

Leveraging Affective Friction to Improve Online Creative Collaboration: an Experimental Design

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Abstract. Emotional contagion is a pillar of social interaction. As such, it has immense potential to facilitate communication and improve collaboration. In the context of remote collaboration, it is especially important that working partners can build trust and a sense of cohesion. While digital capabilities may complicate socio-affective communication, we argue that some capabilities are better able to support processes of affective alignment. We define affective friction as an affective misalignment between workgroup members that may result in diverging affective responses to shared experiences. We propose that affective friction is a central element of affective alignment and a driving force of creative collaboration. As a result, the capacity of a medium to make affective friction perceptible to working partners is essential for successful remote collaboration. We suggest a two-stage experimental design to test our hypotheses.

Keywords: online collaboration · emotional contagion · affective friction · media richness · social presence · media synchronicity · media naturalness

1 Introduction

Advances in technology have enabled the rise of communication technology that has transformed the way people work together. More recently, the COVID-19 pandemic precipitated this transition. As we come out of the emergency response of the corporate world, many organizations are shifting towards hybrid work arrangements with a substantial part of work tasks being conducted online. Academic research needs to support this transition and offer frameworks to optimize and sustain it. Importantly, employees find it challenging to feel a sense of cohesion and community while sitting in different spaces than their colleagues [1–3]. Essential attributes of collaboration like cooperativeness [4] or trustworthiness [5] rely heavily on cues that are naturally present in face-to-face settings. Rich media are those that support the exchange of cues that are most similar to face-to-face (e.g., video-conference), including characteristics such as immediate feedback, personalness, etc. [6–8]. They enable parties to communicate great amounts of affective cues [9] and have traditionally been associated with allowing the effective exchange of equivocal information [6, 7]. Leaner media, on the other hand, are less personal (e.g., e-mail) and provide less support for affective cues [8]. They are usually associated with the effective communication of non-equivocal information [6, 7]. As lean media struggle

to render some of these affective cues, they can inhibit social connection [10] and make social interaction and relationship-building more difficult. Because trust and shared meaning are fundamental to successful collaboration [11, 12], it is important to overcome these challenges and support social connection even during online interaction. Emotional contagion is a primitive mechanism that facilitates effective communication, helping people experience closeness and social connection [13, 14]. This suggests that hindered emotional contagion could be a contributing factor to some of the negative interpersonal experiences of remote collaboration. In this study, we propose an experimental design to analyze how affective alignment between remote work partners impacts their collaborative outcomes and to understand how different media affect the relationship between affective alignment and collaborative outcomes.

2 Theoretical Development

As working partners engage in a collaborative task remotely, they are likely to be in different moods from foregoing events and experiences [15, 16]. These assorted affective states create *affective friction* between the partners (i.e., an affective misalignment between workgroup members that may result in diverging affective responses to shared experiences), leading to miscommunication, hindered collective strategies, and interpretation discrepancies [17]. The digital nature of collaboration media can make it more challenging for partners to notice the friction [18]. Thus, the ability to recognize affective friction relies on a medium’s capability to render assorted affective states. We expect that *affective media*, those traditionally considered to make mediated interaction feel “unmediated” [19] and often associated with high levels of social presence [19], richness [6], synchronicity [20], and naturalness [21], are particularly suited to affective communication and thus more likely to make affective friction perceptible. On the other hand, *non-affective media* tend to muffle them, because they offer limited capability to render users’ core affect.

P1. Media affectivity increases perceived affective friction.

Affective friction is likely to result in repeated instances of unpleasant experiences (e.g., disagreements, misunderstandings, misjudgments, etc.) [17]. A well-documented phenomenon known as the “sensitization hypothesis” posits that repeated exposure to interparental conflict have a strong negative impact on children’s long-term conflict appraisal, and results in increased negative emotionality, exacerbated perception of conflicts, and overall heightened sensitization to conflicts [22–26]. While empirical evidence of the phenomenon has been constrained to parent-children relationships and child-adolescent age ranges, we argue that repeated exposure to symptomatic affective friction is likely to have similar effects for adult work relationships. As tension resulting from affective friction accumulates, colleagues may start noticing the friction and its effects, and become more sensitive to it. In doing so, they start paying increased attention to their diverging perceptions and ideas – we call this process *affective transitioning* (i.e., the formulation and communication

of non-congruent core affect among team members that increase perceived affective friction).

