# ConvoCons: A Tool for Building Affinity Among Distributed Team Members

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## ABSTRACT
In this paper we present the result of a user interface designed to increase social affinity between two remote collaborators working on design tasks. The results suggest that the tool is successful in creating an overall affinity that is 14.6% higher than the control group without adding a significant difference in task completion time. Affinity is measured with a framework with demonstrated inter-rater reliability using codes assigned to specific conversational patterns and video recorded interactions. This research approach provides a platform for future work codifying affinity and trust among larger numbers of remote collaborators.

### Author Keywords
Social Affinity, Distributed Teams, Collaboration, Social Interface Design

### ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

## INTRODUCTION
For modern office workers, an all too common problem in the globalized workforce tends to be a case of feeling misunderstood by fellow employees, disconnected, or even embattled with an individual who is supposed to be on the same team. While part of this problem stems from clashes of cultures and personalities, components of the problem are present in any team setting. However, distributed team arrangements enhance this problem as workers are unable to have the water cooler chats that help them build social affinity bonds. In this paper, we adapted Nardi's framework for affinity and define "social affinity" as the "convergence of thoughts, actions, or ideas" [24]. Using this definition, it can be inferred that a group that lacks affinity will have group members that are more likely to work independently from one another and more likely to enforce personal space.

Increasing globalization has heightened the need for remote collaboration with a distributed workforce where team members may have little information about the individuals with whom they work and no opportunities to learn about their colleagues' expertise through informal face-to-face communication [37]. While instant messaging (IM) and other computer mediated communication tools may allow for some opportunities for colleagues to learn about one another’s background and expertise, the barriers of time zones and limited opportunities for incidental conversation with remote colleagues often prevent these informal dialogues. This situation results in the hidden cost that team members may not be aware of expert knowledge another team member may have. There is also the more salient cost that remote collaborators have an impaired ability to form social affinity bonds that are critical to the creation of social capital and the type of social creativity required by modern product design teams [12, 31].

Much of the work of computer supported cooperative work has examined making the experience more comparable to natural interactions [30, 34], increasing the efficiency of work [6], or improving the flow of project-specific information [25]. Similarly, the design of groupware systems has so far focused primarily on either all participants sharing the same workspace [11, 21] or participants having a shared workspace with personal workspaces that serve to test ideas individually and these personal spaces are often visible to collaborators [32, 33, 35].

For our particular project, we were interested in using privileged information to encourage incidental conversation and affinity building among remotely located strangers working on design tasks, extending our work on the co-located version of this problem [26, 27]. In previous research on co-located collaboration, Oren and Gilbert provided a possible solution design solution called ConvoCons (conversational icons) with which social affinity was 40% higher in the experimental group compared with a control [27]. Furthermore, Aragon demonstrated that simple computational systems could be used in an applied work environment to increase social bonds and collaboration [1]. Theory suggests that by encouraging individual awareness of partner-privileged information, it will increase the sharing of additional information outside of the elements the design solution presents to collaborators [14, 24, 36]. The contributions of this paper include design guidance for interfaces that promote awareness of privileged information and a tool for promoting social affinity among remote collaborators.



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In this research, we had three research questions: (Q1) How can we promote awareness of privileged information in the interface during remote collaboration? (Q2) Are ConvoCons effective at promoting incidental conversations between remote collaborators? (Q3) Does our design solution result in increased observable signs of affinity as measured through behavioral and conversational cues?

### ConvoCons

A ConvoCon, or conversational icon, is a semi-transparent visual interface element that appears for a brief time on top of an existing interface, somewhat like notification alerts from calendar or email software [27]. However, ConvoCons are different in two key ways. First, they are designed specifically not to interfere with the current task; they do not afford any interaction. They are not clickable or closeable; they disappear on their own. They do not interfere with clicking/touching UI elements underneath them. Second, their content, which can be text or media, is chosen to spark conversation. This content may be unrelated to the task at hand. While this design approach may seem to be an apt definition of "distraction" for some readers, the aforementioned success at increasing affinity by 40% without a statistically significant difference in completion time makes them worth further research and development [27].

### Overview of Sections

As we used an iterative pilot study to evaluate elements of the interface and refine the final study, several insights into the design of interfaces with privileged information came to our attention. As these insights were critical to the final design of the remote ConvoCon study, we have chosen to detail this approach as part of addressing Q1. In particular, we see this iteration history as having application in the design of systems in which differing domain expertise may lead to different display configurations even as all collaborators work within the same software application. Following our discussion of the design of remote ConvoCons, we address Q2 and Q3 by presenting the results of a study comparing a control and experimental group based on self-reported metrics, performance metrics, and observed social affinity. Finally, we discuss the implications of these results, how they might be generalized, and several limitations that exist both in our experiment and in the ConvoCons system more generally.

