more competitive. In sequential networks, peer performance may be taken as a simple reference point when setting personal goals. These results are consistent with previous literature in which females, as opposed to males, are found to respond less to financial incentives as the environment gets more competitive. Our results suggest that these differences also hold for non-monetary, informational, incentives. They may shed light on the causes of gender differences in occupational statuses and career paths.

The remainder of the paper is structured as follows. Sections 2 presents our theoretical model of peer effects at work. Section 3 describes the experimental design and procedures. Section 4 presents our econometric strategy and our results. Section 5 discusses the results and concludes.

2. Theoretical setup

Consider three types of work arrangements with increasing levels of interactions. In all three cases, subjects are asked to perform the same sequence of mathematical tasks. At one extreme (Baseline treatment), subjects work in isolation. At the other extreme (Simultaneous treatment), they interact with peers in a given network configuration and are made aware of the latter's mean performance in real-time as the game unfolds. As an intermediate case (Sequential treatment), subjects are randomly matched to peers from the Baseline treatment. Information about peer performance and characteristics flows one-way.

2.1. Baseline treatment

A treatment includes s sessions (or networks) indexed by l, with $i = 1, \ldots, n_l$ subjects who perform a task for a total of $t = 1, \ldots, T_l$ periods. In each session l, there are n_l^m males (or type-m) and n_l^f females (or type-f) (with $n_l^m + n_l^f = n_l$). For notational convenience, we assume, for the moment, that there is a single session per treatment (with $n_l = n$, $n_l^m = n^m$, $n_l^f = n^f$ and $T_l = T$). Total work time per period is fixed and allocated between on-the-job leisure and work. Effort is proxied by the per period individual production and subjects are paid a piece-rate for each unit of production.[8] We order the vectors and matrices in each treatment so that the first rows correspond to type-m subjects and the remaining rows to type-f subjects.

We assume that preferences for consumption and on-the-job leisure is represented by a utility function that rationalizes the useful semi-log effort function (see Heckman, 1974) when maximized under the budget and time constraints:

$$e_{it}^j = \alpha_i^j + \alpha_1^j w_{it}^j + \eta_{it}^j, \tag{1}$$

with $E(\eta_{it}^j | \boldsymbol{w}_i^j, \alpha_i^j) = 0$, $E(\alpha_i^j | \boldsymbol{w}_i^j) = E(\alpha_i^j)$, $j = m, f$, $i = 1, \ldots, n^j$, $t = 1, \ldots, T$. The variable e_{it}^j is type-j individual i's effort at period t, w_{it}^j is his/her piece-rate wage (in log)[9], α_i^j is a time invariant individual effect, η_{it}^j is an idiosyncratic individual term, and $\boldsymbol{w}_i^j = (w_{i1}^j, w_{i2}^j, \ldots, w_{iT}^j)$. Parameters of Eq. (1) can be estimated using a random effects procedure[10] as the model assumes both strict exogeneity of $\boldsymbol{w}_i^j$ [11] and orthogonality between α_i^j and $\boldsymbol{w}_i^j$. Moreover, panel robust standard errors (clustered at the individual level) are used to conduct statistical inferences since idiosyncratic errors are likely to be serially correlated across t.

[8] In principle, a production function could be specified that would relate output to work effort, other inputs and unobservable shocks. However, it would be difficult to identify technology from preferences in the model. Thus, following Dickinson (1999), we assume that work effort is proxied by output.

[9] For notational simplicity, we assume only one observable characteristic, the piece-rate wage, which is randomly determined in the experience. In the empirical section, we introduce other exogenous explanatory variables: the show-up fee (as a proxy for nonlabor income), age, the relative family wealth, the proportion of males in the session, a dummy for being student in the engineering school, and time.

[10] We also estimated a fixed effects model and we obtained very similar estimates.

[11] In the general case with many sessions, we allow for session fixed effect for $l = 1, \ldots, s$. These may possibly be correlated to the explanatory variables and aim at capturing changing laboratory environments (weather, daytime, *etc.*).

2.2. Sequential treatment

In the Sequential treatment, the networks are structured such that the information on wage and performance flows from the Baseline treatment to the Sequential treatment. Subjects in the Sequential treatment are each matched to a specific reference group, N_i^j, that comprises n_i^j individuals from the Baseline treatment. They are informed about the average performance and wage of their peers at the beginning of each period. Social interactions are introduced in the Baseline model by assuming a linear-in-means semi-log effort function:

$$e_{it}^j = \beta_i^j + \beta_1^j w_{it}^j + \beta_2^j \frac{1}{n_i^j} \sum_{k \in N_i^j} e_{kt} + \beta_3^j \frac{1}{n_i^j} \sum_{k \in N_i^j} w_{kt} + u_{it}^j. \tag{2}$$

with $j = m, f, \;\; i = 1, \ldots, n^j, \;\; t = 1, \ldots, T$. Assumptions on the error component terms, β_i^j and u_{it}^j, are the same as those in the Baseline treatment. The performance and contextual peer effects are captured by β_2^j and β_3^j, respectively. In this linear-in-means model, competitiveness and conformity correspond to having $\beta_2^j > 0$. Note that this model assumes between-gender heterogeneity but within-gender homogeneity. Indeed, the peer effects of male and female subjects are assumed to be the same on an individual of a given gender.[12] In the sequential treatment, no endogeneity issues due to simultaneity of outcomes or the presence of correlated effects arise since all explanatory variables are assumed strictly exogenous. Assuming also orthogonality between β_i^j and these variables, equation (2) is a random effects model.

It is useful to combine the Baseline and Sequential treatments into a single model in order to compare them to the Simultaneous treatment discussed below. First, define the type-j non-stochastic interaction matrix $\boldsymbol{R}^j$, with a zero diagonal, where the typical element is $r_{ik}^j = 1/n_i^j$ if k belongs to the Baseline treatment and is a peer of type-j subject i in the Sequential treatment, and $r_{ik}^j = 0$, otherwise. The vector $\boldsymbol{R}^j \boldsymbol{e}_t$ thus corresponds to the mean performance of type-j individuals' reference group at t. By design, the value is equal to 0 for Baseline individuals. Similarly, the vector $\boldsymbol{R}^j \boldsymbol{w}_t$ corresponds to the mean wage rate of type-j individuals' reference group at t. We assume that $\alpha_1^j = \beta_1^j$, with $j = m, f$. If these assumption hold, then combining the two models will yield more efficient parameter estimators.[13] The pooled set of Baseline and Sequential individuals is said to form a *directed bipartite network*. Eqs.(1) and (2) can then be combined into a single *pooled* model:

[12]A more general model would allow individuals to respond differently to peers of each gender, *i.e.*, it would include four heterogeneous effects (*ff, fm, mf, and mm*) rather than two (*f,m*). For the sake of simplicity, we only consider between-gender heterogeneity. However, the proportion of male peers is included as a contextual variable in the econometric specification but turns out never to be statistically significant.

[13]The assumptions are tested in the empirical section of the paper.

$$\boldsymbol{e}_t^j = \boldsymbol{\beta}^j + \beta_1^j \boldsymbol{w}_t^j + \beta_2^j \boldsymbol{R}^j \boldsymbol{e}_t + \beta_3^j \boldsymbol{R}^j \boldsymbol{w}_t + \boldsymbol{u}_t^j, \tag{3}$$

with $j = m, f$, $t = 1, \dots, T$, where $\boldsymbol{e}_t^j$, $\boldsymbol{\beta}^j$ and $\boldsymbol{u}_t^j$ are respectively the concatenated $(n^j \times 1)$ vector of effort levels, time invariant individual effects, and idiosyncratic individual terms of type-j subjects at time t, in Baseline and Sequential treatments. This specification allows for between-gender heterogeneous peer effects since the parameters are all indexed by $j = m, f$. This random effects model is identified as long as the usual (full) rank condition for generalized least squares is satisfied.

2.3. Simultaneous treatment

In the Simultaneous treatment, information on performance and characteristics flows between subjects and peers in real time. Because they likely influence one another, we must make an assumption about preferences for this type of game to reach an equilibrium. Thus each subject is assumed to behave non-cooperatively and to ignore the fact that his own performance may influence other subjects in the network. This is equivalent to assuming that, at the equilibrium, each subject correctly anticipates the mean performance of his peers and behaves accordingly. In other words, a non-cooperative Nash social equilibrium arises because subjects are assumed to form self-consistent expectations.[14]

At the Nash equilibrium, the best response equation for type-j subjects, given the mean effort and characteristics of their peers, is given by:

$$\boldsymbol{e}_t^j = \gamma^j \boldsymbol{\imath}^j + \gamma_1^j \boldsymbol{w}_t^j + \gamma_2^j \boldsymbol{G}^j \boldsymbol{e}_t + \gamma_3^j \boldsymbol{G}^j \boldsymbol{w}_t + \boldsymbol{\varepsilon}_t^j, \tag{4}$$

with $E(\boldsymbol{\varepsilon}_t^j|\boldsymbol{w}) = 0,\ j = m, f,\ \ t = 1, \dots, T$, where $\boldsymbol{\imath}^j$ is a $(n^j \times 1)$ vector of ones, $\boldsymbol{G^j}$ is a row-normalized non-stochastic interaction matrix for type-j subjects, with a zero diagonal, and with $g_{ik}^j = 1/n_i^j$ if k is a peer of the type-j subject i, and 0 otherwise. The endogenous (performance) peer effect and the contextual effect are measured by $\gamma_2^j$and γ_3^j, respectively. It is standard to assume that $|\gamma_2^j| < 1$.[15] For simplicity, we assume for the moment that $\boldsymbol{\varepsilon}_t^j$ is a vector of errors whose elements are i.i.d. with variance given by σ^2, for all i, t, and $j = m, f$.[16]

It is worth emphasizing that equation (3) for sequential networks and equation (4) for simultaneous networks differ in three important aspects. First, while in sequential networks

[14]We describe the convergence procedure to the Nash equilibrium in the section on the experimental design.

[15]More generally, stationarity requires that $1/\omega_{max}^j < \gamma_2^j < 1/\omega_{min}^j$, for $j = m, f$, where ω_{min}^j and ω_{max}^j denote the smallest and the largest eigenvalues of the matrix $\boldsymbol{G}^j$.