P2. Affective transitioning increases perceived affective friction, and perceived affective friction feeds affective transitioning.

As working partners experience *affective transitioning*, they are likely to open themselves to new and conflicting perspectives, resulting in divergent thinking, which “allows one to explore in different directions from the initial problem state, in order to discover many possible ideas and idea combinations that may serve as solutions” [27]. This process is generative, as new possibilities and suggested compromises act as “probes” that force individuals to confront their differences and reconsider what is essential [28]. It encourages team members to reconsider past decisions and new possibilities in light of new information and uncertainties [29].

P3. Affective transitioning improves performance in divergent-thinking tasks.

A fundamental next step for success is that working partners engage in *affective harmonizing*. Noticing the efforts made during the *affective transitioning* phase and its potential successful outcomes creates a positive feedback loop that fuels *convergent thinking* [30–32]. At this stage, working partners are likely to be motivated to resolve their affective friction and may start engaging in socio-affective interaction to create a sense of collectivity (e.g., help-seeking/giving, reinforcing, etc. [33]). In doing so, working partners may start experiencing matching affective reactions. Importantly, having gone through *transitioning* before *harmonizing* prevents the group from suffering the pitfalls of groupthink (i.e., a mode of thinking where a team’s desire to reach unanimity overpowers their ability and motivation to seek the best possible outcome instead of the most consensual one) [32]. Groupthink is likely to occur when a team has elevated perceived collective efficacy. The lack of friction within a group is thus likely to result in elevated perceived collective efficacy, which is a risk factor for groupthink [32]. When a team engages in *harmonizing*, the propensity to think alike and the motivation to reach a consensus may jeopardize the quality of the outcome. However, if the team has gone through *transitioning* first, it is predisposed to better assess the situation and not let its decisions be impacted by in-group pressures.

P4. Affective harmonizing improves performance in convergent-thinking tasks when it is preceded by affective transitioning.

3 Material and Method

We suggest a two-phase experimental approach: Study I aims at testing whether affective friction explains creative and collaborative performance through a combination of affective processes, and Study II aims at testing whether the affectivity of the medium moderates this effect.

The task. Participants take part in an online collaborative creative task [34] based on the following scenario: *after two years of remote teaching due to the COVID-19 pandemic, the colleges of a university located on the West Coast of the United States decide to join forces to welcome students and staff back on campus. The university organizes a large-scale competition to find the best solution to the following challenge: how might we strengthen our university community, as campus reopens, with solutions that reconnect people and enhance collective wellbeing, teaching, and learning?* This scenario is based on a real challenge that was posted on openIDEO.org, an online platform that leverages crowdsourcing to foster open innovation. Using a real-life challenge strengthens its relevance, timeliness, and concreteness. Placing the challenge in a local university further increases personal relevance and self-efficacy for the participants [35].

The task is divided into two sub-activities. For the *first activity*, participants are given 15 minutes to brainstorm and come up with as many creative ideas [34] as possible to address the challenge. They are informed they will be evaluated both on the number of ideas and the creativity of each idea. For the *second activity*, participants are given 10 minutes to agree on one idea they agree is the best overall. Similar studies typically provide 15 minutes for brainstorming and 10-15 minutes for idea selection [34–37].

Data Collection. All interactions will be recorded (video, audio, and text) for both studies using COBALT CAPTURE [38] to obtain facial expression, tone, speech and log data, and additional physiological data will be recorded for Study II (COBALT BLUEBOX for EDA and EKG [39] and Tobii Pro X3 120 eye tracker).

Measures and Instruments. *Affective Friction* is measured through a Perceived Affective Friction questionnaire designed by the author for the purpose of this study (PAF). *Affective Processes* are measured through physiological synchrony. *Divergent thinking* is operationalized as the first activity of the task (brainstorm) and its *Performance* is measured based on common creativity evaluation techniques (quantity, originality, and paradigm relatedness of the ideas generated [34, 40, 41]) and self-reports of perceived group creativity (PGC) [42, 43]. *Convergent thinking* is operationalized through the second activity of the task (idea selection) [35] and its *Performance* is determined based on a blind assessment of the selected ideas conducted by two external evaluators selected for their subject-matter expertise (i.e., pedagogical professionals who are likely to make this kind of decision in a real-life situation), and a cognitive group consensus (CGC) questionnaire [43, 44]. In addition, overall *Performance* includes related measures of team processes using self-reporting of collaboration quality [43, 45], team performance [46], personal success [46], satisfaction [47] (TP). See Table 1 for a full overview.