## Q1 PROMOTING AWARENESS OF PRIVILEGED INFORMATION

By "privileged information" we mean information that only one team member possesses. In the specific case, that information may be a simple fact that is known by one person. In the general case, privileged information includes deep knowledge of a domain that only one member possesses based on expertise, e.g. a neurosurgeon's knowledge when in a surgical team as the only neurosurgeon. In our research context, we adopt the following logic model based on previous research: incidental conversation increases affinity among partners [24, 27], which increases sharing of privileged conversation [14, 24, 31, 36]. While we had previously succeeded in increasing the social affinity of co-located groups, we found that the approach used in the co-located condition was ineffective when working with remote dyads [27]. We attempted to resolve this by utilizing research that explains how technology can define an individual's social expectations as well as work that explored establishing coordination policies outside of traditional social protocols [19, 23]. In addition, we were able to utilize previous research into design and placement of web advertisements to try to alleviate problems of banner blindness by varying the color of the ConvoCons so they would be salient while at the same time matching the style of the content the users were working with [18, 20].

Individuals who lack social affinity will be less likely to share privileged information, which acts as a tangible form of social capital [13, 31]. Privileged information may also not be shared because individuals assume expertise will be shared. and experts assume that other individuals have the same information as they do. Increasing individuals' awareness of these disconnects may reduce these problems, although the evaluation of this question is beyond the scope of this paper. Finally, it should be noted that individuals who have high affinity may also have reduced sharing of privileged information due to an assumption that somebody in agreement with and similar to oneself must share the same information.

As expressed in design teams, privileged information may include technical details about the implementation that engineers are aware of, which they may withhold from designers or not realize need to be shared. On the reverse side of the equation, designers may have critical information about the aesthetics and interaction that might seem intuitively obvious unless they are aware of information gaps.

In examining this problem, we defined the audience as strangers collaborating remotely for the first time with no knowledge of physical appearance, skill set, or expertise. We chose to have participants collaborate via voice communication but not video to minimize the effect of stereotypes based on appearance.

We evaluated the interaction within a multitouch, multiplayer tangram puzzle interface developed internally that made collaborators aware of where their partners were touching in accordance with the recommendation by Kellogg and Erickson [17] for transparency of actions within collaborative applications. Tangram puzzles require a high cognitive load while requiring no interface beyond direct manipulation and thus minimizes the possibility of poorly designed interface elements being the cause of conversation [26]. Partners worked with touch screens in separate rooms, linked by voice using Skype.

Our goal in discussing the iterative design process in this section is to make other designers and researchers aware of seemingly intuitive designs that failed in testing. These iterations helped us better refine the design constraints for a system intended to promote knowledge of privileged information, which was a research question that emerged from the failure of the initial remote prototype.

## Design Process

To evaluate whether our design promoted awareness of privileged information, we used a multiple phase iterative design process to explore different design options given our context. These phases included brainstorming sessions with the research team, informal feedback from colleagues, and examining the effectiveness of the design with participants through pilot studies with each pilot phase consisting of 2-3 dyads. Through this iterative process we examined layout on the screen to promote awareness, different ways to promote knowledge of privileged information, and different ways of making users aware that they do no have all available information. In this context, the privileged information consisted of the question or answer to children's jokes or riddles, e.g.:

Q. Why did Donald Duck go to college?
A. He wanted to be a wise quacker.

Because participants are generally aware of the paired question-answer joke paradigm, we anticipated that seeing just the question or just the answer singly might suggest that their collaborator had the missing information. Even without the participants being aware of the privileged information, we hoped the initial reading of one part might stimulate conversation due to a natural desire to avoid social awkwardness when one person talks and the other does not respond within a culturally dependent timeframe [4]. While jokes may seem overly casual or unrelated to a task, they offer a simple paradigm with which to analyze a privileged information interface that could be generalized to task-related information [14].

We setup the following design constraints due to the larger needs of the research project:

1. The system had to use the same joke/riddles that had been used in the previous co-located experiment [27].
2. The design could not *force* awareness of information in continuing with the design goals of ConvoCons as an unforced and unobtrusive system.
3. At least 50% of participants had to be able to make the connection during either the study or in the exit interview that a partner possessed a different fragment of information.
4. Participants could not be given all available information (e.g. both the question and the answer)
5. The design had to be low bandwidth, in keeping with the goal of making them as unobtrusive as possible.

In exit interviews, participants had to indicate some awareness of privileged information when asked, “At any time, did anything that appeared on your screen differ from your partners’ screen?” or “For the questions that appeared


**Figure 1 A sample timeline showing tasks and ConvoCon appearance.**

on the screen, were you aware of the answers?”For all iterations, ten ConvoCons appeared at the first touch for a duration of thirty seconds each with a minute in between the disappearance of one ConvoCon and the appearance of the next one. The total duration of ConvoCons was thirteen minutes (see Figure 1). We chose to disable them midway through to see if effects from ConvoCons would continue after they stopped appearing.