[16]In the empirical section, this assumption will be relaxed.

subjects in a given session are matched to peers who have played in isolation in a previous session, in the Simultaneous model (equation (4)) social interactions occur in real time in the same session. Since the models do not reflect the same informational environment, we allow the parameters of these two equations to be different. This point is crucial for distinguishing behaviors across genders. Second, the vector of mean reference group's performance, $\boldsymbol{R^j e}_t$, is exogenous in equation (3) whereas the corresponding variable, $\boldsymbol{G^j e_t}$ is endogenous in equation (4). The reason is that, in the Simultaneous treatment, a subject is influenced by his peers but in turn the latter are also influenced by him/her, which is not the case in the Sequential treatment. Third, in the simultaneous treatment, we assume a constant coefficient for each gender (*i.e.*, γ^m and γ^f) and not a (time invariant) individual effect as in the Baseline and Sequential treatments. This allows to simplify the identification and the estimation of the simultaneous model.[17]

To estimate this heterogeneous social network model, it is first important to establish the conditions under which it is identified. To do so, first vertically concatenate the vectors and matrices in equation (4) with respect to genders $j = m, f$. Then, define the two $n \times n$ type-j social interaction matrices $\underline{\mathbf{G}}^j$ such that $\underline{g}_{ik}^j = 1/n_i^j$ if k is a peer of the type-j subject i, and 0 otherwise. It is clear that $\underline{\mathbf{G}}^m + \underline{\mathbf{G}}^f = \mathbf{G}$, where $\mathbf{G}$ is the row-normalized interaction matrix for the entire set of subjects. Define the $n \times 1$ vector $\boldsymbol{d}_t^m$ of dummy variables of male indicators d_{it}^m such that $d_{it}^m = \mathbf{1}(j_i = m)$, for all $i = 1, \dots, n$, where j_i is the individual i's gender. Similarly, define the vector $\boldsymbol{d}_t^f$ of dummy variables for female subjects. By definition, $\boldsymbol{d}_t^m + \boldsymbol{d}_t^f = \boldsymbol{\iota}_t$, where $\boldsymbol{\iota}_t$ is a $n \times 1$ vector of ones. Now define a $n \times 1$ vector $\underline{\boldsymbol{w}}_t^m = I_t^m \boldsymbol{w}_t$, where $I_t^m \equiv diag(\boldsymbol{d}_t^f)$. The element $\underline{w}_{it}^m$ is equal to w_{it}^m when the subject i is a male, and 0 when the subject i is a female. Similarly, define $\underline{\boldsymbol{w}}_t^f = I_t^f \boldsymbol{w}_t$. Since $I_t^m + I_t^f = I_t$, one has $\underline{\boldsymbol{w}}_t^m + \underline{\boldsymbol{w}}_t^f = \boldsymbol{w}_t$. Also, denote $\boldsymbol{e_t} = (\boldsymbol{e}_t^{m\prime}, \boldsymbol{e}_t^{f\prime})'$. The best response function at time t and at the Nash equilibrium can be written as:

$$\boldsymbol{e}_t = \gamma^m \boldsymbol{d}_t^m + \gamma^f \boldsymbol{d}_t^f + \gamma_1^m \underline{\boldsymbol{w}}_t^m + \gamma_1^f \underline{\boldsymbol{w}}_t^f + \gamma_2^m \underline{\boldsymbol{G}}^m \boldsymbol{e_t} + \gamma_2^f \underline{\boldsymbol{G}}^f \boldsymbol{e_t} + \gamma_3^m \underline{\boldsymbol{G}}^m \boldsymbol{w}_t + \gamma_3^f \underline{\boldsymbol{G}}^f \boldsymbol{w}_t + \boldsymbol{\varepsilon}_t. \quad (5)$$

Using an obvious notation, the *macro* model, which includes all periods (in finite number), can be written as:

$$\boldsymbol{e} = \gamma^m \boldsymbol{d}^m + \gamma^f \boldsymbol{d}^f + \gamma_1^m \underline{\boldsymbol{w}}^m + \gamma_1^f \underline{\boldsymbol{w}}^f + \gamma_2^m \underline{\mathbb{G}}^m \boldsymbol{e} + \gamma_2^f \underline{\mathbb{G}}^f \boldsymbol{e} + \gamma_3^m \underline{\mathbb{G}}^m \boldsymbol{w} + \gamma_3^f \underline{\mathbb{G}}^f \boldsymbol{w} + \boldsymbol{\varepsilon}, \quad (6)$$

with $E(\boldsymbol{\varepsilon}|\boldsymbol{w}) = 0$. Also, $\underline{\mathbb{G}}^j = \mathrm{diag}(\underline{\boldsymbol{G}}^j)$ is the block-diagonal type-j interaction matrix for the T periods, with $\underline{\mathbb{G}}^m + \underline{\mathbb{G}}^f = \mathbb{G}$. All vectors in equation (6) have a $Tn \times 1$ dimension,

[17] As discussed later, our pseudo-maximum likelihood approach takes into account both the endogeneity (reflection) and the serial correlation problems (using panel clustered standard errors).

with $\underline{\boldsymbol{w}}^m \equiv \mathbb{I}^m \boldsymbol{w}$, $\underline{\boldsymbol{w}}^f \equiv \mathbb{I}^f \boldsymbol{w}$, and $\mathbb{I}^m + \mathbb{I}^f = \mathbb{I}$.

Finally, using equation (6), the *macro reduced form* is given by:

$$\boldsymbol{e} = \mathbb{S}^{-1}(\gamma^m \boldsymbol{d}^m + \gamma^f \boldsymbol{d}^f + \gamma_1^m \underline{\boldsymbol{w}}^m + \gamma_1^f \underline{\boldsymbol{w}}^f + \gamma_3^m \underline{\mathbb{G}}^m \boldsymbol{w} + \gamma_3^f \underline{\mathbb{G}}^f \boldsymbol{w} + \boldsymbol{\varepsilon}), \tag{7}$$

where $\mathbb{S} = \mathbb{I} - \gamma_2^m \underline{\mathbb{G}}^m - \gamma_2^f \underline{\mathbb{G}}^f$. Since $|\gamma_2^j| < 1$ for $j = m, f$, the inverse matrix $\mathbb{S}^{-1}$ exists.

In our setting, identification means that a consistent estimator of the parameters of the model (6) exists. Assuming standard regularity conditions (see Appendix A in Arduini et al., 2016), we have the following proposition:

Proposition 1. *Assume that the model (6) holds. Assume also that $|\gamma_2^j| < 1$, and $\gamma_1^j \gamma_2^j + \gamma_3^j \neq 0$, for $j = m, f$. If the matrices $\mathbb{I}^m, \mathbb{I}^f, \underline{\mathbb{G}}^m, \underline{\mathbb{G}}^f, \underline{\mathbb{G}}^{m^2}, \underline{\mathbb{G}}^{f^2}, \underline{\mathbb{G}}^m \underline{\mathbb{G}}^f, \underline{\mathbb{G}}^f \underline{\mathbb{G}}^m$ are linearly independent, then the parameters of the model (6) are identified.*

Proof. This proposition is a simple application of Proposition 1 in Arduini et al. (2016) (see case 1.(a), case 1.(b), and their symmetric counterparts).[18] □

From this proposition, it follows that the characteristics of type-m and type-f peers (and their interactions) of distances 2,..., are appropriate identifying instruments.

The standard homogeneous linear-in-means model is a particular case of this model. It is obtained when assuming that $\gamma^m = \gamma^f = \gamma$ and $\gamma_r^m = \gamma_r^f = \gamma_r$, for $r = 1, 2, 3$. Under these assumptions, equation (6) can be written as:

$$\boldsymbol{e} \quad = \quad \boldsymbol{\iota}\gamma + \gamma_1 \boldsymbol{w} + \gamma_2 \mathbb{G}\boldsymbol{e} + \gamma_3 \mathbb{G}\boldsymbol{w} + \boldsymbol{\varepsilon}, \tag{8}$$

with $E(\boldsymbol{\varepsilon}|\boldsymbol{w}) = 0$. In that case, the identification conditions correspond to those of the Bramoullé et al. (2009) model. More precisely, the model is identified if $\gamma_1\gamma_2 + \gamma_3 \neq 0$, and if the matrices $\mathbb{I}, \mathbb{G}, \mathbb{G}^2$ are linearly independent. The latter condition is satisfied in our simultaneous treatment since subjects do not interact in groups.

The model (6) is estimated using a pooled panel spatial maximum likelihood (ML) approach with two lagged spatial dependent variables to take into account gender heterogeneity in endogenous peer effects.[19] Robust panel standard errors (clustered at the subject

[18] Note that Proposition 1 in Arduini et al. (2016) is more general than our own proposition, since it applies to the case where individuals may respond differently to peers of each gender.

[19] Of course, when a 2SLS estimator of the model (6) is identified, the ML estimator is also identified since it imposes more structure to the error terms.

level) are used to provide valid inference in the presence of serial correlation. One interesting feature of our likelihood-based approach, as compared with an instrumental (IV) method, is that the determinant term ensures the stationarity of the model (LeSage and Pace, 2009). Moreover, the ML procedure is less sensitive to various implementation issues such as the choice of instruments in the IV approach.[20]

3. Experimental design and procedures

The above theoretical discussion has outlined three different networks with varying degrees of interactions between subjects. In what follows, we describe laboratory experiments designed to mimic these networks. The experiments follow a between-subject design with random assignment to treatment. The data stemming from the experiments are used to estimate the endogenous and contextual peer effects.

3.1. The Baseline treatment

As mentioned in Section 2.1, Baseline subjects play in isolation for a single session. A session comprises 16 periods that last two and a half minutes each. Subjects are asked to mentally multiply as many two-digit and one-digit numbers as possible (*e.g.*, 22×7). The same numbers are used across subjects and sessions to insure homogeneity of treatment. Once the numbers are displayed on the computer screen, subjects enter the answer and, if correct, a new task is displayed. Otherwise, an error message is shown on the screen and another answer must be entered. The screen keeps track of the number of correct answers and the remaining time until the period ends.

At the beginning of each period, a piece-rate of either €0.10, €0.50, or €1 is randomly assigned to each subject and displayed on the screen. Payoff in a given period is equal to the number of correct answers times the piece-rate. Potential earnings are displayed at the end of each period. When the session ends, the actual payoff corresponds to the earnings of a randomly selected period drawn independently for each subject.

Prior to each session, subjects are paid a fixed randomly selected show-up fee of either €2, €4, or €6. In a standard labor supply model this would correspond to unearned income. In addition, they are told that performing the multiplications is not compulsory. They are free to read the magazines that lay on their desk. These serve as a mimicking device for on-the-job leisure. Subjects may thus choose to rest during a period if they deem

[20]We also estimate the model (6) using fixed effects IV. However, the parameter estimate of peer performance was very close to the one obtained using a ML approach but much less precise. Moreover, one disadvantage of the fixed effects IV estimator is that it cannot identify the individual and contextual effects that are time invariant.

the piece-rate to be too low and benefit from increased concentration at later periods.

Two variants of the baseline have been implemented. In the first, subjects are not informed that they will be matched to other subjects. In the second, they are. The purpose of the latter variant is to measure the extent to which subjects exhibit self-image concern.[21] Comparison between the two variants will help understand differential performances between sequential and simultaneous networks, if any.

3.2. The Sequential treatment

The set-up of the Sequential treatment is similar to that of the Baseline treatment. In each of these treatments, subjects are aligned along rows of six seats. Figure 1 depicts the graph of the directed bipartite network. The nodes correspond to the subjects and the arrows point towards their peers. Those seated at the end of a row are matched to a single peer, while all others are matched to two peers.[22]

Subjects are informed that they are matched to either one or two peers. At the beginning of a session, information on peer characteristics are displayed on the screen. These include average age, number of school years, show-up fee, school, gender and relative family wealth (reported on a scale from 1 to 10 – from the 10% poorest to the 10% wealthiest). At the beginning of each period, in addition to own random piece-rate, average peer piece-rates and performances are displayed on the screen. Subjects are also informed that their peers had to perform the exact same multiplications as themselves, and in the same order. At the end of each period, a summary screen displays own performance, piece-rate and earnings, and recalls the average peer piece-rates and performances.

As with the Baseline treatment, two variants have been implemented. In the first, subjects are told that their peers participated in a previous session. In the other, subjects are informed that their peers are drawn from the current session but that they started performing the task three minutes in advance. They are further informed that their peers will not be communicated any information regarding their own performance and characteristics. In both variants, subjects know that the match will remain the same for the duration of the session.[23] Because no information flows from the subjects to their peers, a comparison between the two variants identifies the pure impact of having one's peers in the room on

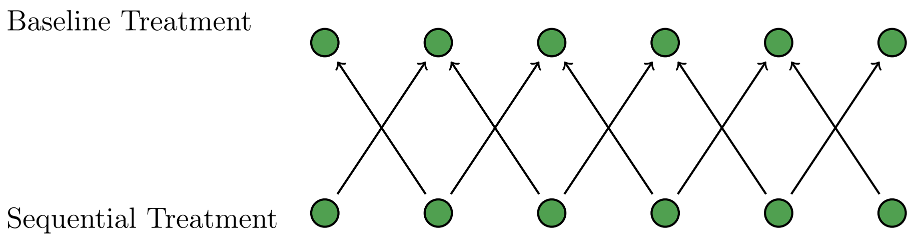
[21]The Baseline model developed in the theoretical section focuses on the first variant. Extending the model to the second variant could be achieved by including a dummy variable in equation (1). The parameter of this variable is identified if we exclude session dummies.