Table 1. Overview of measures and instruments

Type	Description
Physiological	Cardiac activity (ECG)
Physiological	Electrodermal activity (EDA)

Behavioral	Eye gaze
Behavioral	Facial expression
Self-report	Affective state: PANAS [48]
Self-report	Cognitive group consensus (CGC) [43, 44]
Self-report	Team processes (TP): Collaboration quality [43, 45], Personal success [46], Team performance [46], Satisfaction [47], Perceived group creativity [42, 43], Team performance [46]
Self-report	Perceived Affective Friction (developed by author)
Evaluation	Idea quality: external assessment by recruited panel of experts
Evaluation	Idea creativity: quantity, originality, and paradigm relatedness [34, 40, 41]

3.1 Study I

Participants. The experiment uses a one-factor, between-subjects design (see Table 2), with the independent variable being *Affective Processes*. We will recruit 80 participants who will each collaborate with a confederate actor, making for 20 dyads per condition. To prevent fatigue and reduce the risk of carryover effects, 8 different actors will be recruited and randomly assigned across conditions.

Confederate. In natural settings, dyads may need multiple interactions over longer periods of time to start noticing dysfunctions. In addition, some people might be uncomfortable sharing affective displays in the presence of strangers and/or an experimenter. This type of confounds can be controlled for but not manipulated, and are likely to introduce variance when it comes to perceived affective friction. In this study, we suggest inducing artificial and perceptible affective friction with the help of a confederate actor. While controlled collaboration commonly uses conversational agents [50–54], the use of a human agent is preferred for this study given the complexity and dynamism of socio-affective interaction. Although uncommon, using an actor as a confederate is a promising method that has yielded unique insights in prior experimental research on collaborative behavior [49, 55].

Each participant will be paired with an actor, thinking they are being paired with another participant. The confederate is a trained actor with good improvisation skills and elevated emotional intelligence [56]. Additional training (including partial scripts, instructions on verbal and non-verbal affective cues to display, and a sample of pre-determined solutions to the challenge) will be provided to ensure the actor can stick to their role under various circumstances. These instructions will be carefully crafted to ensure symmetrical cognitive stimulation across dyads.

Table 2. Conditions of Study I

Condition	Part 1 (brainstorm)	Part 2 (evaluation & selection)
TH	Affective transitioning	Affective harmonizing
TT	Affective transitioning	Affective transitioning

HH	Affective harmonizing	Affective harmonizing
HT	Affective harmonizing	Affective transitioning

Conditions. The *Affective Processes* vary on four levels and rely on *Affective Transitioning* and *Affective Harmonizing*. In *Affective Transitioning*, the confederate actor manifests evident divergences from their partner both in terms of affective cues and idea generation. In *Affective Harmonizing*, the actor manifests convergence with their partner. The conditions vary in the alternating of each of these processes for each of the two activities in the task through various combinations (e.g., *Affective Transitioning* during brainstorming followed by *Affective Harmonizing* during idea selection). All interactions occur through video conferencing on Zoom (with the possibility to use embedded emoji reactions), and the partners can always see and hear each other, as well as see a shared Google Document where both partners record their ideas. Table 3 describes the hypotheses and measures for Study I.

Table 3. Hypotheses of Study I

Hypotheses	Measures
H1. Affective transitioning increases perceived affective friction.	PAF questionnaire
H2. Affective harmonizing decreases perceived affective frictions.	PAF questionnaire
H3. TH will yield the best performance.	PGC, CGC, TP, experts

3.2 Study II

Participants. The experiment uses a 2 (media affectivity: high vs. low) x 2 (affective friction: high vs. low) between-subjects design. We will recruit 200 participants, resulting in 100 collaborative dyads in total or 25 per condition (see Table 4).

