PRODUCTIVITY THROUGH COFFEE BREAKS: CHANGING SOCIAL NETWORKS BY CHANGING BREAK STRUCTURE

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We gratefully acknowledge the financial support we received from the MIT Media Laboratory Things That Think consortium and the MIT Center for Future Banking.

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ABSTRACT

In this paper we present a two-phase study undertaken to experimentally study in a real world setting the effects of social group strength and how to increase the strength of groups in the workplace. In the first phase of our study we measured interactions between workers at the call center of a large bank based in the United States using Sociometric Badges. We confirmed our hypothesis that the strength of an individual's social group was positively related to productivity (average call handle time) for the employees that we studied. In the second phase of our study we show that by giving employees breaks at the same time we increased the strength of an individual's social groups, demonstrating that low-cost management decisions can be used to act on these results.

INTRODUCTION

The positive effect of strong social groups in face-to-face networks on productivity has been documented in many different settings (Reagans and Zuckerman, 2001). While in one of our previous studies we demonstrated how changes in the strength of social groups were positively associated with changes in job satisfaction (Waber and Pentland, Under Review), since this was a correlational result we could not definitively say that this effect was causal. In this paper we present a two-phase study undertaken to experimentally study in a real world setting the effects of social group strength and how to increase the strength of groups in the workplace.

In the first phase of our study, we measured interactions between workers at the call center of a large bank based in the United States using Sociometric Badges (Olguin Olguin, Waber, Kim, Mohan, Ara, and Pentland, 2009). We were also able to obtain demographic data, psychological survey responses, as well as detailed productivity data from the company. We confirmed our hypothesis that the strength of an individual's social group was positively related to productivity (average call handle time) for the employees that we studied.

We studied employees from four teams of roughly 20 people each. Originally each employee on a team had a separate 15 minute break during the day. The breaks were separate so call loads did not have to be shifted significantly to other teams, however this bank has over 10,000 call center employees, so this is not an important issue for the company. Unfortunately, this break structure made it very difficult for cohesive relationships to develop, since groups of friends will by design have limited opportunities for shared interactions.

To create more of these opportunities we changed the break structure of two of the four teams after the first phase of the study so that all of the employees on a team are given a break at the

same time. After giving this change three months to stabilize, we returned to the call center and measured the behavior of the employees again using SociometricBadges. Our hypothesis is that this change will not only the strength of the individuals' social networks but also increase their productivity.

One of the difficulties with conducting this kind of research in the past was the lack of objective data on face-to-face interactions. The advent of low cost, flexible sensing systems has changed this equation, particularly in the workplace. Many employees in larger companies are required to wear RFID name tags that allow them to open doors or access other resources, although this data is rarely harnessed so people can understand how people are actually moving around the workplace. In addition, it is possible to augment these name tags with additional sensors to understand in more detail how people interact with each other and even fiddle at their desks.

We have created a wearable Sociometric Badge that has advanced sensing, processing, and feedback capabilities (Olguin Olguinet al., 2009). In particular, the badge is capable of:

- Recognizing common daily human activities (such as sitting, standing, walking, and running) in real time using a 3-axis accelerometer (Olguin Olguin and Pentland, 2006).
- Extracting speech features in real time to capture nonlinguistic social signals such as interest and excitement, the amount of influence each person has on another in a social interaction, and unconscious back-and-forth interjections, while ignoring the words themselves in order to assuage privacy concerns (Pentland, 2005).
- Performing indoor user localization by measuring received signal strength and using triangulation algorithms that can achieve position estimation errors as low as 1.5 meters,

which also allows for detection of people in close physical proximity (Sugano, Kawazoe, Ohta, and Murata, 2006).

- Communicating with Bluetooth enabled cell phones, PDAs, and other devices to study user behavior and detect people in close proximity (Eagle and Pentland, 2006).
- Capturing face-to-face interaction time using an infra-red (IR) sensor that can detect when two people wearing badges are facing each other within a 30°-cone and one meter distance. Choudhury(Choudhury and Pentland, 2003) showed that it was possible to detect face-to-face conversations of more than one minute using an earlier version of the Sociometric badge with 87% accuracy.

