

“SILENT PARTNERS” OF HIGH-PERFORMING LEAN CONSTRUCTION TEAMS: OXYTOCIN AND HEART RATE

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ABSTRACT

The neurobiological factors oxytocin and heart rate in high-performing lean construction teams are introduced alongside human relational elements, including trust, empathy, collaboration, and psychological safety. Researched heavily in traditional business organizations, to date no studies have looked at neurobiological factors in high-performing teams in the integrated project delivery (IPD) and collaborative project delivery (CPD) realms. The unique qualities of IPD/CPD design–construction teams, and the tools and interactions used, are compared with traditional business teams, which have been cultivated over years, versus IPD/CPD team cultures, which are established within weeks, but are expected to perform at comparatively high levels. The intent of this paper is to show, conceptually, how lean design–construction of large commercial projects could potentially benefit from future studies that measure neurobiological factors such as oxytocin and heart rate. An in-process lean construction observational study demonstrates how two neurobiological factors, the “silent partners” oxytocin and heart rate, can be evaluated in IPD/CPD teams. The discussion provides a strong conceptual basis for future research of IPD/CPD design–construction teams that could result in real-time data, biometrics, and returns on investments on different tools used that allow practitioners to achieve better team coaching and leadership, improving overall project success.

KEYWORDS

Communication, trust, psychological safety, oxytocin, theory.

INTRODUCTION

This conceptual paper was born from a literature review, described throughout the paper, of how neurobiology correlates to traditional and integrated project delivery (IPD) and collaborative project delivery (CPD) high-performing teams. The overriding question was: Could neurobiological factors examined in traditional teams be measured in real time in IPD/CPD teams to enhance project success? Subsequent questions included: How much research has been conducted in terms of neurobiological factors in IPD/CPD teams? Are there any studies of this topic in the lean literature?

When one examines the composition of IPD/CPD design–construction teams, there are key differences from traditional business organizations. Herein, a CPD team is defined as a project working group that follows the collaborative principles of an IPD team, but is not bound to an official IPD contract, such as a multiparty agreement or an integrated form of agreement (Lean Construction Institute, 2025a). IPD/CPD teams establish lean management philosophies, including ways (a) to increase efficiency by addressing quality, speed, and costs; (b) to eliminate waste and unevenness; and (c) to identify process improvements, all which have been

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refined in the well-known Toyota Production System (Aij & Teunissen, 2017). Structured lean teams consist of three main parties (owners, contractors, and architects) in addition to engineers and design-assist partners (Ashcraft, 2011). These coalitions, with a range of diverse business cultures fostered previously elsewhere, are expected to integrate quickly into a brand-new project team culture. From the onset, a newly formed project team is responsible for making a broad range of decisions with regard to design, construction, and overall feasibility while the project moves actively through preconceived timelines, deadlines, and approvals from all stakeholders.

Traits of high-performing teams in traditional business organizations that are also valued in lean construction teams include social capital aspects and drivers such as connectedness, recognition/acknowledgment, encouragement, learning and growth potential, psychological safety, empowerment, spirit of cooperation, and the opportunity to share ideas. Everyone, including senior leaders and managers, human resource personnel, and employees are responsible for understanding others' roles, values, and perspectives, fostering empathy, trust, and accountability, thus increasing productivity and effective communication that is clear and transparent (Hart, 2023).

Teams within traditional high-performing business operations have member relationships that have been established and honed for years. Trust, connectedness, and a host of other factors are proven based on team member associations. Yet, this is not the case with IPD/CPD teams, which are assembled quickly and may include team players from different organizations, all of whom are expected to function effectively as a cohesive team without any history of working together.

The challenge begins when we are required to establish an IPD/CPD team culture within a 3- to 4-week period. While fulfilling the demands of an actively developing project, we must prepare contracts and communication plans; implement onboarding protocols, team rosters, schedules, and budgets; and set meeting cadences concomitantly. Basically, we launch a new team culture while the “plane is in flight.” However, and more importantly, we must cultivate prosocial factors: a culture that is based on trust, empathy, cooperation, psychological safety, and openness among a new team. And we do this by using effective coaching and lean tools.