Conditions. Dyads will either communicate using a *High Affectivity Medium* (Zoom video conference) or a *Low Affectivity Medium* (Zoom chat with camera and microphones turned off). Their screen will be split between their interaction medium and a Google Document where they can both contribute. Prior to starting the collaborative task, participants will take part in a mood induction pre-task. Participants will either play an intentionally buggy Pac-man game (f-pacman) [57, 58] or a regular Pac-man game (r-pacman) for 5 minutes. They will be told that we are interested in player performance while wearing non-intrusive sensors. After the game, they are asked to write down their thoughts about the game in a few sentences. 50 of the dyads will experience the *High Affective Friction* condition (within each dyad, one participant plays the control game and the other plays the frustrating game, by random assignment). The remaining 50 experience the *Low Affective Friction* condition (within each dyad, both participants play the same game – either the control or the frustrating version, by random assignment).

Table 4. Conditions of Study II

Condition	Affective Friction	Media Affectivity
HH	High (f-pacman, r-pacman)	High (Zoom)
HL	High (f-pacman, r-pacman)	Low (Chat)
LH	Low (r-pacman, r-pacman OR f-pacman, f-pacman)	High (Zoom)
LL	Low (r-pacman, r-pacman OR f-pacman, f-pacman)	Low (Chat)

Mood Manipulation. Each version of the game (f-pacman and r-pacman) was pre-tested by subjects recruited through Amazon Mechanical Turk, a web service that coordinates demand and supply for a variety of tasks that requires human intelligence. Once the MTurk workers accepted the task, they were taken to a Qualtrics survey. The participants’ baseline mood was measured through self-report using the PANAS scale prior to starting the task [48]. They were then redirected to the Pac-man game¹ which they played for 5 minutes. Once the 5 minutes were up, the participants were asked to return to the main survey, where they answered an open-ended question (“Please write down any thoughts you had about the game you just played”) and the PANAS scale again, as a manipulation check. We controlled for game completion using an embedded timer as well as a completion code disclosed after 5 minutes of playtime and included an attention check to further maximize the quality of the responses.

Physiological Analysis Strategy. To test Study II hypotheses (See Table 5), we propose *Affective Processes* as a measure of affective instability (*transitioning*) and stabilization (*harmonizing*) over a time period. This concept is closely related to the concepts of physiological synchrony, often referred to as physiological linkage or compliance [e.g., 59–61]. The physiological data of each participant is recorded using the COBALT Bluebox, which uses a system of LED signals to synchronize the recordings of the screen, camera, audio, cardiac and electrodermal activity within each participant. Cardiac activity will be recorded through 2 electrodes positioned on the upper chest of the participants and 1 electrode on the left lower rib. Electrodermal activity will be recorded through 2 electrodes placed on the non-dominant hand of the participant and secured with a hand-glove and wristband. For each dyad, we plan to time-synchronize the data by sending a parallel trigger to both devices at the beginning of each collaborative task. Within each dyad, we will use a set of analytical techniques to measure physiological synchrony, including cross-correlation [59–63], coherence, cross-recurrence and delayed coincidence count [61, 64]. We will further augment our findings by analyzing gaze data, which have been associated to affective expressions and intimacy [65, 66]. Prior to the experiment, hotspots will be predefined on the participants’ face (Zoom), conversation (Chat), and shared document. Using gaze overlap signals [67, 68], we will measure shared and mutual gaze (when both participants look at the same area of the screen or when they look at

¹ GitHub repositories: <https://github.com/maxkonrad/frustrating-pacman>,
<https://github.com/maxkonrad/regular-pacman>.

each other through the video). Finally, we will analyze speech and voice tone data to look for evidence of vocal mimicry [69].

Table 5. Hypotheses of Study II

Hypotheses	Measures
H1. Perceived affective friction will be highest in HH.	PAF questionnaire
H2. HH will yield the best performance.	PGC, CGC, TP, experts
H3. Affective processes moderate this relationship.	Cardiac activity, EDA, gaze

4 Preliminary Findings

Mood Induction Pre-tasks. First, we test the mood induction pre-task. 83 subjects (46 for f-pacman and 37 for r-pacman) were recruited for the pre-test. The selection criteria were based on MTurk quality criteria (master’s qualification and at least 100 completed tasks with an approval rate above 95%) and having at least obtained a US High School diploma.

Based on our attention and completion checks, we dropped 6 responses for the regular version ($n = 31$), and 2 responses for the frustrating version ($n = 44$).