Insert Figure 1About Here

This technology has the potential to fundamentally alter the types of questions that we ask. This data is naturally more precise, and so we have examined, for example, behavioral data on the order of five-minute chunks related to specific tasks automatically logged by an IT services firm (Wu, Waber, Aral, Brynjolfsson, and Pentland, 2008) and the relationship between face-to-face and e-mail communication (Olguin Olguin et al., 2009).

BACKGROUND

Call center employees are put under a large amount of psychological pressure in their job (Wallace, Eagleson, and Waldersee, 2000). Not only do they have to deal with a never-ending

stream of unhappy customers, but they must also deal with a management system that frequently sacrifices employee well being for short term results (Wallace et al., 2000). It is also difficult for these employees to spend time venting with their fellow workers, since breaks are often staggered to prevent lapses in call center coverage.

Many call centers today, however, have grown large enough so that individual teams do not have one specialty, and call loads can be easily shifted between teams at no cost to the organization. Despite this, policies of only allowing one employee on a team to be on break at a time persist.

Breaks themselves are often viewed in the literature as an individual function. Breaks function to allow employees to recharge (Dababneh, Swanson, and Shell, 2001), avoid injury (Hedge, 1999), etc. The emphasis is operations research is usually on minimizing break overlaps(Dababnehet al., 2001), and little regard is given to the idea that social interaction during breaks provides the employee with a valuable opportunity to discuss difficult issues as well as exchange knowledge about their job.

Social Networks and Productivity

Social networks have recently become an active area of research in the social sciences describing the pattern of relationships that connect individuals together. Previous research in this area has linked social network patterns to productivity(Reagans and Zuckerman, 2001), personality(Fishbach, Schoder, and Gloor, 2009), and organizational commitment (Leiter and Maslach, 1988), to name a few of the more salient connections.

Previous research on the relationship between social networks and productivity mostly use surveys and so measures people's perceptions rather than their actual interaction patterns (although recently electronic communication data has been employed (Aral, Brynjolfsson, and

Van Alstyne, 2006)). Many results in the social network literature have been mixed, and it has even been pointed out that many of the conflicting results may be due to lack of a standard measurement mechanism (Flap and Volker, 2001). We believe that the Sociometric badges and sensing technology in general will help rectify this situation by acting as consistent and objective data sources.

In the literature there is often a tension between the entrepreneurial advantages of structural holes versus the supportive nature of cohesive ties. Krackhardt's theory on Simmelian ties (Krackhardt, 1999) attempts to disambiguate this debate by placing the context of the type of network examined in the center. The theory states that in certain circumstances being in a bridging position (i.e. having high betweenness, although Krackhardt advocates for the use of a different measure that uses clique detection and other methods) can be more constraining than being in a non-bridging position since one's behaviors have to conform to the norms of multiple groups rather than one. This is in contrast to Burt's structural holes theory (Burt, 1992), which asserts that bridging individuals are more empowered than non-bridging people. Krackhardt clarifies the mutual compatibility of these views by asserting that when people have to express themselves publicly, bridging positions will be more constraining, but when people are able to communicate more in private, Burt's theory would apply.

In our previous work where we deployed Sociometric Badges at an information technology firm we have also found that being embedded within a dense social group was related to higher productivity (Wu et al., 2008). This agrees with work by other researchers examining social networks and employee performance at a call center (Castilla, 2005). While the author primarily examined hiring practices, he found that socially connected employees influenced productivity. In particular, performance is better in new employees over the first three months at the call

center if they were referred by someone compared to those hired through standard applications. He also uses the average handle time (AHT) as the measure of productivity, which we do in this study.