Experienced coaches demonstrate mentorship, transparency, compassion, and clear communication. They listen to team members' contributions and opinions, they recognize the value that each person brings to the team, and they create an environment of trust and psychological safety (Ashcraft, 2011). Coaches encourage leaders to be empathetic and vulnerable in order to drive team innovation, performance, and effective collaboration (Power, 2024). When led with these traits, all participants could begin to experience the prosocial and neurobiological factors set to flourish within the project team. “Neurobiological factors encompass [everything] from genes to brain structure and function including psychophysiological factors such as heart rate, skin conductance, hormones, and neurotransmitters” (Kempes, 2023, n.p.). Oxytocin and dopamine are both neurotransmitters that are released in response to social interactions (Petersson & Uvnäs-Moberg, 2024), which are explored later through the lens of IPD/CPD teams.

In addition to experienced coaching, IPD/CPD teams incorporate lean tools and practices such as onboarding, component teams, big rooms, swarms, daily huddles, colocation, target value delivery (TVD), last planner system, pull and takt planning, A3s, and more (Lean Construction Institute, 2025b). Another tool embraced by these teams is a project communications framework that places communications on equivalent footing with other primary subsystems: “the big four” (financial, scheduling, quality, and life safety) (Kaufman et al., 2025).

The goal is to encourage face-to-face interactions during which information is shared openly to solve challenging problems in an environment that promotes prosocial behaviors. These

direct interactions affect oxytocin and heart rate (to name just two neurobiological factors), which have been studied extensively in members of traditional high-performance business teams. For example, one of these studies (Zak, 2017) examined oxytocin and dopamine, the ways in which the brain synthesizes them, and their reciprocal effects on trust and empathy within a team. Another study (Sharika et al., 2024) examined consensus decision making (a social engagement), which may stimulate coregulated physiological responses such as interpersonal heart rate synchronization. To date, however, no studies of neurobiological factors and the effect they have on IPD/CPD teams have been published.

Moving forward, the “silent partners” oxytocin and heart rate, and how they relate to IPD/CPD teams, are described theoretically. Established data on these neurobiological factors are not present in the design–construction industry. To rectify this situation, an observational study of how these factors could affect IPD/CPD teams was begun—and is still in process. The aim of this conceptual study is to test the hypothesis that biometrics are present, and can be measured in real time in IPD/CPD team members, thus offering future opportunities for study.

OXYTOCIN

In 2018, there were nearly 25,000 publications related to oxytocin and its effects on neuro- and psychobiology that range from maternal instincts and bonding to varying impacts on the human brain and body, and assorted aspects of human relations (Jurek & Neumann, 2018). A search of the PubMed database in 2025 returned almost 33,000 citations, highlighting the burgeoning interest in the effect of oxytocin in humans.

Oxytocin is linked to prosociality, empathy, and consolation. It enhances in-group conformity and facial mimicry; increases behavioral coordination; and improves memory and learning from feedback (Zhang et al., 2019). “One of the most highly publicized effects of [oxytocin] is its role in trust” (Evans et al., 2014, p. 72). In addition, it has been associated with “awe felt for morally courageous and kind acts” (Monroy & Keltner, 2022, p. 310), and with “anti-stress effects that induce a feeling of safety and support the approach behaviors required for bonding” (Feldman, 2012, p. 382).

When researchers examine oxytocin, specifically its role in team dynamics, leadership, and performance, they begin to see effective insights from neuroscience. The neurochemical oxytocin is a key neurological signal for trustworthiness, and it activates regions of the brain network that make people more empathetic (Zak, 2018). Called “the moral molecule,” when released, oxytocin causes people to treat each other well. High-performance organizations with a culture of increased interpersonal trust have highly motivated employees and, objectively, perform better (Zak, 2017).

Zak’s noted studies (Zak, 2017, 2018, 2022) consist of taking blood samples before and after diverse types of social interactions during experiments in the laboratory and at numerous field sites around the world. Other field site measurements have been acquired during studies of tribal rituals, movements, and dances such as the haka, a traditional Māori war dance performed by the New Zealand rugby team, the All Blacks, before each game. This dance of strength and power has synchronized movements and rigorous chants intended to intimidate opponents. However, it is the camaraderie of the dancers that induces and strengthens emotional and intragroup bonds, which produce significant performance benefits (von Zimmermann & Richardson, 2016). Such rituals influence the release of oxytocin, which promotes cognitive, motivational, and behavioral tendencies that are beneficial to the groups within which humans operate and upon which they depend for survival and prosperity (Ten Velden et al., 2014).

Although not exactly a Māori war dance, ritual gatherings created in a recently coached CPD team (the in-process observational study noted earlier) are listed in Table 1. The continuous nature of team member collaboration to align design–construction decisions week after week builds a shared culture and fosters positive relationships. These gatherings are just

one theoretical example of how social behavior and neurobiology could make IPD/CPD teams unique. The activities in Table 1 allow team members to expand their energy, effort, and creativity in support of objectives, which could in turn increase prosocial behavior.