[22]As explained below, this spatial configuration parallels that of the Simultaneous treatment although in both the Sequential and the Simultaneous treatments subjects are not aware of this.

[23]The sequential model developed in the theoretical section focuses on the first variant. Extending the model to the second variant could be achieved by interacting a dummy variable for this variant with peer performance in equation (2).

own performance. Measuring this potential influence is important when contrasting the Sequential and Simultaneous treatments.

Figure 1: Graph of a Sequential Network



3.3. The Simultaneous treatment

The set-up of the Simultaneous and the Sequential treatments are similar, except that in the former the interactions occur concurrently and information flows between subjects and peers. A session consists of only four *periods*, each comprising up to five *rounds* lasting two and a half minutes to allow convergence to the Nash equilibrium. The Simultaneous treatment unfolds pretty much like the Sequential treatment. Information on peer characteristics are displayed on the screen at the beginning of the session. As each period begins, information is provided on own and peer mean piece-rates. At the end of the first round, subjects receive information about their peers' performance. They then proceed to round 2, at the end of which they are once again informed about their peers' performance. The period ends once the difference in mean network performance between two successive rounds is less than 5%. When this criterion is satisfied, the model is said to have reached a non-cooperative Nash social equilibrium with self-consistent expectations: Subjects are not willing to deviate any more when choosing their effort.[24] A session thus includes a maximum of 20 rounds. The duration of a session is thus approximately the similar to that of other treatments and comparisons between the latter cannot be contaminated by fatigue.

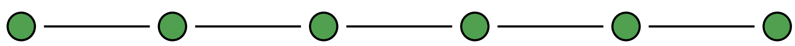
Recall from Section 2.3 that there exists an intimate link between the structure of a network, as described by its graph matrix $\boldsymbol{G}$, and the identification of the endogenous peer effects. In designing a specific network, we have tried to satisfy two separate criteria: (strong)

[24]Note that subjects are not aware of the convergence rule. If convergence is not reached within 5 rounds, the entire period for this network is omitted from the analysis. Upon convergence, expected and contemporaneous expectations are only "almost" equal for two reasons: First, the convergence criterion is not zero. Second, for reasons of tractability, the criterion is applied at the network level, not at the individual level. We applied the same convergence method in Fortin et al. (2007).

identification and external validity. As for identification, the gender-homogeneous model requires that the matrices $\mathbb{I}, \underline{\mathbb{G}}, \underline{\mathbb{G}}^2$ be linearly independent. From *Proposition 1* the gender-heterogeneous model is identified when the matrices $\mathbb{I}^m, \mathbb{I}^f, \underline{\mathbb{G}}^m, \underline{\mathbb{G}}^f, \underline{\mathbb{G}}^{m^2}, \underline{\mathbb{G}}^{f^2}, \underline{\mathbb{G}}^m\underline{\mathbb{G}}^f, \underline{\mathbb{G}}^f\underline{\mathbb{G}}^m$ be linearly independent. The lower the collinearity between these matrices, the more precise the estimated peer effect will be. With respect to external validity, the network should reflect real life interactions between individuals in their work environment.

Based on these two criteria, we have chosen an *undirected line social network*. Each row of six subjects in the laboratory constitutes a network whose graph is depicted in Figure 2. Such a network ensures that at least two subjects are separated by a link of distance 2, a sufficient condition for identification of the peer effect to hold under homogeneity. We also checked that the matrices corresponding to the heterogeneous model were linearly independent. Moreover, the degree of collinearity of the matrices was ascertained by computing the *condition number* of the matrix that results from the vectorization and concatenation of the relevant matrices (Bramoullé et al., 2009).[25] The gender-homogeneous and gender-heterogeneous undirected line networks have condition numbers equal to 7.7 and 1.85, respectively, which are considerably lower than 30, and should thus help obtain relatively precise estimates of the peer effects. An undirected line network is also likely to have good external validity properties. Indeed, it mimics many work environments in which employees work in isolation but have the ability to observe their colleagues' pace and performance.

Figure 2: Graph of a Simultaneous Network



As shown in Figure 2, subjects located at the end of a row are matched to a single peer while all others are matched to two peers. Subjects are not aware of the network structure. They are not told that their peers are their direct neighbors.

3.4. Experimental procedures

The experiment was programmed using the Z-Tree software (Fischbacher, 2007). All sessions were conducted at GATE-LAB, Lyon, France. Undergraduate students from the local engineering schools (most from École Centrale de Lyon) and business schools (most from EMLyon Business school) were invited via the ORSEE software (Greiner, 2015). As

[25]The condition number of a matrix $\boldsymbol{A'A}$ is given by the square root of the ratio of its maximum and minimum eigenvalues. A condition number above 30 is indicative of serious collinearity.

outlined in Table A1 of Appendix A, between 6 and 18 subjects took part in each session, for a total of 375 subjects and 24 sessions. We made sure we had as many females as males in each treatment. For the Baseline treatment, we organized 10 sessions with 84 subjects (2 sessions with 36 subjects in isolation, and 8 sessions with 48 subjects in the variant with information), of which 39 are females. In the Sequential treatment, we organized 11 sessions with 87 subjects (3 sessions with 39 subjects in the variant without the presence of peers, and 8 sessions with 48 subjects in the variant with the presence of peers from the Baseline), of which 42 are females. Note that we implemented the second variant of the Baseline and the Sequential treatments in the same sessions: in each of these eight sessions, we had 6 subjects playing the Baseline, knowing that their performance would be reported to other subjects, and 6 subjects playing the Sequential treatment, knowing that their peers were present in the session. Finally, 11 sessions of the Simultaneous treatment were organized that involved over 204 subjects (102 of each gender). Subjects in the Simultaneous treatment are more numerous since each session provides a maximum of four observations per subject since we only use the round when convergence has been achieved.

Upon arrival in the laboratory, subjects drew a ticket from an opaque bag assigning them to a specific computer terminal. The instructions describing the task, the payment scheme and the available set of information were distributed and read aloud (see Appendices B, C and D). Next we used a questionnaire to assess the subjects' understanding of the rules. Answers were verified individually. Subjects then had to report their age, gender, school, number of years of study, and belief about the wealth of their family relative to that of the other students of the same school. This was followed by a practice period of two and a half minutes to get familiarized with the task, after which the game started.

Once the final period ended, subjects were told individually which period (or which round in the Simultaneous treatment) was randomly selected for payment along with their earnings. They next had to complete an exit survey. A session lasted about 60 minutes and subjects earned on average €13.27 (standard deviation = €8.99), including a €4.13 average show-up fee (S.D. = €1.63).

4. Results

We start by presenting descriptive statistics on the sample of subjects and the main parameters of the treatments. We then turn to econometric results.

4.1. Summary statistics

Table 1 reports the means and standard deviations of the main variables used in the econometric analysis. The statistics are presented separately for the three treatments. The three rightmost columns of the table report the p-values of two-tailed test statistics of equality between the Sequential/Baseline treatments, the Simultaneous/Baseline treatments and the Sequential/Simultaneous treatments, respectively (Mann-Whitney tests for performance, Show-up fee, piece-rate, age, relative wealth, and t-tests for the proportion of males and students from the engineering school). Table 2 compares the two variants of the Baseline and the Sequential treatments by reporting means, standard deviations and test statistics.

According to the p-values in Table 1, most variables are balanced across the three treatments, including the gender variable. This is, however, not the case for subjects' and peers' age, relative family wealth, and engineering school.[26]

The bottom panel of these tables focuses on the parameters and the outcomes of the different treatments. Not surprisingly, there is no significant difference in the mean piece-rates across treatments and variants. The mean performance is not significantly different either across variants and treatments, although the comparison between the Sequential and the Simultaneous treatments reveals a marginally significant difference.

4.2. Estimation Strategy

The main purpose of the paper is to investigate gender-specific responses to peer effects in various network environments. Our empirical strategy consists first in estimating performance in the Baseline, Sequential and Simultaneous treatments under the null assumption that males and females subjects respond similarly to variations in peer performances (gender-homogeneous models). Under this assumption, we have shown that the Baseline and the Sequential treatments can further be pooled so that the parameter estimates can be more efficient. Next, we contrast these estimates to those obtained from relaxing the null assumption (gender-heterogeneous models).

In principle, testing the null assumption should give the same result for both the Sequential and Simultaneous treatments. Yet, it can be argued that the Simultaneous treatment is qualitatively different from the Baseline and Sequential treatments. This is because playing simultaneously may entail more competition between subjects and their peers. In addition, unlike the Baseline and Sequential treatments, subjects in the Simultaneous treatment know their performance is monitored in real time by their peers. They may thus be behave differently out of "pure image" concern and also because their peers are physically present in their

[26]Subjects in the Sequential and Simultaneous treatments are slightly older than those of the Baseline, whereas subjects in the Sequential treatment report the lowest relative family wealth. Subjects in the Simultaneous treatment are paired with slightly older peers than those in the Sequential treatment. This is because the latter are paired with individuals from the Baseline treatment who happen to be younger. Students from the ECL engineering school represent a lower proportion of the subjects in the Sequential treatment than in the other treatments.

session. These potential influences can be inferred indirectly by estimating two variants of the Baseline and Sequential treatments. In the former, we tell subjects their performances will be communicated to future subjects. Contrasting the estimates of the two Baseline variants provides a measure of the "pure image" concern. In the latter case, subjects are told their peers are in their session but started playing one period ahead of them. Contrasting the estimates of the two Sequential variants provides a measure of playing against a "real" rather than a "virtual" peer. Should the "pure image" and "presence" effects not be statistically significant, any remaining difference between the Sequential and Simultaneous treatments can presumably be attributed to the more competitive nature of the latter.

4.3. Estimation Results

In what follows, we begin by focusing on the gender-homogeneous models in Table 3. We next present the parameter estimates of the gender-heterogeneous model in Table 4. Recall that panel random-effects are used in the Baseline, Sequential and pooled models since all explanatory variables including peer effects are assumed strictly exogenous in these specifications.[27] The Simultaneous model is estimated using a pooled spatial ML approach with two lagged spatial dependent variables. Robust panel standard errors clustered at the individual level are used in every specification. In all cases, we report specifications with and without session fixed effects.

4.3.1. Gender-Homogeneous Peer Effects

Result 1: *a) Individual performance is positively linked to peer performance in both the Sequential and Simultaneous networks; b) Knowing own performance will be communicated to future subjects has no impact; c) Knowing peers are in same session has no impact. d) Individual and peer performances are linearly related.*

Support for Result 1. The most noteworthy result in Table 3 is that peer performance enhances own performance significantly in all the treatments. When session fixed effects are accounted for, the parameter estimate is equal to 0.209 in the Sequential model, 0.198 in the Pooled model, and 0.051 in the Simultaneous model (absent fixed effects, we get 0.176, 0.179 and 0.107, respectively). The estimates are statistically significant at the 1% level in almost all models.[28] The peer effect is somewhat smaller in the Simultaneous models than

[27]Alternatively, we could have used panel OLS. It would also provide consistent estimators, albeit not as asymptotically efficient as a random-effects estimator.

[28]Note that our estimates are slightly smaller in magnitude than previously found in the literature: Falk and Ichino (2006) find a 1.4% increase in individual performance following a 10% increase in peer productivity. Mas and Moretti (2009) and Lindquist et al. (2015) estimate a 1.7% increase, whereas Kuhnen and Tymula (2012) find a 12% increase in productivity when workers can compare themselves to others. These estimates are not strictly comparable since the work environment varies considerably across studies.

in the Pooled and Sequential models. We delay a discussion on this intriguing result to the section on heterogeneous models.