Some researchers have suggested that promoting high turnover at call centers improves performance (Wallace et al., 2000). The authors lament that call centers require strong supportive management systems to stave off employee burnout, which is costlier to implement than retraining new, more motivated call center employees. We believe that the answer to this problem is not a formal mechanism at all, but rather simple management practices that support the creation of an informal support structure. This leads us to our first hypothesis:

> *Hypothesis 1: the most productive employees are those who are embedded within the strongest social groups.*

By changing the break structure of call center employees, we will show that we can increase the strength of these social ties and by extension increase their productivity and job satisfaction all at no cost to the organization.

Break Structure

Ergonomics researchers have an extensive history examining break structure at work, particularly at physically demanding jobs (Hedge, 1999). In laboratory studies workers performed best if they were allowed to choose their own breaks, and this was confirmed in several real-world studies (Hedge, 1999). Importantly gains were also realized in terms of worker physical health, implying that there might be similar gains for mental health, which is an important factor in job satisfaction(Sullivan and Bhagat, 1992).

Other researchers examined changes in break structure at a meat processing plant, finding that having longer break periods distributed throughout the day were more effective than a larger number of short breaks (Dababneh et al., 2001). While this was not examined in the paper, we hypothesize that a potential benefit of the longer breaks were more opportunities for meaningful interactions, which would have been difficult to engage in for the short break condition.

A large number of models treat the workforce as a homogeneous group when making scheduling decisions such as breaks, particularly in the case of telephone operators (Baker, 1976). Staffing decisions are not made in a vacuum, but rather than emphasizing staff requirements and other formal concerns (Baker, 1976) we believe that the informal context (who is important from the perspective of the social network of the group) deserves consideration even in jobs that are typically not viewed as having a strong social component.

In particular, we hypothesize that:

> *Hypothesis 2: Scheduling employee breaks to overlap for people on the same team will lead to stronger social groups.*

METHODS

Detecting Face-to-Face Interactions

IR transponders can be used as a proxy for the detection of face-to-face interaction between people. In order for one badge to be detected through IR, two Sociometric badges must have a direct line of sight to each other. The receiving badge's IR sensor must be within the transmitting badge's IR signal cone of height less than one meter and radius r such that$r \leq h \tan \theta$ and $\theta =$

±*15*. Figure 2 shows a receiving badge's IR sensor within the specified range. Every time an IR signal is detected by a badge we say that face-to-face interaction may occur.

Insert Figure 2 About Here

We define the total amount of face-to-face interaction time per person as the total number of consecutive IR detections per person multiplied by the IR transmission rate, which in our experiment was once every two seconds.

Relational Data Analysis

Relational data (i.e. IR detections, e-mail exchanges, Bluetooth proximity) must be placed into an adjacency matrix in order to analyze it under a social network framework. In relational data there are two participants: a sender *i* and a receiver *j*. We define the matrix *A* with elements a_{ij} such that$a_{ij} = max(a_{ij}, a_{ji})$, where a_{ij} is the amount of communication measured between *i* and *j*. This procedure creates a symmetric matrix and a social network representation.

We define the "betweenness'" of a node *i* in a social network as the proportion of all paths between any two nodes in the network that pass through *i*(Scott, 2001). Mathematically, we have:

$$b_i = \sum_{v,t} \frac{\alpha_{vt}(i)}{\sum_j \alpha_{vt}(j)} \text{ ,} o \neq v \neq t \text{ and } j \neq v \neq t$$

where*j*, *v*, and *t* are nodes, α_{vt} is the number of unique paths in the social network from node *v* to node *t* that pass through *i*, and b_i is the betweenness of *i*.

We define the *"kith*[1] *index"* c_i of a node *i* in a social network as the degree to which an individual's contacts are also connected to each other. $P_{ij}$is the proportion of *i*'s time invested in communicating to *j*, and is similar to the notion of network constraint(Burt, 1992). The equation is as follows:

$$c_i = \sum_j (p_{ij} + \sum_q p_{iq} p_{qj})^2, q \neq i, j$$

This quantity operationalizes the concept of strength of social groups by rewarding people for speaking to a greater number of people, but taking into account the strength of ties between their conversational partners.