Table 1: gatherings on a recently coached CPD team

Component Team Meetings	Cadence/Duration (min)	Average No. of Attendees	Virtual or In-person
TVD/risk and opportunity log review	Weekly/30–45	4	Virtual
Design	Weekly/60–90	14	Virtual
Mechanical/electrical	Weekly/30–45	8	Virtual
Schedule	Weekly/60	7	Virtual
Structural	Weekly/60–90	14	Virtual
Enclosure	Weekly/60–90	12	Virtual
Core group	Weekly/60–90	8	Virtual
Big room	Weekly, biweekly/90	25	Both
In-person swarms	Monthly/60	25	In person
BIM coordination	Weekly/60	8	Virtual

IPD/CPD teams strive to avoid siloed work, which is when team members work in isolation. Instead, they share incomplete information often, in facilitated, open discussions (Cruikshank, 2019). There are no wrong questions, and quieter individuals have found their voice in these truly collaborative environments. Kaufman et al. (2025) expand on the organizational structure of IPD/CPD teams:

“Contrasted with the more traditional, hierarchical pyramid of authority and information flow, the IPD approach to communications is deterministically concentric and organized in a manner akin to a heliocentric orbital structure. Information flows between and among teams and individuals working within specified spheres of influence in the overall project” (p. 7).

We begin to see how the establishment of these lean teams mirrors studies of traditional business cultures that perform well. Zak (2018) noted that when leadership and organizational culture are aligned, they promote the opportunity for oxytocin to be released. He created the acronym OXYTOCIN—“Ovation, eXpectation, Yield, Transfer, Openness, Caring, Invest, and Natural” (p. 48)—to remember the eight factors for building a high-trust environment.

Table 2 and Figure 1 show, numerically and figuratively, the raw data from one health survey conducted by observational study members that embodies some of the organizational and leadership practices noted previously. Thus far, team members on the current project have completed multiple surveys during the design and preconstruction stages of an ~13,470-m² four-story medical office building and cancer center, and an ~22,249-m² four-story parking structure, both of which will be added to an existing hospital. The health survey is an eight-item, Likert-scale instrument designed to assess conditions of satisfaction among project team members. The survey continues to be administered during the monthly team big-room meeting, during which project team members are asked to complete the survey prior to resuming their work for the day. The raw data are collected and aggregated, then presented to the team during the next big room to facilitate discussion and reflection. Team members are provided with both the distribution of scores and the average, along with a contextualization of current averages

with past trends. Project participants include the owners of the hospital, architects, engineers (mechanical, electrical, plumbing; civil; structural; landscape; garage), a general contractor, and eight design–assist partners.

Table 2: Survey results from a CPD team and their conceptual relationship to oxytocin

Original Factor Statement (Conceptual Relationship to OXYTOCIN)	Survey Dates and Avg. Factor Scores (1 pt = Strongly Disagree; 5 pt = Strongly Agree)				
	15 Oct 24	21 Jan 25	19 Mar 25	24 Jun 25	16 Sep 25
There is effective communication among all team members. (eXpectation, Openness)	4.24	3.94	4.17	4.22	4.14
Concerns and problems are acknowledged. (Yield)	3.95	3.53	3.89	3.91	3.91
Concerns and problems are addressed in a timely manner. (eXpectation, Yield)	3.62	3.65	3.83	3.48	3.68
There is cooperation among all team members. (eXpectation, Invest, Caring)	4.48	4.35	4.44	4.35	4.23
There is timely follow-through when issues are raised. (eXpectation, Openness)	4.14	4.06	4.28	4.09	4.32
There is a sense of teamwork among members. (Yield, Invest, Caring)	4.14	4.29	4.44	4.39	4.27
There is trust among team members. (Invest, Caring)	4.19	4.00	4.28	4.26	4.23
Team members respect one another. (Invest, Caring)	4.48	4.35	4.61	4.61	4.5
Total score	4.15	4.02	4.24	4.16	4.16
Total no. of survey responses received	21	17	18	23	22

Factors of a high-trust culture exemplified by the CPD team scores of the current study noted in Table 2 correlate conceptually with Zak’s (2018) OXYTOCIN metrics. For example, “Ovation” is exemplified by coaches and leaders by recognizing members for outstanding performance, and by awarding those members with a certificate of recognition. “eXpectation,” which refers to facing challenges together with achievable expectations and goals, is demonstrated via communication, cooperation, and follow-through. “Yield,” which refers to engaging with each other and the team experience to complete the project at hand, is demonstrated via the acknowledgment of concerns and a sense of teamwork. “Openness,” which refers to the sharing of information, is demonstrated via communication and follow-through. “Invest,” which refers to investments in team members’ personal growth and mastery of skills, is demonstrated via teamwork, trust, respect, and cooperation. “Caring,” which refers to caring about each other, is demonstrated via cooperation, teamwork, trust, and respect.