F-pacman. We operationalized “frustration” using 3 items of the PANAS scale (“hostile”, “irritable”, and “upset”), and the value for Cronbach’s Alpha for the frustration construct was $\alpha = .87$. D’Agostino and Pearson’s test and the Shapiro-Wilk test (using SciPy [70]) both rejected the null hypothesis that our data comes from a normal distribution. Consequently, we tested our hypothesis (H_a : *frustration scores are greater post-treatment*) using a Wilcoxon signed-rank test, which is considered to be the non-parametric equivalent of the paired T-test [71] using the Python package Pinguin [72]. The difference between the pre and post-treatment levels of frustration was significant ($W = 46.5$, $p < .0001$, with a right-tailed alternative). We report a matched pairs rank-biserial correlation of $r = -.834$ [73] and a common language effect size of $CL = .697$ [74, 75], indicating that most of our participants reported feeling more frustrated after playing the game. The difference in median frustration pre/post-treatment is shown in Figure 1.

R-pacman. To verify the absence of a frustrating effect in our regular Pac-man, we applied the same statistical tests as the frustrating condition, albeit we used a two-sided hypothesis (H_0 : *the median of differences between pre and post-treatment is 0*). The difference between the pre and post-treatment levels of frustration was non-significant ($W = 23$, $p = .68$, with a two-sided alternative). We thus accept the null hypothesis that there is no significant difference between the pre and post-treatment frustration levels of the participants for the r-pacman.

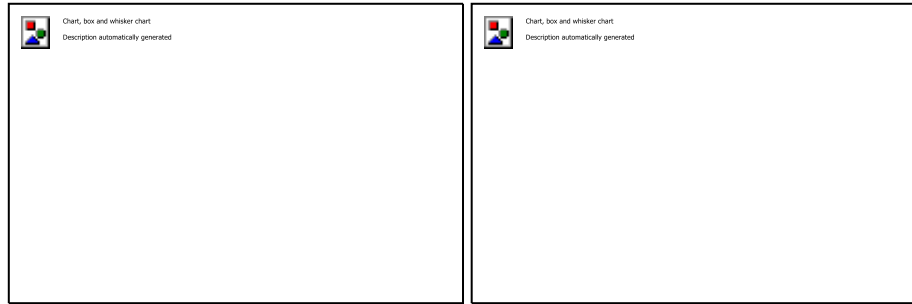


Fig. 1: Box-plot of self-reported frustration before and after playing the game (5-point Likert scale, frustration being the mean of the scores for “hostile”, “irritable”, and “upset”). The left box-plot shows the results for f-pacman ($p < .0001$), the right box-plot shows the results for the r-pacman ($p = .68$).

5 Expected Contributions and Conclusion

The suggested experimental design compares different combinations of affective processes to understand their impact on a creative task’s outcome. Importantly, this work addresses questions that are fundamental in the post-pandemic corporate world. It explores how medium affectivity impacts the perception of affective friction among team members and subsequently results in differentiated affective processes that improve or worsen collaborative outcomes. This is an important avenue for improving team processes and management in the context of increased hybrid and remote work arrangements. Moreover, psychophysiological data have been under-represented as a method to capture emotional alignment during online creative collaboration. Capturing and measuring affective friction and processes would constitute an important methodological contribution to the field of NeuroIS. Moreover, the use of an online Pac-man game is compatible with online experiments, allowing other researchers to design experiments that can be conducted remotely. Finally, while using a confederate actor is common in experimental research, it is rare to use an actor for a collaborative task – especially in studies about affective processes. The success of this study would thus democratize the use of confederate actors in research on team processes and online collaboration, potentially opening a wealth of much-needed research in the context of a complete re-invention of work relationships.

Acknowledgments. This research is partially funded by a Carlsberg Foundation Young Researcher Fellowship awarded to Rob Gleasure, with the title “Mood synchronicity, collaboration media, and task outcomes”. I also thank Rob for his clever ideas and valuable feedback, the COBALT team at the HEC Montreal Tech3Lab for providing the hardware and software used in this study, Brian N. Huh for coordinating the practical aspects of the study and facilitating access to the Behavioral Research Lab at the Marshall School of Business (USC), and Furkan Selek for developing f-pacman and r-pacman.

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