STUDY DESCRIPTION

We ran a two phase study at a call center with over 3000 employees for a major North American banking firm in the northeastern United States. During the first phase of the study we targeted four teams at this call center, each consisting of around 20 employees. These employees were instructed to wear the Sociometric Badges all day while they were at the call center for a period of six weeks.

[1] "Kith and kin" is a thousand year-old phrase that is still familiar although "kith" alone has fallen out of use. The word "kith" comes from the old English and old German words for "knowledge," and it means "a more or less cohesive group with common beliefs and customs." These are also the roots for "couth," which means to act with a high degree of sophistication. Your kith is the circle of friends that you bounce ideas off of and from whom you learn sophisticated habits of action. See (Alex Pentland, "Kith, Kin, and Charisma," *American Scientist Magazine*, Under Review).

The purpose of this phase of the study was to identify social behaviors that could lead to an intervention that would effect these behaviors and enhance productivity. The executives in charge of the call center unit of this bank had the intuition that limiting interaction for the call center employees during break periods had negative effects on the mental well being of the employees and may lead to higher turnover.

The structure of breaks for these employees, as in many call centers, was to reduce as much as possible the overlap between breaks for people on the same team. Each employee was given one 15-minute break per day in addition to a 30 minute lunch break. This organization has over 10000 call center employees, so shifting call loads has greatly reduced in importance over time.

The four teams were each headed by a single manager, who had a desk in the group area. Employees sat in cubicles in front of a computer terminal taking customer calls on a variety of banking issues.

In addition to the Sociometric Badges, we obtained productivity data from the call center which is automatically logged by an enterprise software system. The measure of productivity we will use here is average call handle time (AHT), which represents the cost of running a call center. For example, reducing AHT by 5% at this call center would save this company roughly one million dollars. The bank also gave the employees surveys as part of their regular monthly employee assessment, and we also were able to use this data in our analysis.

RESULTS

For the first phase of this study, we first wanted to discover whether or not face-to-face interactions had any affect on productivity or stress levels. We performed a linear correlation analysis to determine the relationship between these features, and the results are shown in table 1. For the gender variable females were assigned the number 0 and males were assigned 1. The amount of interaction variable represents the number of seconds of face-to-face interaction that were detected over the course of the study.Tenure is measured in days since the employee was hired. For each correlation we used only individuals that had data for both variables, while in the multi-linear regression below we used only subjects that had data for all variables.

Insert Table 1About Here

We then performed a multi-linear regression to predict AHT using the kith index, stress, and gender. The results are listed below in table 2.

Insert Table 2About Here

Next we examine if cohesion significantly changed for participants across different waves of the study. While at the call center has not yet released performance data to us, the managers have expressed confidence that the new break structure has also enhanced performance. We found that the kith index significantly changed across the different waves of the study ($p < 0.05$) and the mean difference between the two waves was 0.19.

DISCUSSION

In this study we hoped to get a better understanding of the relationship between the strength of an individual's social group. While we are still awaiting productivity data for phase two to be able to causally confirm our first hypothesis, we have shown that this holds in a correlational fashion using data from the first phase of our study. Results in our other studies strengthens the case for causality, although there is clearly a complex set of causes and consequences at work. For example, we have previously found a strong relationship between objective productivity and cohesion in an IT services firm, where a one standard deviation increase in the kith index implied a 10% increase in productivity(Wu et al., 2008). The fact that stress was also negatively related to the kith index (albeit at a non-significant level) as well as its previously documented positive impact on job satisfaction (Waber and Pentland, Under Review) indicates a number of benefits of strong informal social groups.

We also found that tenure was not significantly related to either AHT or the kith index. As has been shown previously, long organizational tenure does not relate to higher productivity in call centers (Castilla, 2005)but it is interesting that it does not appear that tenure effects an individual's kith index. This is counter intuitive, since one would imagine that people

accumulate friends in the workplace over time and will build a closed network of friends. Since it appears that strong social groups drive performance, however, it is clear that other management interventions, such as giving employees breaks at the same time, is crucial since this behavior will not necessarily emerge naturally for all people.