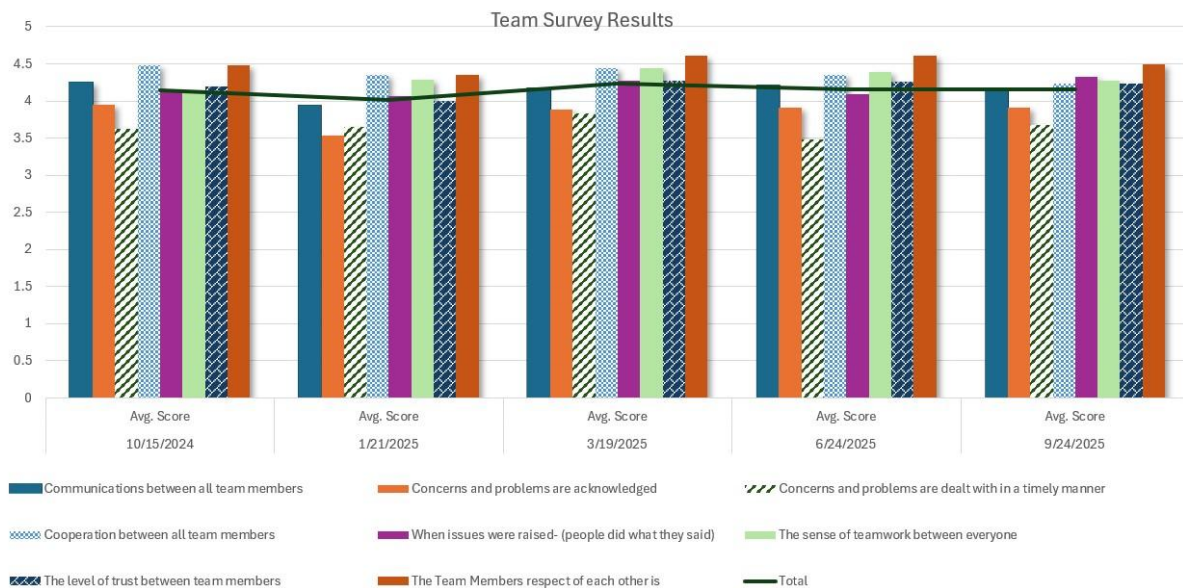


Figure 1: graphical representation of raw survey data to be analyzed

Based on these examples, we theorize that oxytocin could be one silent partner present in IPD/CPD teams. However, the challenges to prove this theory include the difficulty encountered with acquiring on-the-spot measurements of oxytocin in team members by blood draws or brain imaging, for example. Having to submit to a blood draw in the middle of a meeting would most likely disrupt a team’s flow. But that is nothing compared to leaving a meeting and entering a trailer to be scanned by a portable magnetic resonance imaging machine, never mind the cost associated with the equipment and the personnel required to run it. The goal, therefore, is to find simple, effective methods for measuring oxytocin in an attempt to prove that it has either a positive or negative effect on IPD/CPD team members. A positive correlation could provide promising new avenues to study neurobiological factors in high-performing lean project teams.

HEART RATE

Heart rate, another neurobiological factor, has also been proved to be a measurable performance indicator in traditional business studies. For example, Sharika et al. (2024) found that heart rate synchrony in groups of more than two people in a naturalistic group discussion scenario can predict a greater level of group decision making.

As noted previously, IPD/CPD teams gather frequently in component teams, big rooms, core groups, and swarms. These meetings are an integral part of lean teams and relational elements that go beyond streams of information exchange. Richert and McGuffey (2019), developed a transformational model for lean thinking relating the Toyota Production System (TPS) and the history of the Toyota Motor Corporation. Their four elements—Connection, Cognition, Commitment, and Challenge—interconnect team engagements, mindfulness, relationships, responsibilities to others, and aligned goals within the holistic elements of lean teams. A variety of processes and the lean tools mentioned earlier allow information to be shared openly, and depend on the knowledge and expertise of the teams’ professional trade partners, architects, contractors, and owners to reach a consensus on decisions. Sharika et al. (2024), described in detail the complexity involved in making these types of decisions:

“Arriving at the correct consensus answer may require active social attention on group members during discussion to resolve differences of opinion arising from unequal distribution of information. Such motivated social engagement, acting via processes like empathic listening

and perspective-taking, may engage coregulated physiological responses between group members, making interpersonal heart rate synchrony during discussion a strong predictor of group outcome” (p. 6).