## First Iteration

In the first iteration (Figure 2), the system gave one person the question half of a riddle or joke (unrelated to the tangram puzzles) while the collaborator received the answer half. Participants were told neither that the messages would be appearing nor the significance of the messages. The messages did not allow interaction and did not interfere

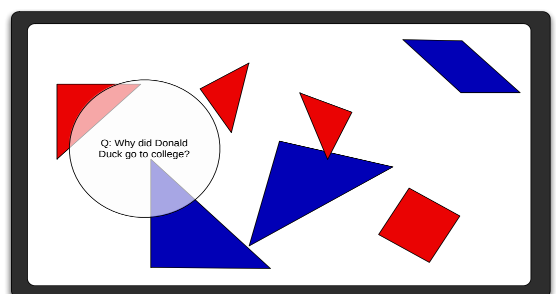


**Figure 2 Iteration 1 with the message left-aligned and no indication of a second half.**

with the tangram interface beneath them.

Dyads used the tangram interface for approximately 25 minutes and experienced these messages for the first 10 minutes of that time; we experimented with the placement of the information—left, center, and right side to see if that would affect the likelihood of collaborators discussing the information. We also manipulated the presence of a half circle at the top center of the screen with the content of the other participant’s message displayed upside down.

From this iteration, we learned that participants were most likely to discuss the information when the text was placed on the left. We thought that placing it in the center, on top of the work, might increase their awareness and thus the number of conversations associated with the jokes and riddles. However, center alignment tended to result in banner blindness. Informal interviews after the study indicated that participants chose to ignore the center-aligned text in favor of focusing on the work at hand. Since participants were from Western cultures, the failure of the right aligned configuration was unsurprising although in cultures where text is right aligned, the optimal placement may be different.

Exit interviews also uncovered that regardless of layout, individuals in both groups believed they had the same information on their screen as their collaborator. Those with the half-circle indicating part of the content of their collaborator had noticed the half-circle but assumed they could pull down the answer/question from the half-circle and wrongly assumed the inability to do so was due to a software bug. Given these results, we observed that the first design failed at design constraints 3 and 6.

### Second Iteration

The decision was made to run a new round of pilot studies with just the subtle change of making the half circle containing the text of the other participant as a dashed circle instead of a solid circle in an attempt to indicate lack of ownership of the ConvoCon content (see Figure 3).

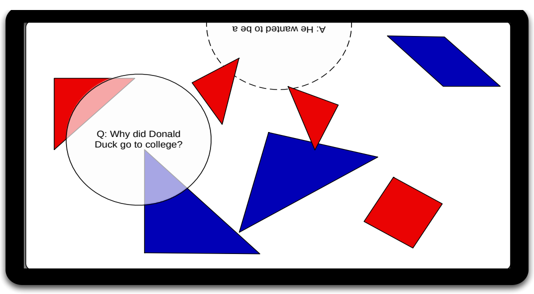


**Figure 3 The layout for the second iteration, with second half indicated as "other" by dotted line.**

While this minor tweak tested slightly better than the solid half-circle, participants were still unlikely to begin discussing the content in the same manner as the co-located groups had in our previous experiment [27]. Furthermore, exit interviews still indicated that participants believed their collaborator shared the same content they did and that there was no difference in terms of the text shown.

Ultimately this design also failed to meet design constraints 3 and 6, but we also observed a failure to meet constraint 4 in some cases where the answer to the joke or riddle was a single word that participants could read upside down.

### Final Iteration

The failure of the second design led us to begin rethinking our approach to making participants aware of their collaborator's privileged information. Instead of displaying the content as solid text, we began to explore the use of varying the opacity of the content as a means of indicating privileged information. With this in mind, we developed three primary designs to test in the pilot phase. Before moving to the pilot phase we ran the mockups of the previous designs and the new mockups by colleagues and several strangers in an attempt to get more feedback on what worked and what did not for each design. Based on informal polling, we decided to eliminate a design in which the primary content fades (see Figure 4).