The peer effect holds regardless of whether peers are present or not in the same session, since the parameter estimates associated with *Presence×Peer performance* effect is never found to be statistically significant. Likewise, own performance is not related to the "pure image" concern since the parameter estimates of the *Observability* variable is never statistically significant either. This finding runs counter to Mas and Moretti (2009), but is consistent with Georganas et al. (2015) who found that, under piece-rate, being observed does not affect performance while observing others does.

It has been argued that estimating "average" peer effects may yield misleading results if individual and peer performances are nonlinearly related (Sacerdote, 2011; Tincani, 2015). We investigate the link between the two through a series of random effects quantile regressions (see Table A.2). Estimation results, using the sequential treatment and the gender-homogeneous model, indicate that the same parameter estimates are statistically significant across quantiles. In addition, a standard random effects regression (column *RE*) yields very similar results to the 50th percentile regression (column *Q(0.5)*). The performance peer effect is only statistically significant for the 30th and 90th percentiles. A Wald test on the equality of the peer performance parameter estimates across quantiles yields a p-value equals to 0.369. These results provide evidence that individual and peer performances are linearly related.

Result 2: *Contextual peer effects have little impact on individual performance in any type of network.*

Support for Result 2. Table 3 indicates that only peer mean age is statistically significant (p-value < 0.1) in both the Sequential and Pooled models. The parameter estimate in the pooled model is much smaller in absolute value as expected.[29] Its negative sign suggests that younger peers may induce subjects to increase effort so as to remain competitive. In the Simultaneous treatment, only peer piece-rate and being matched to someone from the ECL engineering school have any impact on own performance. Subjects may thus attempt to compensate their lower potential earnings by increasing their effort. On the other hand, having more peers from the engineering school may discourage subjects with weaker mathematical backgrounds. That these effects are only significant in the Simultaneous networks may indicate that this context enhances the sense of competition among subjects and peers. Interestingly, the gender composition of the peer group has no impact on own performance.

[29]The pooled sample must necessarily yield estimates that correspond to some average of the Baseline and the Sequential treatments.

Only few individual variables have any significant impact on performance. Higher piece-rate increases effort in all models and are of similar magnitude (significant at the 1% level in the Baseline, Sequential and Pooled models, and at the 5% level in the Simultaneous models). The parameter estimates indicate that increasing the piece-rate twofold increases output by as much as 0.552 units in the Simultaneous model (column (8)) to 0.607 units per period in the Pooled model (column (6)). Attending the ECL engineering school is also associated with increased performance. Older individuals perform better only in the Simultaneous treatment. The Show-up fee parameter estimate is positive[30] in the Simultaneous treatment and negative (only marginally significantly) in the Sequential treatment when there is no session fixed effects. Finally, in all models, performance increases with the number of periods. The larger effect in the Simultaneous model results from the fact that each period consists of several rounds.[31]

All in all, the parameter estimates are relatively robust across all specifications. In all treatments mean peer performance increases individual effort, individuals exhibit some form of learning and they respond to financial incentives. The only somewhat surprising result concerns the smaller impact of peer performance in the Simultaneous model. The estimates of the heterogeneous models explain this finding.

4.3.2. Gender-Heterogeneous Peer Effects

Result 3: *a) Peer effects differ by gender. Male subjects respond positively to peer performance in all network configurations. Female subjects respond positively in the Sequential, but not so in the Simultaneous networks; b) Both female and male performances are insensitive to the fact that own performance is communicated to future subjects; c) Male and female subjects are indifferent to having peers in the same session.*

Support for Result 3. Table 4 shows that mean peer effects vary strongly across gender. For instance, male subjects increase own performances in the Sequential, Pooled, and Simultaneous specifications considerably (0.175, 0.178 and 0.274, respectively, absent session fixed effects and 0.254, 0.227 and 0.172, respectively, with fixed effects). In contrast, the responsiveness of females to peer performance decreases as we move from the Sequential to the Simultaneous treatments (0.183, 0.179 and -0.057 for, respectively, the Sequential, Pooled and Simultaneous specifications without fixed effects and 0.188, 0.194 and -0.049, respectively, with session fixed effects). In the Simultaneous treatment, the parameter estimates associated with peer performance is negative, albeit not statistically significant.

[30]This could be due to a gift effect on performance.

[31]The estimation uses periods and not rounds because the number of rounds is not exogenous, as it depends on convergence across the network.

What may explain that female subjects are indifferent to peer performance in the Simultaneous networks only? Close inspection of the parameter estimates reveals an interesting empirical regularity: male and female subjects behave similarly whenever information about own or peer performances flows one way. Indeed, in the Baseline treatments, males and females subjects do not react to having their performances communicated to future subjects. Likewise, males and females subjects in the Sequential and Pooled treatments are indifferent to having their peers in the same session.These results rule out the so-called "pure image" and "presence" effects alluded to above. It must be, then, that female subjects perceive the Simultaneous environment, with its two-way interactive flow of information, differently from their male counterparts. Male performances, on the other hand, are fairly constant across network configurations. We postpone the interpretation of these findings to the Discussion section.

Result 4: *Only in the Simultaneous treatment do the contextual peer effects vary across gender.*

Support for Result 4. Table 4 shows that peer contextual effects vary across gender and specifications in the Simultaneous networks, with males being more responsive than female subjects. In particular, females react negatively, and males positively (but marginally so), to having more males among their peers, whereas no such effects are observed in the other environments. Moreover, while females appear to be indifferent to their peers' mean wage in all network configurations, males tend to respond negatively in the Pooled models but increase their effort marginally in the Simultaneous treatment (when we include session dummies) as if to compensate for the higher mean wage rate of their peers. In addition, the proportion of peers from the ECL engineering school has little impact on female performances but a large and negative one on males in the Simultaneous treatment. Males appear demotivated when matched with potentially more able individuals. Mean peer age also affects male and female subjects differently.

Individual effects also vary considerably across gender. As found in the psychology literature (Torrubia et al., 2001; Li et al., 2007)[32] and in Kuhn and Villeval (2015), but in contrast to Paarsch and Shearer (2007) and to the recent meta-analysis of Bandiera et al. (2016), males appear to be more sensitive to the level of financial incentives. Indeed, in nearly all specifications, their performances are intimately linked to the piece-rate. For females, on the other hand, the parameter estimate is marginally statistically significant only in the Baseline treatment and is much smaller than that of males. Attending the ECL engineering school is generally associated with a larger performance for both males and females. But female attendees always outperform the other females, regardless of the

[32]Possibly for evolutionary reasons (Browne, 2002; Kanasawa, 2005).

treatment, whereas male attendees outperform other males only in the Simultaneous treatment. Finally, note that the evolution of effort over time also differs by gender in the Simultaneous treatment. Indeed, the parameter estimate associated with *Period* indicates that females exhibit significant learning in each specification. For males, it is marginally statistically significant only if session dummies are included, and its value is much smaller (0.679 *vs.* 1.624 for females). Gender differences observed in the Simultaneous treatment only, coupled with the fact that the *Period* parameter estimate is much higher for females, suggest that the latter may have underperformed at the beginning of the game in the simultaneous networks. Overall, these findings indicate that females react differently than males to information about their peers in the Simultaneous networks. A possible interpretation is that females perceive this environment as more competitive than the Sequential networks. The next section provides more details on these findings.

5. Discussion and Conclusion

The empirical literature has shown that males and females respond differently to various incentive schemes. Not surprisingly, they tend to favor different schemes when given choice. These results stem mostly from experiments wherein the focus is on the link between expectations and/or confidence on individual behavior. Information about others is usually limited when not entirely omitted. Another strand of the literature which focuses precisely on the link between own and peer performances seldom reports gender-specific results. This paper tries to bridge the gap between these two sets of results. The contributions are thus twofold: First, we explicitly focus on gender-specific responses of own performance to peer performances. Second, we investigate these within various networks configurations rather than the more common group framework. Resorting to social interactions within networks to investigate work effort is relatively novel despite the fact few workers ever work in isolation. We thus develop two linear-in-means social interactions models with gender heterogeneity. In the first, the networks are structured such that the information on wages and performances flows one-way from the peer to the subject (sequential model). In the second, information flows both ways (simultaneous model). Gender-specific peer effects we can identified in both models.

Our analysis has unearthed important results about peer and gender effects in a network setting. On the whole, subjects behave as predicted by theory: they respond to financial incentives and are sensitive to information about their peers. Yet, there are important differences as regards gender responses to social interactions. While males increase their effort when learning about the productivity of their peers, irrespective of the network structure, females behave entirely differently in different network settings. In a sequential network, they are sensitive to the productivity of their peers, although to a slightly lesser extent than males. But in a simultaneous setting, they behave as if information on peer performances was irrelevant and work almost as if in isolation. In addition, not only do the endogenous peer effects differ across genders, so do the contextual peer effects. Indeed, females are indifferent to their peers' wage regardless of the network configuration; in contrast, males adjust their effort to their peers' wages, although differently across networks.

Informational variants are used to investigate whether differences between the sequential and simultaneous networks are due to having one's performance scrutinized by a peer, albeit in an anonymous fashion. Our results are consistent with those of Georganas et al. (2015) in that only the observer changes his effort, not the observee, and they differ from those of Mas and Moretti (2009). In addition, our data show no evidence of any impact of having one's peer in the lab on individual performances. We are thus lead to infer that females, as opposed to males, perceive the simultaneous network as a more competitive environment, and to view their peers' performance in the sequential one as a simple reference point in terms of motivational goal settings. To the extent females do indeed perceive the Simultaneous network as a more competitive environment, they may be lead to ignore their peers' performance or to respond by decreasing their own effort. Indeed, it is now well-established that females unlike males tend to under-perform in competitive environments and to shy away from competition (e.g. Gneezy et al., 2003; Niederle and Vesterlund, 2007). Our experiments suggest that this may also apply to non-monetary, informational incentives. Gender differences in contextual peer effects are also consistent with the simultaneous setting being perceived as more competitive by female subjects. It could be argued following Möbius et al. (2011) that females are more "ego-defensive", *i.e.* less confident and more conservative updaters, to exhibit more aversion toward relative performances. Yet, such an argument fails to explain why females would be averse to informational incentives in the Simultaneous but not so in the Sequential networks.

Empirical evidence on peer effects at work is relatively scant.[33] This is partly because obtaining proper estimates in real-life settings raises notoriously difficult identification problems. Indeed, social networks at work are likely to be endogenous and disentangling performance from contextual peer effects is difficult when workers interact in groups and that the average size of these groups is large. In this paper, we argue that a carefully designed laboratory experiment can help solve this problem for two reasons. First, individual reference groups can be determined exogenously by the experimentalist. Second, the structure of the network can be designed in a manner that guarantees identification of all social interactions within the linear-in-means model. Van Veldhuizen et al. (2014) stress the many advantages of using such a controlled environment for the study of social interactions. We acknowledge, however, that laboratory experiments have their own limitations. In our particular case,

[33] A recent study by Cornelissen et al. (2017) focuses on peer effects in wages rather than in performance, in a general workplace setting. Interestingly, they find quite large peer effects in occupations where coworkers can easily observe each other's output.

networks are formed exogenously and the task subjects are asked to perform is artificial. In addition, subjects may feel scrutinized by the experimenter and thus change their behavior accordingly (see Levitt and List, 2007). Notwithstanding this, there is now widespread agreement about the external qualitative validity of laboratory experiments (Fréchette and Schotter, 2014). Importantly, in their recent meta-analysis Herbst and Mas (2015) have shown that the laboratory estimates of peer effects on productivity are similar to those obtained from field experiments.

Keeping in mind the aforementioned caveats, our results may have a number of implications for real workplace arrangements. Indeed, the existing literature has already shown that providing feedback on peer performances may increase effort under certain conditions. We show that these conditions include the mode of work organization (network type) and the gender composition of the workforce. In a predominantly female environment, it may be preferable to organize the networks such that the information on performance flows one way. In a predominantly male environment, the network structure matters little. Our results also suggest that relative wages have little impact on performance, if at all. Thus, contrary to some literature, concealing the wage structure amongst workers does not necessarily enhance productivity.