Since our manipulation increased the kith index among the study participants, it indicates that serendipitous mechanisms may be a major factor in determining interaction patterns. This is supported by previous ethnographic work as well (Roy, 2003).

We also believe that we have shown a natural, low-cost way to increase the strength of social groups in workplaces. Contrary to some previous work, using detailed behavioral data we have shown that strong social groups are beneficial to productivity and can be supported without extensive management interventions.

CONCLUSION

In this paper we have shown that productivity as measured by AHT can be predicted quite strongly using the kith index calculated using behavioral data. The Sociometric badge was instrumental in helping us examine this phenomenon, as these fine-grained interaction data would be extremely difficult to obtain using human observers. This result is all the more interesting since it had previously been hypothesized that interaction between call center employees is reduces productivity.

We hope that future research will delve deeper into the qualitative experiences of employees as they undergo these schedule changes and employ additional quantitative data collection

mechanisms to more firmly connect behavioral data research to other work in the management literature.

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FIGURE 1

Sociometric Badge.

FIGURE 2

Face-to-face interaction is detected when the receiving badge's IR sensor is within the transmitting badge's IR signal cone.

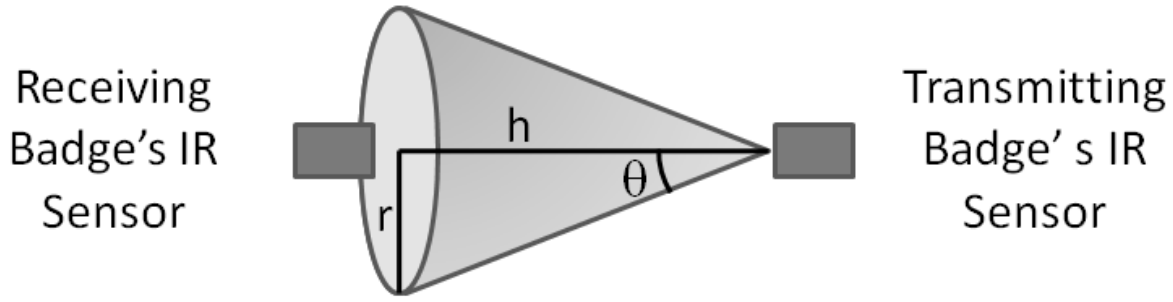

TABLE 1

Correlation Results.

Variable	AHT	Kith Index	Degree	Betweenness	Amount of Interaction	Stress	Gender	Age	Tenure	Mean	Std Dev
AHT	1	-	-	-	-	-	-	-	-	263	38
Kith Index	-0.61***	1	-	-	-	-	-	-	-	1.07	0.41
Degree	0.23	-0.48**	1	-	-	-	-	-	-	3.06	2.08
Betweenness	0.21	-0.36	0.53**	1	-	-	-	-	-	1.33	1.76
Amount of Interaction	-0.06	0.08	0.31	0.25	1	-	-	-	-	1214	1608
Stress	0.33*	-0.23	0.25	-0.04	0.06	1	-	-	-	3.07	0.97
Gender	-0.25*	0.10	-0.14	-0.16	-0.14	-0.10	1	-	-	0.67	0.47
Age	0.06	0.24	-0.30	-0.23	-0.24	0.02	0.23	1	-	33.48	12.10
Tenure	0.11	-0.06	-0.05	-0.14	-0.14	-0.09	-0.07	-0.09	1	832	331

N = 68

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

TABLE 2

Multi-linear regression results for predicting AHT.

Variable	ß
Intercept	296.77***
Kith Index	-52.15***
Stress	8.57
Gender	-9.40
R^2	0.49
Adjusted R^2	0.43
F	8.57***

N = 31

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$