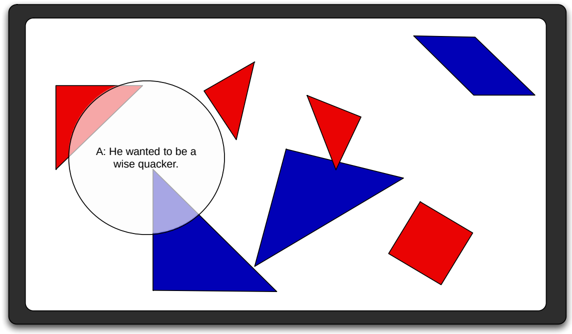


**Figure 4 Stage three design with fading text eliminated via informal polling.**

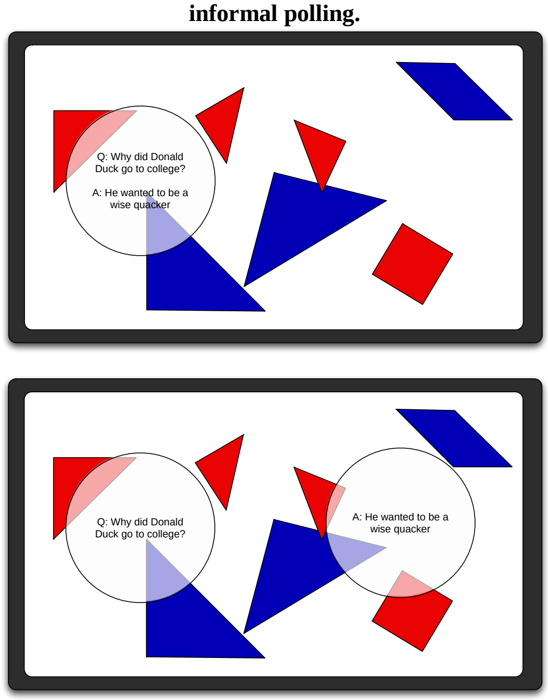


**Figure 5 The new designs evaluated in the pilot studies.**

Figure 5 shows the two new designs that were evaluated in this round. Both of these new designs provide participants with both halves of the information but fade out the information that belongs to their partner. In addition, we explored swapping which piece of information a participant owned—before one person always owned the question half and the other always owned the answer half. In this round, the design where both the question and answer were in the same bubble with the other half faded tested the most successfully and resulted in discussions being prompted.

Exit interviews also indicated that this last design was successful in making participants aware of privileged information, addressing Q1.

This final design (Figure 5, top) satisfied all six design constraints, including constraint number 4 since we found that even with half the characters showing with a single word answer, participants could not easily determine the answer individually.

### Additional Observations

In some cases, it was apparent that one participant noticed the information while the other participant either failed to notice the text or chose to ignore their partner. Failing to notice may be related to research into road signs showing that some individuals do not attend to textual information while working on another task [3].

### Q2 & Q3: Improving Social Affinity

To evaluate the effectiveness of our system in stimulating conversations and improving social affinity between remote collaborators, we first pre-tested 50 participants using the form board test and a subset of Goldberg *et al*'s AB5C personality test [2, 9, 15, 16]. Since the reliability of AB5C is evaluated on each subsection, in addition to the big 5 factors, we chose to only use the aspects of personality relevant to our study, specifically: sociability ($\mu$=2.79; $\sigma$=0.69), creativity ($\mu$=3.46; $\sigma$=0.51), friendliness ($\mu$=3.59; $\sigma$=0.63), leadership ($\mu$=3.40; $\sigma$=0.57), gregariousness ($\mu$=3.21; $\sigma$=0.63), assertiveness ($\mu$=3.68; $\sigma$=0.41), cooperation ($\mu$=3.33; $\sigma$=0.48), and ingenuity ($\mu$=3.80; $\sigma$=0.43). Individuals with high spatial ability and high sociability scores were paired with individuals who scored low to ensure all dyads were balanced on both of these scales. Dyads were then randomly assigned to either the control group or the experimental group and Student T-Tests ($\alpha$=0.05) were run to ensure that no significant difference existed on any personality aspect or on spatial abilities between groups. Effect sizes reported were calculated by dividing the means by the standard deviation. Participants also indicated their previous experience with multitouch systems such as the iPhone (a mean score of 3, $\sigma$=1.05 on a 5-point Likert scale) and computers, and no significant differences appeared between groups on these measures. All participants came from the psychology department's participant pool and had a mean age of 19.6 ($\sigma$=3.09).

### Methods

Having minimized the impact of individual variance affecting the results, we then attempted to schedule participants for the follow-up study to complete the tasks. We faced some difficulty with participants failing to respond for the follow-up study or failing to show up. However, we were still able to successfully run nine control dyads and ten experimental dyads (for a total of 40 participants, a 20% attrition rate). To ensure participants did not meet before the start of the experiment, we had one participant enter the lab on the second floor and the other enter on the first floor. The process of starting requiring mutual touch was done to ensure accuracy of task timing and to make sure both participants were ready to begin the task. Aside from piece movements, participants' touch points were transmitted and displayed as circles on the interface to allow for translucence of action [10].

The researcher simultaneously gave both participants the following instructions via a 3-way Skype audio call: "For the study you will be participating in today, you will be using a multitouch device that allows multiple hand and finger inputs. For this study, you will be working with a person in another location with whom you can communicate through Skype. Please wear the headset at all times. The application you will be working on is a virtual version of tangrams, where there are pieces that you use to complete a puzzle. You will have 5 minutes where you will play with the system and figure out how to manipulate the pieces. After that you will be given the first of three puzzles that you will complete. There is no time limit on the puzzles, so take as much time as you need to complete it to your satisfaction. After all three puzzles are completed, you will have up to 5 minutes to build anything you want with the pieces. When you are ready to begin, you will both need to touch the screen—you can touch and hold until the other person touches his/her screen." Both the control group and the experimental group received these exact instructions. In addition, the term "partner" was specifically avoided in the instructions, as we did not want to reduce the possibility that participants would compete with one another by priming them for collaboration using the term "partner."