References

Arduini, T., Patacchini, E., Rainoney, E., 2016. Identication and estimation of network models with heterogeneous externalities. Tech. rep., mimeo, Bank of Italy.

Azmat, G., Iriberri, N., August 2010. The importance of relative performance feedback information: Evidence from a natural experiment using high school students. Journal of Public Economics 94 (7-8), 435–452.

Bandiera, O., Barankay, I., Rasul, I., 2005. Social preferences and the response to incentives: Evidence from personnel data. The Quarterly Journal of Economics 120 (3), 917–962.

Bandiera, O., Barankay, I., Rasul, I., 2009. Social connections and incentives in the workplace: Evidence from personnel data. Econometrica 77 (4), 1047–1094.

Bandiera, O., Barankay, I., Rasul, I., 2010. Social incentives in the workplace. The Review of Economic Studies 77 (2), 417–458.

Bandiera, O., Fischer, G., Prat, A., Ytsma, E., December 2016. Do women respond less to performance pay? Building evidence from multiple experiments. CEPR Discussion Paper No. DP11724.

Barankay, I., 2012. Rank incentives: Evidence from a randomized workplace experiment. Wharton School, University of Pennsylvania.

Bellemare, C., Lepage, P., Shearer, B., January 2010. Peer pressure, incentives, and gender: An experimental analysis of motivation in the workplace. Labour Economics 17 (1), 276–283.

Bertrand, M., Luttmer, E. F. P., Mullainathan, S., August 2000. Network effects and welfare cultures. The Quarterly Journal of Economics 115 (3), 1019–1055.

Blanes i Vidal, J., Nossol, M., 2011. Tournaments without prizes: Evidence from personnel records. Management Science 57 (10), 1721–1736.

Blume, L. E., Brock, W. A., Durlauf, S. N., Jayaraman, R., 2015. Linear social interactions models. Journal of Political Economy 123 (2), 444–496.

Bramoullé, Y., Djebbari, H., Fortin, B., 2009. Identification of peer effects through social networks. Journal of Econometrics 150 (1), 41–55.

Browne, K. R., 2002. Biology at work: Rethinking sexual equality. New-Brunswick: Rutgers University Press.

Calvó-Armengol, A., Patacchini, E., Zenou, Y., 2009. Peer effects and social networks in education. The Review of Economic Studies 76 (4), 1239–1267.

Cason, T., Masters, W., Sheremeta, R., 2010. Entry into winner-take-all and proportional-prize contests: an experimental study. Journal of Public Economics 94 (4), 604–611.

Cassar, A., 2007. Coordination and cooperation in local, random and small world networks: Experimental evidence. Games and Economic Behavior 58 (2), 209–230.

Cornelissen, T., Dustmann, C., Schönberg, U., February 2017. Peer effects in the workplace. American Economic Review 107 (2), 425–56.

Croson, R., Gneezy, U., 2009. Gender differences in preferences. Journal of Economic Literature 47 (2), 448–474.

de Paula, Á., 2015. Econometrics of network models. cemmap, working paper CWP52/15.

De Weerdt, J., Dercon, S., 2006. Risk-sharing networks and insurance against illness. Journal of Development Economics 81 (2), 337–356.

Delfgaauw, J., Dur, R., Sol, J., Verbeke, W., 2009. Tournament incentives in the field: Gender differences in the workplace. Journal of Labor Economics 31 (2).

Dickinson, D. L., 1999. An experimental examination of labor supply and work intensities. Journal of Labor Economics 17 (4), 638–670.

Dieye, R., Fortin, B., 2017. Gender peer effects heterogeneity in obesity. Cirano Scientific Series, Discussion Paper No. 2017s-03.

Eckel, C. C., Grossman, P. J., June 2008. Differences in the Economic Decisions of Men and Women: Experimental Evidence. Vol. 1 of Handbook of Experimental Economics Results. Elsevier, Ch. 57, pp. 509–519.

Eriksson, T., Poulsen, A., Villeval, M. C., 2009. Feedback and incentives: Experimental evidence. Labor Economics 16 (6), 679–688.

Falk, A., Ichino, A., 2006. Clean evidence on peer effects. Journal of Labor Economics 24 (1), 39–57.

Fischbacher, U., 2007. Z-tree: Zurich toolbox for ready-made economic experiments. Experimental Economics 10 (2), 171–178.

Fortin, B., Lacroix, G., Villeval, M. C., 2007. Tax evasion and social interactions. Journal of Public Economics 91 (11), 2089–2112.

Fortin, B., Yazbeck, M., 2015. Peer effects, fast food consumption and adolescent weight gain. Journal of Health Economics 42, 125–138.

Fréchette, G., Schotter, A. (Eds.), 2014. Handbook of Experimental Economic Methodology. Oxford: Oxford University Press.

Georganas, S., Tonin, M., Vlassopoulos, M., 2015. Peer pressure and productivity: The role of observing and being observed. Journal of Economic Behavior & Organization 117 (C), 223–232.

Gill, D., Prowse, V., 2012. A structural analysis of disappointment aversion in a real effort competition. The American Economic Review 102 (1), 469–503.

Gneezy, U., Niederle, M., Rustichini, A., 2003. Performance in competitive environments: Gender differences. The Quarterly Journal of Economics 118 (3), 1049–1074.

Gneezy, U., Rustichini, A., 2004. Gender and competition at a young age. American Economic Review 94 (2), 377–381.

Goldin, C., Katz, L., Kuziemko, I., 2006. The homecoming of american college women: the reversal of the college gender gap. Journal of Economic Perspectives 20 (4), 133–156.

Greiner, B., 2015. Subject pool recruitment procedures: organizing experiments with ORSEE. Journal of the Economic Science Association 1, 114–125.

Guryan, J., Kroft, K., Notowidigdo, M. J., October 2009. Peer effects in the workplace: Evidence from random groupings in professional golf tournaments. The American Economic Journal: Applied Economics 1 (4), 34–68.

Heckman, J., 1974. Shadow prices, market wages, and labor supply. Econometrica 42 (4), 679–694.

Herbst, D., Mas, A., 2015. Peer effects on worker output in the laboratory generalize to the field. Science 350 (6260), 545–549.

Jackson, M. O., 2010. Social and economic networks. Princeton University Press.

Jackson, M. O., 2011. The Handbook of Social Economics. Elsevier Press, Ch. An overview of social networks and economic applications.

Kanasawa, S., 2005. Is "discrimination" necessary to explain the sex gap in earnings? Journal of Economic Psychology 26, 269–287.

Kandel, E., Lazear, E. P., 1992. Peer pressure and partnerships. Journal of Political Economy, 801–817.

Karlan, D., Möbius, M., Rosenblat, T., Szeidl, A., 2009. Trust and social collateral. The Quarterly Journal of Economics 124 (3), 1307–1361.

Kuhn, P., Villeval, M. C., 2015. Are Women More Attracted to Cooperation Than Men? Economic Journal 125 (582), 115–140.

Kuhnen, C. M., Tymula, A., 2012. Feedback, self-esteem, and performance in organizations. Management Science 58 (1), 94–113.

Laschever, R., 2011. The doughboys networks: Social interactions and labor market outcomes of World War I veterans. Mimeo.

Lee, L.-F., 2007. Identification and estimation of econometric models with group interactions, contextual factors and fixed effects. Journal of Econometrics 140 (2), 333–374.

LeSage, J., Pace, R., 2009. Introduction to Spatial Econometrics. CRC Press.

Levitt, S., List, J., 2007. What do laboratory experiments social preferences reveal about the real world. Journal of Economic Perspectives 21 (2), 153–174.

Li, C.-S. R., Huang, C.-Y., Lin, W.-y., Sun, C.-W. V., 2007. Gender differences in punishment and reward sensitivity in a sample of taiwanese college students. Personality and individual differences 43 (3), 475–483.

Lindquist, M., Sauermann, J., Zenou, Y., 2015. Network effects on worker productivity. CEPR Discussion Paper No. 10928.

Manski, C. F., 1993. Identification of endogenous social effects: The reflection problem. The Review of Economic Studies 60 (3), 531–542.

Mas, A., Moretti, E., 2009. Peers at work. The American Economic Review 99 (1), 112–45.

Möbius, M. M., Niederle, M., Niehaus, M., Rosenblat, T. S., 2011. Managing self-confidence : Theory and experimental evidence. NBER WP 17014.

Munshi, K., 2010. Labor and Credit Networks in Developing Economies. Handbook of Social Economics. Elsevier Science, Ch. 23, pp. 1223–1254.

Niederle, M., Vesterlund, L., 2007. Do women shy away from competition? Do men compete too much? The Quarterly Journal of Economics 122 (3), 1067–1101.

Paarsch, H. J., Shearer, B. S., 2007. Do women react differently to incentives? Evidence from experimental data and payroll records. European Economic Review 51 (7), 1682–1707.

Patacchini, E., Zenou, Y., 2008. The strength of weak ties in crime. European Economic Review 52 (2), 209–236.

Sacerdote, B., 2011. Handbook of the Economics of Education, 1st Edition. Vol. 3. Elsevier, Ch. 4.

Tincani, M., June 2015. Heterogeneous peer effects and rank concerns: Theory and evidence. Mimeo, University College London.

Topa, G., 2011. Chapter 22 - Labor markets and referrals. In: Jess Benhabib, A. B., Jackson, M. O. (Eds.), Handbook of Social Economics. Vol. 1 of Handbook of Social Economics. North-Holland, pp. 1193 – 1221.

Torrubia, R., Avilab, A., Moltob, J., Caserasa, X., 2001. The sensitivity to punishment and sensitivity to reward questionnaire (SPSRQ) as a measure of Gray's anxiety and impulsivity dimension. Personality and Individual Differences 31, 837–862.

Van Veldhuizen, R., Osterbeek, H., Sonnemans, J., 2014. Peers at work: From the field to the lab. WZB Discussion Paper SP II 2014-204.

Waldinger, F., 2012. Peer effects in science - evidence from the dismissal of scientists in nazi germany. Review of Economic Studies 79, 838–861.

Wozniak, D., 2012. Gender differences in a market with relative performance feedback: Professional tennis players. Journal of Economic Behavior & Organization 83 (1), 158–171.

Wozniak, D., Harbaugh, W., Mayr, U., 2015. Gender differences: The effects of free and costly feedback on the willingness to compete. SSRN 1976073.

Table 1: Comparaison between the Baseline, Sequential and Simultaneous treatments

Treatments	Baseline (V1+V2)		Sequential (V1+V2)		Simultaneous		Seq/B	Sim/B	Seq/Sim
	Average	S.E.	Average	S.E.	Average	S.E.			
Males (%)	46.43	50.17	48.28	50.26	50.00	50.12	0.810	0.530	0.758
Age	21.08	1.71	22.99	6.19	21.85	2.98	0.005	0.015	0.221
Relative wealth	4.96	2.15	4.66	1.88	5.12	1.85	0.180	0.738	0.031
Central Engineering School (%)	27.38	4.86	16.09	36.96	27.94	44.98	0.074	0.913	0.017
Endowment (show-up fee)	4.29	1.52	3.98	1.82	4.13	1.60	0.266	0.458	0.514
Male peers (%)			45.40	41.51	50.00	42.96			0.333
Age of peers			20.97	1.55	21.68	2.04			0.001
Relative wealth of peers			5.03	1.69	5.05	1.53			0.977
Peers in Central Engineering School (%)			22.99	32.17	28.19	38.79			0.224
Endowment of peers (show-up fee)			4.17	1.18	4.12	1.35			0.847
Number of individuals	84		87		204				
Piece-rate	0.54	0.38	0.54	0.37	0.53	0.37	0.898	0.947	0.994
Piece-rate of peers			0.54	0.31	0.54	0.29			0.728
Performance	18.20	7.39	17.84	8.78	18.95	7.58	0.332	0.564	0.101
Performance of peers			17.96	5.93	18.81	6.22			0.319
Number of observations	1344		1392		510				

Note: Columns 7 to 9 report the p-values of various non-parametric tests, all two-tailed. Column 7 compares the Sequential and the Baseline treatments; column 8 compares the Simultaneous and the Baseline treatments; column 9 compares the Sequential and the Simultaneous treatments. In the non-parametric statistics, each individual (and one mean value for observations regarding the same individual) gives one independent observation. For the Simultaneous treatment, we only consider rounds in which convergence has been achieved. For age, endowment, piece-rate, wealth, score, we use Mann-Whitney tests. For gender and Central School, we use two-sample t-tests with equal variances.