The complexity and scale of large commercial design–construction projects demonstrate a demand for the social attentions noted, along with trust that team member expertise will result in a successful project.

IPD/CPD processes are similar to “hidden profile tasks,” which have been defined as “a method of distributing information among members of a decision-making group, leaving the optimal decision alternative hidden from members unless they thoroughly pool their unique knowledge” (Levine & Hogg, 2010, p. 1). For example, as part of the observational study, a deep sewer needed to be rerouted and coordinated with foundation piers. This task involved knowledge and input from civil, structural, and geotechnical engineers; and the sitework trade partner, general contractor, and owner. During a 1-hour meeting, the six professionals presented their most recent data. The group then discussed the latest information together, along with risks, and questioned the sequence of work, which resulted in agreement of a plan to move forward. This group synchrony resulted in a working, viable strategy. Whether heart rate played a factor is still yet to be determined.

In support of this approach, Sharika et al. (2024) found that “interpersonal heart rate synchrony predicted the likelihood of teams overriding inferior, default options and reaching the correct consensus decision, with more than 70% cross-validation accuracy” (p. 7).

When we look at the construction industry in general, we can see that IPD/CPD teams establish a foundation for collaboration that allows for better outcomes. Figure 2 shows risk and opportunity (R&O) savings of more than US\$21 million (an ~10% project budget reduction) from the same team members who completed the health surveys. Strong social engagement and the pooling of knowledge present in that team indicated evidence that neurobiological factors were involved. The data to support this assumption are yet to be analyzed. As noted by Sarkur and Tomar (2018),

“IPD projects demonstrate superior performance in terms of quality, schedule, project updates, communication among stakeholders, environmental aspects, and financing. . . . Projects in the US and UK that used TVD were brought in as much as 19 percent below market cost” (pp. 2468, 2475).

As part of the TVD process, similar to the R&O process noted, IPD/CPD teams make complex decisions to adjust design during the early stages of the project, with appropriate evaluation, to achieve budget savings. TVD aims to eliminate waste, achieve more collaboration in small and big groups, spurring creativity and adding value to the client through iterative design to reach predetermined budget targets (Musa & Pasquire, 2020). These challenges open a new level of collaboration and psychological safety, which are contributing factors to heart rate synchrony and successful group performance.

“Psychological safety describes the ability of team members to take interpersonal risks in a group by expressing, say, an unpopular opinion or unique perspective without fear of dismissal or negative evaluation. The ability of teams to critically examine available information and arrive at a decision contrary to the option favored by shared information would be expected to correlate with high group psychological safety” (Sharika et al., 2024, p. 6).

The Andon Cord is yet another tool that promotes psychological safety and it is a foundational element in lean construction teams based on the TPS. You pull the Andon Cord, figuratively, to raise a concern, ask for help, or suggest an idea for improvement. There are interpersonal consequences for doing so, but you do it anyway because an environment has been created that makes it not only safe to do so, but also it is the right thing to do (Geraghty, 2022).