Participants had five minutes, or until they were satisfied, to learn how to use the tangram application ("Playtime"). Next, they were given the first of three puzzles with no time limit. Participants worked together to solve a puzzle (with the silhouette of the desired shape shown to both participants) using a shared set of seven pieces. For puzzle tasks, completion was determined when participants successfully filled in the silhouette of the shape they were building (multiple correct solutions existed). While using this networked multitouch tangram application, participants were free to move as many pieces as they chose. If both users touched a piece, the piece changed to orange and would not move until one participant ceded control. After all three puzzles had been completed, the participants were given up to five minutes to create anything they wanted with the pieces ("Freeform") and could stop when they were satisfied with their creation. During all activity, the experimenter was silently present in the 3-way conference call. Participants' audio and touchscreen interactions were recorded as video.

Upon completing all tasks, participants then completed a short exit survey based on Convertino's survey to assess common ground [5]. The exit survey also asked them to rate their prior familiarity with their partner and all participants indicated that their partner had previously been a stranger. The video was categorized based on two overall constructs: the type of **behavior** (9 codes) and type of

**conversation** (16 different codes) using the affinity-coding technique defined by Oren and Gilbert, which has interrater reliability of 90% (Cohen's $k$=.612) for behavioral tags and 90.7% ($k$=.708) for verbal tags [27, 28]. Each five-second block of video received one code related to dyad behavior and one related to dyad conversation. The total number of affinity related blocks were then calculated and divided by the total number of blocks for each task. The overall affinity score is based on two parts: the proportion of affinity conversation and the proportion of affinity behavior (all affinity blocks / all blocks that exhibited some conversation or behavior). Affinity is calculated independently for each task, looking only at the instances of behavioral and verbal affinity in the given task.

## RESULTS

A significant limitation of this study was lost data that arose from network issues and problems with the commercial screen recording software that worked well during pilots. We ultimately had only four control dyads and four experimental dyads (16 participants total) for the detailed video analysis. We excluded the majority of dyads due to empirical evidence suggesting that the affinity of the rejected groups was likely affected by bonding due to network bugs that forced different communication to solve the puzzle. However, some of the groups had to be removed due to simple data loss of network connections preventing communication and recording of conversations. Despite this loss of data, we believe the findings of the detailed video analysis present an accurate view of the overall trend. The dyad compositions were two male-male dyads and two male-female dyads in the control group; with three male-male dyads and one female-female dyad in the experimental group. Participants could identify one another's gender via the voice communication but were unaware of any other traits of their collaborator. No significant differences existed among the demographics or spatial ability between the dyads in the control group and the dyads in the experimental group—this was examined using the Student T-Test both at the dyad unit of analysis and at the individual participant level of analysis. Additionally, no significant difference existed between the dyads where usable data was obtained and the larger sample population.

### Completion Time—Log Data

Some dyads from the full sample are not included in this analysis due to the network issues; below we report results separately from both the full sample data set and the eight dyads where no factors have contaminated the data, the final sample set. The data from the full sample is reported as the results indicate some possible downsides of ConvoCons and are reported here in case they represent a trend that was not statistically significant in the reduced sample due to the small sample size. Including the Playtime and the Freeform task, there was a marginally significant difference ($p$=.08, $r$=.37) between the experimental group (n=7 dyads; $\mu$=27.85 minutes, $\sigma$=4.43) and the control group (n=7 dyads; $\mu$=22.51 minutes, $\sigma$=8.54) when examining the entire sample. Within the final sample, there was no significant difference ($r$=.31) in completion time between the experimental group (n=4 dyads; $\mu$=26.72; $\sigma$=4.44) and the control group (n=4 dyads; $\mu$=21.69; $\sigma$=9.84). Since one concern was that ConvoCons and the incidental conversations might distract groups from the work at hand, we calculated the mean completion time just for the three puzzles to look at just the effects of ConvoCons on work efficiency. Looking at the full sample, there was a marginally significant difference ($p$=.057, $r$=.35) puzzle completion time between the experimental group (n=7; $\mu$=21.62 minutes; $\sigma$=3.14) and the control group (n=7; $\mu$=17.45; $\sigma$=7.35). There was no significant difference ($r$=.31) for the final sample in time spent on the three puzzle tasks between the experimental group (n=4; $\mu$=20.88 minutes; $\sigma$=3.62) and the control group (n=4; $\mu$=16.60 minutes, $\sigma$=8.48). In the full sample, no single task indicated a significant difference in completion time between the experimental and control group. However, Play time was marginally significantly longer ($p$=.066, $r$=.53) when looking at the final sample between the experimental group (n=4; $\mu$=3.11 minutes; $\sigma$=0.91) and the control group (n=4; $\mu$=2.16; $\sigma$=0.59).

### Exit Survey

In the full sample, the experimental group reported significantly higher (experimental $\mu$=4.05; $\sigma$=.39; control $\mu$=3.72; $\sigma$=.75; $p$=0.048; $r$=.27) feelings of "shared task understanding" as well as a marginally significant higher feeling of "role understanding" (experimental $\mu$=3.75; $\sigma$=0.55; control $\mu$=3.39; $\sigma$=0.55; $p$=.063; $r$=.31) with both metrics coming from Convertino's survey on assessing common ground, which utilizes a 5-point Likert scale [5]. All other survey metrics were non-significant.