Table 2: Comparaison between the two variants of the Baseline and the Sequential treatments

Treatments	Baseline-V1		Baseline-V2		V1/V2	Sequential-V1		Sequential-V2		V1/V2
	Average	S.E.	Average	S.E.		Average	S.E.	Average	S.E.	
Males (%)	52.78	50.63	41.67	49.82	0.318	51.28	50.64	45.83	50.35	0.618
Age	20.78	1.77	21.31	1.64	0.049	23.38	5.21	22.67	6.92	0.153
Relative wealth	5.19	1.85	4.79	2.35	0.394	4.49	1.86	4.79	1.90	0.420
Central Engineering School (%)	27.78	45.43	27.08	44.91	0.944	28.21	45.59	6.25	24.46	0.005
Endowment (show-up fee)	4.22	1.49	4.33	1.56	0.713	3.79	1.88	4.12	1.77	0.397
Male peers (%)						51.28	43.66	40.62	39.49	0.236
Age of peers						20.82	1.79	21.08	1.33	0.121
Relative wealth of peers						5.26	1.51	4.85	1.81	0.213
Peers in Central Engineering School (%)						28.21	37.69	18.75	26.55	0.174
Endowment of peers (show-up fee)						4.08	1.16	4.25	1.21	0.561
Number of individuals	36		48			39		48		
Piece-rate	0.52	0.38	0.54	0.38	0.382	0.54	0.38	0.37	0.37	0.510
Piece-rate of peers						0.53	0.31	0.55	0.31	0.149
Performance	17.33	7.85	18.85	6.94	0.228	18.12	8.92	17.61	8.68	0.695
Performance of peers						17.34	6.21	18.46	5.64	0.481
Number of observations	576		768			624		768		

Table 3: Gender-Homogeneous Model

	Baseline†		Sequential†		Pooled†		Simultaneous‡	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Observability	1.358	-			1.473	-		
	(1.343)				(1.373)			
Peer performance			0.176***	0.209***	0.179***	0.198***	0.107***	0.051*
			(0.044)	(0.049)	(0.045)	(0.049)	(0.035)	(0.038)
Presence × Peer performance			-0.038	-0.091	-0.044	-0.083		
			(0.069)	(0.089)	(0.066)	(0.082)		
Peer characteristics								
Wage (log)			-0.028	-0.03	-0.03	-0.03	0.486*	0.466*
			(0.149)	(0.149)	(0.148)	(0.148)	(0.350)	(0.399)
Wealth			0.189	0.057	0.632	0.629	0.061	0.125
			(0.4823)	(0.464)	(0.441)	(0.452)	(0.185)	(0.203)
Age			-1.105**	-1.259***	-0.266	-0.358*	0.12	0.05
			(0.489)	(0.486)	(0.190)	(0.196)	(0.117)	(0.191)
Show-up fee			-0.534	-0.29	-0.207	-0.057	0.163	0.102
			(0.719)	(0.822)	(0.772)	(0.777)	(0.229)	(0.231)
ECL engineering school			3.383	3.346	2.079	2.488	-1.633***	-2.158
			(2.432)	(2.47)	(2.588)	(2.648)	(0.698)	(0.93)
Proportion of males			0.652	0.719	1.573	2.447	-0.618	-0.139
			(2.067)	(1.965)	(2.032)	(1.936)	(0.703)	(1.126)
Individual characteristics								
Wage (log)	0.573***	0.571***	0.643***	0.642***	0.608***	0.607***	0.55**	0.552**
	(0.183)	(0.184)	(0.225)	(0.225)	(0.144)	(0.145)	(0.312)	(0.34)
Wealth	-0.107	-0.098	0.705	0.718	0.209	0.2	0.072	0.074
	(0.338)	(0.321)	(0.537)	(0.516)	(0.297)	(0.31)	(0.165)	(0.196)
Age	0.125	0.134	-0.041	0.061	-0.016	0.043	0.35***	0.313***
	(0.349)	(0.314)	(0.121)	(0.139)	(0.114)	(0.125)	(0.09)	(0.128)
Show-up fee	0.342	0.367	-0.759*	-0.613	-0.299	-0.253	0.362**	0.34**
	(0.407)	(0.412)	(0.413)	(0.421)	(0.307)	(0.32)	(0.188)	(0.188)
ECL engineering school	2.58*	3.216**	4.747**	5.756**	3.38***	4.043***	6.479***	5.977***
	(1.59)	(1.587)	(2.293)	(2.354)	(1.327)	(1.349)	(0.758)	(0.911)
Period	0.247***	0.247***	0.249***	0.248***	0.248***	0.248***	0.98***	1.097***
	(0.039)	(0.039)	(0.036)	(0.036)	(0.026)	(0.026)	(0.341)	(0.427)
Intercept	11.617	10.546	36.858***	31.919**	15.589***	12.56***	1.483	1.744
	(8.939)	(8.277)	(11.635)	(14.337)	(3.511)	(3.996)	(1.944)	(6.069)
Sessions	No	Yes	No	Yes	No	Yes	No	Yes
N	1344	1344	1392	1392	2736	2736	510	510
Log-likelihood							-3047	-3024
Sessions Dummies =0 (p-value)		0.000		0.0152		0.1341		0.000
Pooled Model Test (p-value)	-	-	-	-	0.0685	0.0007	-	-
Gender Homogeneity Model Test (p-value)	0.4853	0.7446	0.455	0.0000	0.1770	0.0487	0.021	0.000
Peers' performance Gender Homogeneity Test (p-value)	-	-	0.9382	0.5155	0.9944	0.7388	0.0000	0.0027

†Random effects with panel clustered S.E. ‡Maximum likelihood wih panel clustered S.E.
***Indicates 1% significance level, **Indicates 5% significance level, *Indicates 10% significance level.

Table 4: Gender-Heterogeneous Model (Male Variables)

	Baseline†		Sequential†		Pooled†		Simultaneous‡	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Observability	1.386	-	-	-	0.922	-		
	(2.301)				(2.195)			
Peer performance			0.179***	0.261***	0.179***	0.227***	0.274***	0.172***
			(0.074)	(0.075)	(0.072)	(0.077)	(0.081)	(0.06)
Presence ×Peer performance			-0.012	-0.139	-0.002	-0.083		
			(0.079)	(0.079)	(0.078)	(0.088)		
Peer characteristics								
Wage (log)			-0.289	-0.303	-0.3**	-0.306*	0.695	0.751*
			(0.190)	(0.190)	(0.185)	(0.184)	(0.585)	(0.511)
Wealth			-0.152	0.206	0.349	-0.119	-0.062	0.016
			(0.686)	(0.519)	(0.659)	(0.608)	(0.289)	(0.346)
Age			-1.436**	0.003	-0.372	-0.284	-0.44**	-0.798***
			(0.737)	(0.664)	(0.286)	(0.226)	(0.22)	(0.206)
Show-up fee			-0.388	1.410	0.455	0.453	0.262	0.22
			(1.636)	(1.133)	(1.327)	(0.964)	(0.361)	(0.368)
ECL engineering school			4.967	4.080	5.211	2.938	-4.999***	-6.759**
			(4.416)	(4.117)	(4.380)	(4.074)	(2.423)	(1.436)
Proportion of males			1.392	2.058	2.411	3.584	1.654	2.33*
			(3.989)	(2.669)	(3.529)	(2.764)	(1.727)	(1.68)
Individual characteristics								
Wage (log)	0.873***	0.872***	1.069***	1.071***	0.973***	0.972***	0.728*	0.686*
	(0.338)	(0.339)	(0.380)	(0.379)	(0.253)	(0.254)	(0.475)	(0.562)
Wealth	-0.162	-0.356	0.624	1.129*	0.173	0.235	-0.098	0.022
	(0.439)	(0.411)	(0.941)	(0.639)	(0.488)	(0.454)	(0.219)	(0.212)
Age	0.029	0.106	0.000	0.715***	-0.024	0.299	0.324***	0.228**
	(0.425)	(0.365)	(0.360)	(0.253)	(0.247)	(0.254)	(0.108)	(0.12)
Fixed	-0.177	-0.238	-1.023	-0.642	-0.606	-0.386	0.608**	0.549**
	(0.681)	(0.642)	(0.708)	(0.538)	(0.487)	(0.453)	(0.302)	(0.325)
ECL engineering school	2.244	2.105	4.243	4.429	3.059*	3.097*	6.237***	5.408***
	(2.289)	(2.618)	(3.324)	(3.134)	(1.869)	(1.913)	(0.88)	(1.109)
Period	0.209***	0.209***	0.228***	0.225***	0.218***	0.217***	0.41	0.679*
	(0.071)	(0.071)	(0.059)	(0.058)	(0.046)	(0.046)	(0.492)	(0.482)
Intercept	16.456	15.996	45.472*	-21.217	17.769***	7.645	13.145***	20.297***
	(25.983)	(27.643)	(27.097)	(31.347)	(7.199)	(7.628)	(5.453)	(5.826)
Sessions	No	Yes	No	Yes	No	Yes	No	Yes
Sessions Dummies =0 (p-value)		0.000		0.000		0.0548		0.001

†Random effects with panel clustered S.E. ‡Maximum likelihood wih panel clustered S.E.
***Indicates 1% significance level, **Indicates 5% significance level, *Indicates 10% significance level.

Table 4 Continued: Gender-Heterogenous Model (Female Variables)

	Baseline†		Sequential†		Pooled†		Simultaneous‡	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Observability	2.17	-			2.453	-		
	(2.15)				(1.843)			
Peer performance			0.183***	0.187***	0.179***	0.193***	-0.057	-0.049
			(0.058)	(0.067)	(0.059)	(0.065)	(0.058)	(0.072)
Presence × Peer performance			-0.082	-0.09	-0.077	-0.112		
			(0.113)	(0.155)	(0.107)	(0.139)		
Peer characteristics								
Wage (log)			0.224	0.221	0.226	0.223	0.4	0.499
			(0.225)	(0.225)	(0.223)	(0.222)	(0.472)	(0.582)
Wealth			0.845	0.806	0.956**	0.917**	-0.063	-0.093
			(0.532)	(0.624)	(0.477)	(0.484)	(0.276)	(0.354)
Age			-0.174	0.168	-0.158	-0.259	0.440***	0.719***
			(0.711)	(0.671)	(0.273)	(0.286)	(0.184)	(0.226)
Show-up fee			-1.139	-0.683	-0.975	-0.853	0.151	0.289
			(0.796)	(1.068)	(0.794)	(0.940)	(0.276)	(0.326)
ECL engineering school			0.908	-0.024	0.432	1.834	0.462	0.953
			(3.366)	(3.303)	(3.309)	(3.247)	(1.018)	(2.799)
Proportion of males			0.848	0.193	1.237	1.955	-2.761**	-2.974*
			(1.992)	(2.291)	(2.047)	(2.204)	(1.562)	(2.45)
Individual characteristics								
Wage (log)	0.306**	0.306*	0.24	0.239	0.271**	0.268**	0.422	0.24
	(0.162)	(0.16)	(0.236)	(0.235)	(0.141)	(0.141)	(0.442)	(0.484)
Wealth	-0.109	0.223	0.968**	0.96	0.323	0.228	0.238	0.271
	(0.528)	(0.75)	(0.505)	(0.636)	(0.367)	(0.496)	(0.272)	(0.277)
Age	-0.159	-0.253	-0.083	-0.017	-0.044	-0.018	0.373**	0.333**
	(0.736)	(0.751)	(0.134)	(0.127)	(0.141)	(0.129)	(0.231)	(0.214)
Show-up fee	0.906**	1.249**	-0.505	-0.597	0.02	0.074	0.274	0.482**
	(0.479)	(0.545)	(0.478)	(0.472)	(0.355)	(0.427)	(0.236)	(0.268)
ECL engineering school	6.857***	7.466***	5.837**	5.745*	5.956***	6.538***	6.238***	6.277***
	(2.332)	(2.36)	(2.561)	(3.225)	(1.586)	(2.002)	(1.817)	(1.891)
Period	0.282***	0.283***	0.282***	0.282***	0.282***	0.282***	1.665***	1.624***
	(0.035)	(0.036)	(0.04)	(0.041)	(0.026)	(0.026)	(0.527)	(0.657)
Intercept	14.305	11.146	14.913	3.908	13.283***	12.143***	-4.067	-12.698***
	(16.476)	(18.189)	(13.382)	(16.403)	(3.982)	(4.622)	(5.038)	(4.743)
Sessions	No	Yes	No	Yes	No	Yes	No	Yes
N	720	720	720	720	1440	1440	510	510
Log-likelihood	-	-	-	-	-	-	-3018	-2964
Sessions Dummies =0 (p-value)		0.0158		0.0000		0.6314		0.001
Pooled Model Test (p-value)	-	-	-	-	0.3111	0.0969	-	-

†Random effects with panel clustered S.E. ‡Maximum likelihood wih panel clustered S.E.
***Indicates 1% significance level, **Indicates 5% significance level, *Indicates 10% significance level.

A. Tables

Table A1: Characteristics of the experimental sessions

Session	Number of subjects	% of females	Treatments	Information on peers' performance	Presence of peers in the session	Performance visible to others in the session
1	18	50	Baseline - V1	-	-	No
2	18	44.5	Baseline - V1	-	-	No
3	18	55.5	Sequential - V1	Yes	No	No
4	12	41.5	Sequential - V1	Yes	No	No
5	9	44.5	Sequential - V1	Yes	No	No
21	18	50	Simultaneous	Yes	Yes	Yes
22	18	33.3	Simultaneous	Yes	Yes	Yes
23	12	50	Simultaneous	Yes	Yes	Yes
24	12	50	Simultaneous	Yes	Yes	Yes
25	18	55.5	Simultaneous	Yes	Yes	Yes
26	18	72.2	Simultaneous	Yes	Yes	Yes
27	18	55.5	Simultaneous	Yes	Yes	Yes
28	6	66.7	Baseline - V2	-	-	Yes
	6	50	Sequential - V2	Yes	Yes	No
29	6	33.3	Baseline - V2	-	-	Yes
	6	33.3	Sequential - V2	Yes	Yes	No
31	6	50	Baseline - V2	-	-	Yes
	6	33.3	Sequential - V2	Yes	Yes	No
32	6	83.3	Baseline - V2	-	-	Yes
	6	50	Sequential - V2	Yes	Yes	No
33	6	50	Baseline - V2	-	-	Yes
	6	66.7	Sequential - V2	Yes	Yes	No
35	6	33.3	Baseline - V2	-	-	Yes
	6	66.7	Sequential - V2	Yes	Yes	No
36	6	83.3	Baseline - V2	-	-	Yes
	6	66.7	Sequential - V2	Yes	Yes	No
38	6	66.7	Baseline - V2	-	-	Yes
	6	66.7	Sequential - V2	Yes	Yes	No
40-43	24	45.8	Simultaneous	Yes	Yes	Yes
44-46	18	44.5	Simultaneous	Yes	Yes	Yes
47-50	24	58.3	Simultaneous	Yes	Yes	Yes
51-54	24	37.5	Simultaneous	Yes	Yes	Yes
TOTAL	375	51.2				

Table A2: Quantile Regressions of the Sequential Gender-Homogeneous Model

	RE†	Q(0.1)	Q(0.3)	Q(0.5)	Q(0.7)	Q(0.9)
Peer performance	0.209***	0.100	0.163	0.266**	0.186	0.227*
	(0.049)	(0.153)	(0.130)	(0.122)	(0.122)	(0.128)
Presence × Peer performance	-0.091	0.001	-0.001	-0.098	-0.019	-0.032
	(0.089)	(0.197)	(0.193)	(0.188)	(0.188)	(0.190)
Peer characteristics						
Wage (log)	-0.03	-0.004	-0.015	-0.082	-0.188	-0.123
	(0.149)	(0.239)	(0.233)	(0.226)	(0.219)	(0.239)
Wealth	0.057	-0.063	0.120	0.011	-0.502	-0.130
	(0.464)	(0.518)	(0.518)	(0.506)	(0.511)	(0.522)
Age	-1.259***	-1.393**	-1.315*	-1.349**	-1.254*	-1.194*
	(0.486)	(0.696)	(0.686)	(0.682)	(0.693)	(0.698)
Show-up fee	-0.29	-0.507	-0.471	-0.244	0.133	-0.225
	(0.822)	(0.881)	(0.899)	(0.904)	(0.920)	(0.929)
ECL engineering school	3.346	3.572	3.530	3.542	3.439	3.53
	(2.47)	(3.075)	(3.079)	(3.081)	(3.081)	(3.079)
Proportion of males	0.719	0.333	0.454	0.421	0.498	0.488
	(1.965)	(2.512)	(2.517)	(2.517)	(2.519)	(2.518)
Individual characteristics						
Wage (log)	0.642***	0.529*	0.463*	0.443**	0.336*	0.484**
	(0.225)	(0.284)	(0.236)	(0.212)	(0.179)	(0.195)
Wealth	0.718	0.211	0.724	0.673	0.521	1.009
	(0.516)	(0.677)	(0.669)	(0.670)	(0.663)	(0.659)
Age	0.061	0.094	-0.001	0.104	0.126	0.175
	(0.139)	(0.227)	(0.219)	(0.230)	(0.224)	(0.232)
Show-up fee	-0.613	-0.788	-0.541	-0.695	-0.357	-0.592
	(0.421)	(0.522)	(0.498)	(0.491)	(0.506)	(0.5)
ECL engineering school	5.756**	5.665**	5.785**	5.771**	5.7776**	5.773**
	(2.354)	(2.572)	(2.568)	(2.567)	(2.564)	(2.564)
Period	0.248***	0.350***	0.285***	0.253***	0.224***	0.172***
	(0.036)	(0.069)	(0.051)	(0.042)	(0.038)	(0.047)
Intercept	31.919**	34.203*	34.221*	34.215*	34.207*	34.228*
	(14.337)	(19.488)	(19.488)	(19.488)	(19.489)	(19.489)
Sessions	Yes	Yes	Yes	Yes	Yes	Yes
N	1392	1392	1392	1392	1392	1392
Non linearities test		$H_0 : Q(0.1) = Q(0.3) = Q(0.5) = Q(0.7) = Q(0.9)$				
in Peers' performance effect‡		*p-value* = 0.369				

†Random Effects with panel clustered S.E., ‡ Wald test of peers' performance coefficients equality between quantile regressions.
***Indicates 1% significance level, **Indicates 5% significance level, *Indicates 10% significance level.

B. Instructions for the Baseline treatment

(These instructions are for both variants, except the sentence in italics that is used only for variant 2.) We thank you for participating in this experiment on economic decision-making. The session consists of 16 periods during which you will be able to perform a task, as described in detail below.

One of these periods will be randomly selected at the end of the session to determine your earnings in Euros. Your earnings in Euros depend on your performance during this period. Moreover, you will receive an initial endowment for the whole session. The amount of this endowment will be randomly selected among the following values: 2, 4 or 6 Euros. You will be informed on the amount of this endowment for the session before starting the first period.

Your earnings will be paid to you in cash and in private in a separate room.

At the beginning of the session, you will be asked a few personal questions (gender, age, relative wealth of your family compared to the other students, school, year of study).

All your decisions during the session will remain anonymous. You will never have to enter your name in the computer.

Description of each period

Each period lasts 2 minutes 30. During these 2 minutes 30, you are invited to perform the following task.

This task consists of multiplying two-digit numbers by one-digit numbers that are displayed on your screen (for example, 15×3, 22×7). You must enter a value in the corresponding box and submit your answer by clicking the "validate" button. You must make these calculations in your head. It is strictly forbidden to use a pen, a calculator, a mobile phone or any device to multiply the numbers, otherwise you will be immediately excluded from the session and the payoffs. Once you have submitted an answer:

- If this answer is not correct, a message will inform you and you will be able to enter a new answer. Only a correct answer will make another multiplication appear.
- If this answer is correct, your score is increased by one unit and a new multiplication is displayed on your screen.

You can make as many multiplications as you like during each period. You are also allowed to read the magazines that are available on your desk.

Please note that before the beginning of the first period, a practice round of 2 minutes 30 will allow you to train at the task. Your performance during this round will count for the determination of your earnings.

Determination of your earnings

Your earnings during this experiment depend on your piece-rate and your score (your number of correct answers) in a period randomly drawn by the computer program at the end of the session. Your piece-rate for each correct answer is randomly selected at the beginning of each period. It can change across periods.

This piece-rate for each correct answer can take the following values: €0.10, €0.50, €1. Your earnings for the experiment are therefore calculated as follows:
Your total earnings = your initial endowment + (your piece-rate × your score in the randomly selected period). The incorrect answers are not accounted for in the determination of your earnings.

Information

At the beginning of the first period, you are informed on the piece-rate for the period. Note that the piece-rate of the other participants in this session in a given period can differ from your piece-rate. But all the participants in the session have to solve the same multiplications and in the same order as you in each period.

You are permanently informed on your current score in the period and on the time remaining until the end of the period. At the end of each period, your final score in the period is displayed, as well as a reminder of your piece-rate for the period.

Only in Variant 2: At the end of each period, your score is communicated to one or two other participants. They cannot identify you in the room.

You can find below a copy of the screenshot during the task. The numbers indicated are only an example.

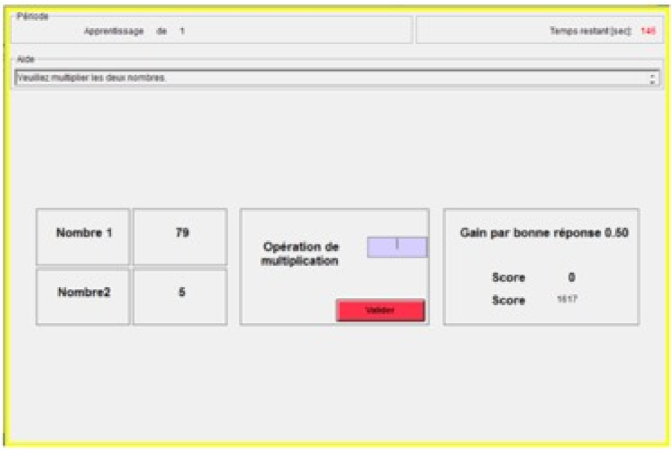


Figure 3: An example of a screenshot - Baseline treatment

To sum up:

- In each of the 16 periods you can solve multiplication problems.
- From one period to the next, the multiplications and the piece-rates are modified randomly.
- The other participants receive the same multiplications problems and in the same order than you.
- In each period the piece rates are randomly determined for each participant.
- At the end of each period, you are informed on your score for this period, and on your potential payoff for this period.