In the final sample, we analyzed the data on both the individual level as well as comparing on paired dyads. Comparison by dyadic units follows the recommendation of

| Individual | | Time | Amount of Work | Quality | Task 1 | Turns |
|---|---|---|---|---|---|---|
| n=8 | **Experimental** | 3.25 (.71) | 3.75 (.47) | 3.63 (.92) | 3.375 (1.06) | 0.25 (0.46) |
| n=8 | **Control** | 3.75 (.71) | 4.00 (0) | 4.25 (.46) | 4.13 (.64) | 0.75 (0.46) |
| | | $p$=.09 $\mid$ $r$=-.33 | $p$=.074 $\mid$ $r$=-.35 | $p$=.054 $\mid$ $r$=-.39 | $p$=.054 $\mid$ $r$=-.40 | $p$=.024 $\mid$ $r$=-.48 |
| **Dyadic** | | | | | | |
| n=4 | **Experimental** | 3.25 (.29) | 3.75 (.29) | 3.63 (.25) | 3.375 (.85) | 0.25 (0.29) |
| n=4 | **Control** | 3.75 (.29) | 4.00 (0) | 4.25 (.29) | 4.13 (.48) | 0.75 (0.29) |
| | | $p$=.025 $\mid$ $r$=-.65 | $p$=.067 $\mid$ $r$=-.52 | $p$=.008 $\mid$ $r$=-.75 | $p$=.088 $\mid$ $r$=-.48 | $p$=.024 $\mid$ $r$=-.65 |

**Table 1 Exit Survey results indicating the control group self-reported higher on their assessment of time-efficiency, amount of work, quality of work, Task 1 satisfaction, and use of turn-taking strategy.**

| | *Play* | *Task 1* | *Task 2* | *Task 3* | *Freeform* | *Total* |
|---|---|---|---|---|---|---|
| *ConvoCons (n=4)* | 8.25 (6.40) | 8.00 (4.24) | 5.25 (4.27) | 4.50 (.58) | 7.25 (2.99) | 6.65 (1.53) |
| *Control (n=4)* | 0 (0) | 0 (0) | 0.75 (.96) | 1.50 (2.38) | 1.75 (1.26) | 0.80 (.67) |
| *p-Values* | .021 | .005 | .043 | .025 | .007 | <.001 |
| *Effect Size (r)* | .67 | .80 | .59 | .65 | .77 | .93 |

**Table 2 Means and standard deviations of incidental conversations over all tasks indicate a higher frequency in the experimental (ConvoCons) group.**

[22]. In the comparison based on individual units, we found marginally significant differences between the experimental and control group on ratings of time efficiency, amount of work, the quality of work, the satisfaction with their work on Task 1, and self-reported use of the turn-taking strategy (significant) with higher scores in the control group.

### Incidental Conversations

In calculating the frequency of incidental conversations, we did not count all conversational labels that we classified as signs of affinity—only the tags that were not related to work were counted (e.g. "playful conversations" and "talking about partner"). There was a significant difference between the frequency of incidental conversations between groups across all tasks, with a higher frequency count seen in the experimental group. Overall, there was a significant difference between groups thus supporting the idea that ConvoCons increase the frequency of incidental conversations for remote collaborators (see Table 2).

### Affinity Metrics

In reading the following graphs it should be noted that, per the method in Figure 1, ConvoCons typically stopped appearing between the end of Task 1 and the middle of Task 2. In addition, the puzzles used for each task, presented in a consistent order, were intended to go from simplest to solve to hardest to solve. All Student T-Tests were conducted with an $\alpha$=0.05.

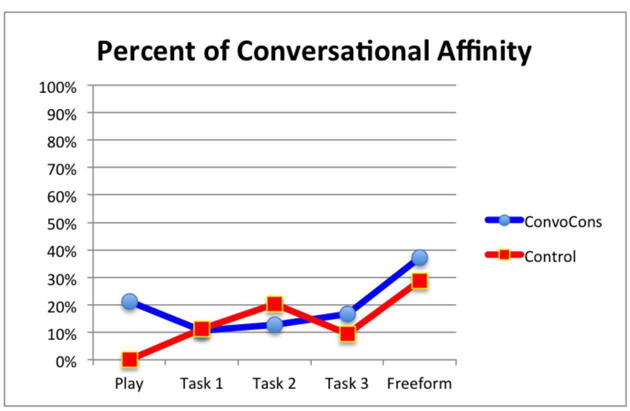


**Figure 6 ConvoCons serve as an early conversation starter for groups and the conversational affinity increases steadily (after an initial drop when switching from play to work).**

Figure 6 presents the percentage of conversational affinity across all tasks. As expected from the literature on ice breakers that providing a shared framework for conversation allowed participants to begin incidental conversations at an early stage, resulting in a 21% increase in conversational affinity which was statistically significant at $p$=.031; $r$=.63. However, outside of Task 3 ($p$=.021; $r$=.52), no statistically significant difference was seen in conversational affinity between the experimental and control groups. Taking the mean across all tasks (not seen in the graph), there was a marginally significant difference ($p$=.097; $r$=.32) between the experimental group with a mean of 17.68% affinity ($\sigma$=6.14%) and the control group with a mean of 13.90% affinity ($\sigma$=5.10%).

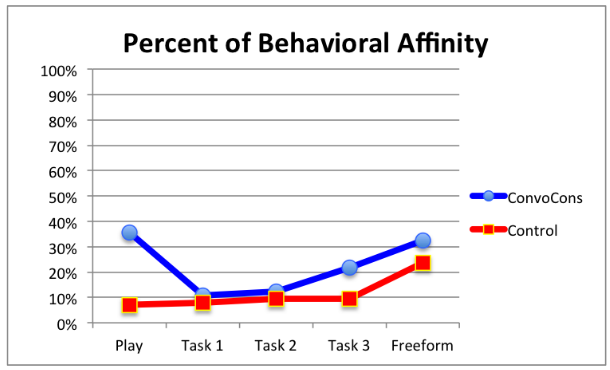


**Figure 7 Behavioral affinity begins almost 30% higher for the experimental group and remains slightly higher during the work tasks (after an initial drop) and ends about 10% higher than the control group.**

Figure 7 shows the measured behavioral affinity across all tasks. To the researchers, this is the more important question since our ultimate goal for ConvoCons is to enable individuals to work with one another in a collaborative manner. One of the more interesting findings in this study is that the experimental group actual began with significantly higher behavioral affinity ($p$=.033; $r$=.62), which stands in contrast to findings from the co-located study [27]. This initially high affinity, which we suggest stems from participants' building on to each other's creative designs during play, falls drastically when the work begins. A statistically significant difference in behavioral affinity is seen again in Task 3 ($p$=.021; $r$=.67). Taking the mean score across all tasks results in a significant difference ($p$=0.013; $r$=.72) between the experimental group with a mean of 22.57% affinity ($\sigma$=7.35%) and the control group with a mean of 11.52% affinity ($\sigma$=1.76%).

Figure 8 displays the composite, overall affinity across all tasks. Playtime and Task 3, both had statistically significant differences between the experimental and control groups ($p$=.003; $r$=.72 and $p$=.002; $r$=.85); additionally, the Freeform task had a marginally significant difference between groups ($p$=0.099; $r$=.46). The mean across all tasks was statistically significant ($p$<0.001; $r$=.94) with the experimental group having a mean of 32.06% affinity (σ=3.90%) compared to a mean of 17.46% affinity (σ=2.33%) for the control group.

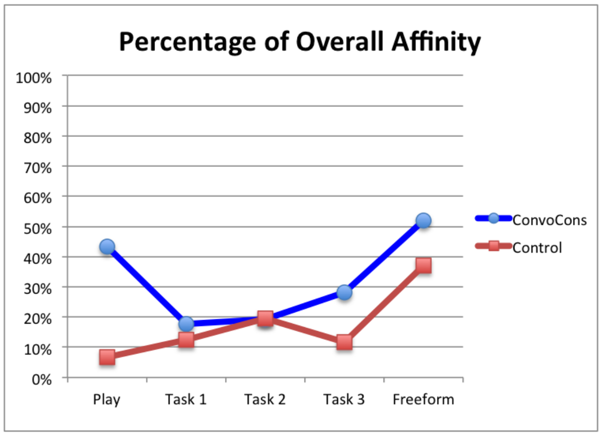


**Figure 8 The experimental group starts out with just over 35% higher affinity, due to the increased conversational and behavioral affinity occurring due to ConvoCons. There is a drastic decrease in affinity when the puzzle tasks begin, but the affinity of the experimental group grows during each task and ends nearly 25% higher than the control group in the Freeform task. Across all tasks there was a mean difference of 14.6% ($p$<0.001; $r$=.94) between the groups.**

## DISCUSSION

Through an iterative design process, we determined some of the basic visual elements that contribute to the discovery of privileged information within an interface. While an additional study still needs to be conducted to ensure that this approach will lead people to share more privileged information, the results of the iterative design process have at least shown the potential for indicating privileged interface information in a subtle way to collaborators. A qualitative assessment also suggested that this design approach will lead to participant conversations about the privileged information, which our previous research has shown leads to participants having more conversations in general (both work and non-work related) without a negative affect on performance as measured by completion time. We suggest that this approach of presenting both halves of privileged information but fading it out can be generalized to other projects needing to promote awareness of privileged information—whether that information is text (such as previous work experience), images (such as a design), or another visual medium.