Please read again these instructions. If you have any question, please raise your hand and we will answer to your questions in private. Once we will have answered your questions, a questionnaire will be displayed on your computer screen. Then the practice period will start. The following periods will start automatically. At the end of the session, you will be invited to fill out a final questionnaire.

You are not allowed to communicate with any other participant.

C. Instructions for the Sequential treatment

(These instructions are for both variants, except the sentence in italics that is used only for variant 1 or 2) We thank you for participating in this experiment on economic decision-making. The session consists of 16 periods during which you will be able to perform a task, as described in detail below.

One of these periods will be randomly selected at the end of the session to determine your earnings in Euros. Your earnings in Euros depend on your performance during this period. Moreover, you will receive an initial endowment for the whole session. The amount of this endowment will be randomly selected among the following values: 2, 4 or 6 Euros. You will be informed on the amount of this endowment for the session before starting the first period.

Your earnings will be paid to you in cash and in private in a separate room. During the session, you will be matched with one or two participants, named "peers" in the rest of these instructions. You will keep the same peers throughout the experiment. You will never know their identity.

(Only in variant 1: This or these peers are not present in the room today: these persons recently participated in another session. During this session, your peer(s) performed the same task as you and their earnings were calculated according to the same rules as you. The difference with you is that they had no peers.)

(Only in variant 2: This or these peers are present in the room today. Your peer(s) perform the same task as you and their earnings are calculated according to the same rules as you. The difference with you is that they receive strictly no information about you.)

At the beginning of the session, you will be asked a few personal questions (gender, age, relative wealth of your family compared to the other students, school, year of study). Then, you will be informed on your peer's answers to these questions. If you have two peers, you will be informed of their mean answers to the questions about their age and the relative wealth of their family. "Men" indicates that your two peers are men; "women" indicates that your two peers are women; "mixed" indicates that one peer is a man and the other peer is a woman.

You will be also informed on the initial endowment of your peer or the average initial endowments of your two peers for the session. All your decisions during the session will remain anonymous. You will never have to enter your name in the computer.

Description of each period

Each period lasts 2 minutes 30. During these 2 minutes 30, you are invited to perform the following task.

This task consists of multiplying two-digit numbers by one-digit numbers that are displayed on your screen (for example, 15×3, 22×7). You must enter a value in the corresponding box and submit your answer by clicking the "validate" button. You must make these calculations in your head. It is strictly forbidden to use a pen, a calculator, a mobile phone or any device to multiply the numbers, otherwise you will be immediately excluded from the session and the payoffs. Once you have submitted an answer:

- If this answer is not correct, a message will inform you and you will be able to enter a new answer. Only a correct answer will make another multiplication appear.
- If this answer is correct, your score is increased by one unit and a new multiplication is displayed on your screen.

You can make as many multiplications as you like during each period. You are also allowed to read the magazines that are available on your desk.

Please note that before the beginning of the first period, a practice round of 2 minutes 30 will allow you to train at the task. Your performance during this round will count for the determination of your earnings.

Determination of your earnings

Your earnings during this experiment depend on your piece-rate and your score (your number of correct answers) in a period randomly drawn by the computer program at the end of the session. Your piece-rate for each correct answer is randomly selected at the beginning of each period. It can change across periods.

This piece-rate for each correct answer can take the following values: €0.10, €0.50, €1. Your earnings for the experiment are therefore calculated as follows:

Your total earnings = your initial endowment + (your piece-rate × your score in the randomly selected period). The incorrect answers are not accounted for in the determination of your earnings.

Information

At the beginning of the first period, you are informed on the piece-rate for the period. You are also informed of the piece-rate of your peer in the same period. If you have two peers, you are informed on their average piece-rate. Indeed, your peers can receive different piece-rates than yours during a period. Their piece-rate is also randomly selected among the following values: €0.10, €0.50, €1. Note that the piece-rate of the other participants in this session in a given period can also differ from your piece-rate.

(Only in variant 2: Your peer(s) will start the task about three minutes before you: there is always a lag of one period with you. Thus, you will start the first period as soon as your peers will have completed the task in the first period.)

At the beginning of each period, you are also informed on your peer's final score for his piece-rate in the period; if you have two peers, you are informed on their mean final score in the same period. Please note that your peer or your peers had to solve exactly the same multiplications as you and in the same order as you in each period. Similarly, all the participants in the session have to solve the same multiplications and in the same order as you in each period.

You are permanently informed on your current score in the period and on the time remaining until the end of the period. At the end of each period, your final score in the period is displayed, as well as a reminder of your piece-rate for the period, your peer's piece-rate and final score or your two peers' average piece-rate and average final score.

You can find below a copy of the screenshot during the task. The numbers indicated are only an example.

To sum up:

- In each of the 16 periods, you can solve multiplication problems.
- From one period to the next, you keep the same peer or the same two peers. (Only in variant 2: This or these peers are present in the room today. Your peers receive no information about you and they start the first period about 3 minutes before you).

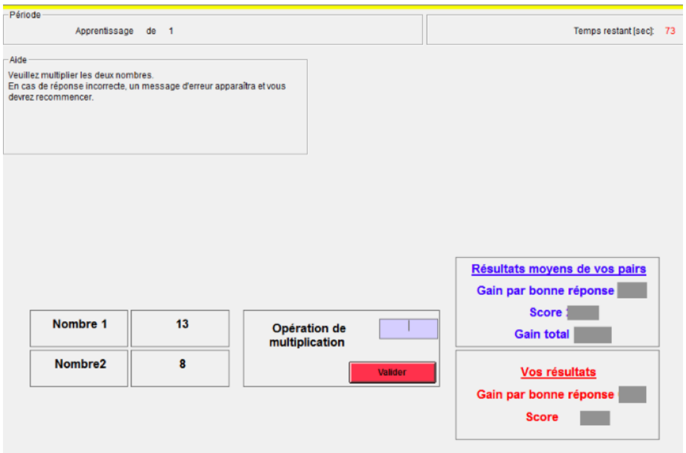


Figure 4: An example of a screenshot - Recursive treatment

- From one period to the next, the multiplications and the piece-rates are modified randomly. Your peer or your peers have received the same multiplications problems and in the same order than you.
- The other participants receive the same multiplications problems and in the same order than you.
- You are informed at the beginning of the period on your peer?s piece-rate and on his final score for the same period or on the average piece-rate and average final score of your two peers if you have two peers.
- At the end of each period, you are informed on your score and on your potential payoff for this period, and you are reminded your peer?s piece-rate and his final score for the same period or the average piece-rate and average final score of your two peers for the same period if you have two peers.

Please read again these instructions and answer the questions on the questionnaire that has been distributed to you. If you have any question, please raise your hand and we will answer to your questions in private. Once we will have answered your questions, a questionnaire will be displayed on your computer screen. Then the practice period will start. The following periods will start automatically. At the end of the session, you will be invited to fill out a final questionnaire.

You are not allowed to communicate with any other participant.

D. Instructions for the Simultaneous treatment

We thank you for participating in this experiment on economic decision-making. The session consists of 4 periods, each divided into several rounds during which you will be able to perform a task, as described in detail below.

One of these rounds will be randomly selected at the end of the session to determine your earnings in Euros. Your earnings in Euros depend on your performance during this round. Moreover, you will receive an initial endowment for the whole session. The amount of this endowment will be randomly selected among the following values: 2, 4 or 6 Euros. You will be informed on the amount of this endowment for the session before starting the first period.

Your earnings will be paid to you in cash and in private in a separate room. During the session, you will be matched with one or two participants, named "peers" in the rest of these instructions. You will keep the same peers throughout the experiment. You will never know their identity.

At the beginning of the session, you will be asked a few personal questions (gender, age, relative wealth of your family compared to the other students, school, year of study). Then, you will be informed on your peer's answers to these questions. If you have two peers, you will be informed of their mean answers to the questions about their age and the relative wealth of their family. "Men" indicates that your two peers are men; "women" indicates that your two peers are women; "mixed" indicates that one peer is a man and the other peer is a woman.

You will be also informed on the initial endowment of your peer or the average initial endowments of your two peers for the session. All your decisions during the session will remain anonymous. You will never have to enter your name in the computer.

Description of each period

Each of the four periods consists of several rounds. The number of rounds can change across periods. Each round lasts 2 minutes 30. During these 2 minutes 30, you are invited to perform the following task.

This task consists of multiplying two-digit numbers by one-digit numbers that are displayed on your screen (for example, 15×3, 22×7). You must enter a value in the corresponding box and submit your answer by clicking the "validate" button. You must make these calculations in your head. It is strictly forbidden to use a pen, a calculator, a mobile phone or any device to multiply the numbers, otherwise you will be immediately excluded from the session and the payoffs. Once you have submitted an answer:

- If this answer is not correct, a message will inform you and you will be able to enter a new answer. Only a correct answer will make another multiplication appear.
- If this answer is correct, your score is increased by one unit and a new multiplication is displayed on your screen.

You can make as many multiplications as you like during each round. You are also allowed to read the magazines that are available on your desk.

Please note that before the beginning of the first period, a practice round of 2 minutes 30 will allow you to train at the task. Your performance during this round will count for the determination of your earnings.

Determination of your earnings

Your earnings during this experiment depend on your piece-rate and your score (your number of correct answers) in a round of a period randomly drawn by the computer program at the end of the session. Your piece-rate for each correct answer is randomly selected at the beginning of each period. It can change across periods. In contrast, it remains constant across the rounds of a same period.

This piece-rate for each correct answer can take the following values: €0.10, €0.50, €1. Your earnings for the experiment are therefore calculated as follows:
Your total earnings = your initial endowment + (your piece-rate × your score in the randomly selected round). The incorrect answers are not accounted for in the determination of your earnings.

Information

At the beginning of the first round of each period, you are informed on the piece-rate for the period. You are also informed of the piece-rate of your peer in the same period. If you have two peers, you are informed on their average piece-rate. Indeed, your peers can receive different piece-rates than yours during a period. Their piece-rate is also randomly selected among the following values: €0.10, €0.50, €1. Note that the piece-rate of the other participants in this session in a given period can also differ from your piece-rate.

At the end of each round, you are also informed on your peer's final score in the round for his piece-rate in the period; if you have two peers, you are informed on the mean final score in this round. Please note that your peer or your peers had to solve exactly the same multiplications as you and in the same order as you during each round. Similarly, all the participants in the session have to solve the same multiplications and in the same order as you in each round.

You are permanently informed on your current score in the round and on the time remaining until the end of the round. At the end of each round, your final score in the round is displayed, as well as a reminder of your piece-rate for the period, your peer's piece-rate and final score or your two peers' average piece-rate and average final score.

You can find below a copy of the screenshot during the task. The numbers indicated are only an example.

Figure 5: An example of a screenshot - Simultaneous treatment

To sum up:

- Each of the four periods consists of several rounds during which you can solve multiplication problems.

- From one period to the next, you keep the same peer or the same two peers. The piece-rates are randomly determined.
- During a period, you keep the same piece-rate across rounds.
- From one round to the next, the multiplications are modified randomly. Your peer or your peers receive the same multiplications problems and in the same order than you.
- You are informed at the beginning of the period on your peer's piece-rate or on the average piece-rate of your two peers.
- At the end of each round, you are informed on your final score and your potential earnings for this round, and on your peer's score or on the average score of your two peers. You are reminded your piece-rate and your peer's piece-rate or the average piece-rate of your two peers.

Please read again these instructions and answer the questions on the questionnaire that has been distributed to you. If you have any question, please raise your hand and we will answer to your questions in private. Once we will have answered your questions, a questionnaire will be displayed on your computer screen. Then the practice period will start. The following periods will start automatically. At the end of the session, you will be invited to fill out a final questionnaire.

You are not allowed to communicate with any other participant.