The large drop in affinity conversation and behavior may be due to participants' switching from play to work. It may be because the play phase, combined with the ConvoCons, served as an icebreaker period and the drop in affinity is similar to the drop seen when moving from icebreakers to actual work. Or, it might be due to a combination of these two factors. There is some evidence that the decrease is related to a change from play to work, however, since the majority of behavioral affinity in the play task came from participants' building off of one another's designs rather than working in close proximity or in cooperative turn taking. Similarly, there is only a very small drop in frequency of incidental conversation from play to the first task, which suggests that the drop in conversational affinity is due to increased work-related conversations.

While the exit survey for the full sample must be considered carefully, the responses do suggest that the ConvoCon group members were able to establish stronger bonds of affinity and form a greater understanding of working with their partners. In looking at the final sample, the results suggest that the control group felt that they were generally more efficient at accomplishing good quality work. There is no evidence that this is true when examining their completion times, although we do see evidence of efficiency in the faster completion times seen in the full sample. However, the finding of groups with higher affinity performing less efficient work is unsurprising as previous research on remote collaboration showed a similar result when comparing videoconferencing to teleconferencing, with videoconferencing still being recommended as a tool to help bond individuals at the first team meeting [7, 8]. While the experimental group is potentially less efficient, there are other potential benefits to increased affinity such as recognizing the strength of collaborators and the build up of social capital that can produce more efficient work over a longer period of time [31].

### Limitations of Findings

Due to the low sample size, some non-significant results may have been found to be significant, had we been able to collect a larger sample. However, as seen from the reported effect sizes, many of the results are medium to large and the most important finding, that overall affinity is higher in the experimental group shows a strong effect (near 1). Some results, such as the significant result for "shared task understanding" in favor of the experimental group, had low effect sizes, though, and should be interpreted cautiously until further evidence is available. It should be noted that the participants from the full sample that were removed from the analysis were interrupted by network lag while working, which led to both longer completion times and bonding over the network frustration. This bonding over technology frustration has been observed in other studies [26, 29]. Due to the difficulty in quantifying that mitigating factor as a covariate in analysis, we excluded the data.

However, one finding that is clear is that control group participants perceived work as more efficient and that work was of higher quality. This lower rating in the experimental group may be due to negative side effects of increased affinity and conversation or to a latent property of the distracting effect of the ConvoCons themselves. In either case, this finding, in combination with longer completion times for the ConvoCon dyads, which was significant in the full sample (although perhaps due to network lag), suggest a cost to efficient work practice when building affinity. Thus, for tasks where efficiency is critical, the use of a solution similar to ConvoCons may be ill-advised. In creative tasks where efficiency is less critical and affinity bonds are necessary for productive collaboration, a similar approach may help distributed teams function better.

### Implications for Practitioners

While the results presented above derived from a controlled experiment, the findings from both the design of interfaces for privileged information and building affinity can be generalized for practitioner use. First, in the case of interfaces where collaborators will necessarily require different information being displayed based on their expertise, such as the ad-hoc teams created to respond to national disasters, other users should be given some indication of information that they do not have. We have shown several approaches to this indicator. Showing a portion and fading the remaining information appeared to be most effective.

Also, while the tangrams task is fairly simplistic, the work involves a high cognitive load. This may partially explain the slowdown in work observed from the study, while tasks that require lower cognitive load may see a smaller delay from the conversational intervention. These conjectures, however, will require additional studies for confirmation.

While the results varied in significance and tended toward medium effect sizes for building affinity, the large effect size ($r$=.93) of the overall affinity across all tasks does provide strong evidence that subtle interface manipulations can successfully increase social affinity among team members. Furthermore, the particularly large gap in initial affinity provides support that such manipulation might be most effective at the onset of remote collaboration. Integrating subtle user interface elements into remote meeting software may help teams build the initial affinity they need without the expense of expensive site visits or time-consuming ice breakers. While there is evidence that use of user interface elements may also come with a cost in increased time, further research is needed to determine if the affinity bonds formed during work are more stable than those formed through pre-work icebreakers and perhaps worth the relative costs in time.

## CONCLUSION

We have presented the design of user interface elements to encourage awareness of privileged information and in future work, we plan to test whether or not increased awareness of privileged information within the user interface will increase sharing of privileged information given to participants prior to the start of the study. One element of the design that needs to be improved in the future is the inclusion of both graphical and textual information to increase the salience of indicators and reduce the possibility of one individual's ignoring the information while the other attends to it.

Despite the aforementioned limitation, the results of this study do suggest that ConvoCons can be used to increase incidental conversation. Additionally, there is evidence that ConvoCons have an initial impact on conversational and behavioral affinity as well as a significant effect on overall affinity. We believe that the aforementioned change to the system, which may increase awareness of the ConvoCons, will result in heightened effectiveness of ConvoCons in terms of increasing conversations and all affinity metrics.

Finally, as the results of this study also indicated that the affinity bonds associated with ConvoCons may decrease work efficiency, we plan to conduct future work that attempts to decrease affinity bonds to improve efficiency. We hope that over time we can categorize the optimal range of affinity for various types of tasks.

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