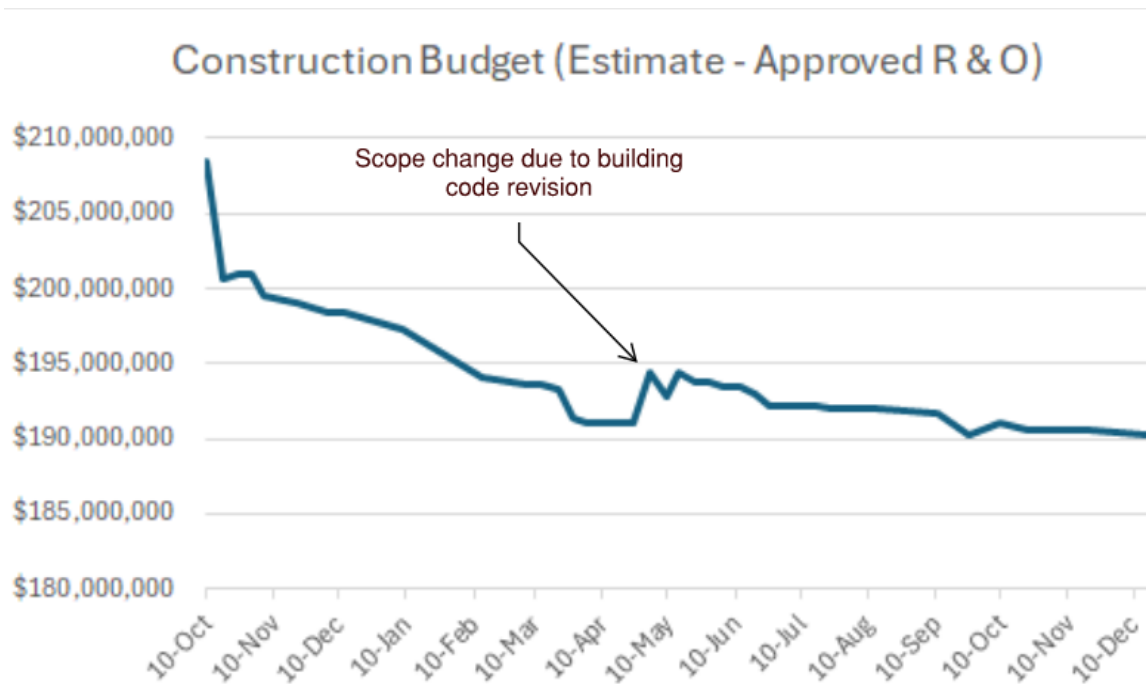


Figure 2: Approved R&O savings

In high-performance business organizations, the presence of psychological safety among team members was found to be a critical prerequisite for trust and oxytocin production (Zak, 2017). Zak and his team created a tool to measure trust and psychological safety neurologically in real time, without surveys. Using wearable devices such as Apple watches, their proprietary tool measures what the brain values through subtle changes in heart rhythm and in key signals generated by oxytocin and dopamine (Zak, 2022).

Research in the lean construction industry by Gomez et al. (2020) relates behavior-based qualities to psychological safety through “respect for people” and team alignment. In addition, literature reviews for best practices and improvements in psychological safety, along with surveys or questionnaires to measure team health, provide the most accurate data thus far in our industry (Villanueva et al., 2024). Data from surveys attempt to query the unconscious—the part of the mind that affects behavior and emotion—consciously (Zak, 2022). There is nothing wrong with these tools, but are there better ways to measure psychological safety through heart rate metrics?

DISCUSSION

While researching this paper, it was discovered that several traditional studies on oxytocin and heart rate have been focused in lab settings, along with a few by Zak (2017, 2018, 2022) that were performed in the field. Zak’s studies were more complex in terms of acquiring biometric measurements. Samples were stored on dry ice in the field and were then returned to a laboratory for analysis. The scant number of studies that correlate neurobiological factors with traditional high-performing teams—and the dearth of these types of studies in lean construction—has opened a window for exploring the potential effects of neurobiology on IPD/CPD team members. Although some methods exist for collecting neurobiological data, the data collection methods can be costly and disruptive to work procedures. In addition, there is a challenge in linking the validity of the science and the numbers. Clearly, more research on groundbreaking tools that could be used in this pursuit are in order and need to be evaluated further.

CONCLUSIONS

This conceptual study hypothesizes how IPD/CPD teams could benefit from the positive effects of neurobiological studies of traditional business teams, particularly in terms of oxytocin and heart rate synchronization among groups of people from different industry cultures. These silent partners allowed individuals from traditional teams to perform actively and effectively as one, to bond with improved trust and empathy (oxytocin), and to improve team performance (heart rate) that operates within a healthy environment built on psychological safety. The ability to reach consensus decisions among a diverse group of experts demonstrates how social attention dynamics and psychological safety can be related to heart rate biometrics, as shown by Sharika et al. (2024).

This paper is the first attempt to bring attention to the large gap in lean construction and neuroscience, and to postulate what we might learn and achieve. Team collaboration, frequency of interaction, ability to solve challenges, and coaching and leadership principles elevate the level of trust within a lean construction IPD/CPD team, and they could be related to oxytocin production. The unique nature of IPD/CPD teams provides an opportunity to acquire and measure biometric data, which has never been attempted in the design–construction industry. With these raw data, we can begin the process of analysis to evaluate their potential effects and perhaps find new ways to improve team performance.

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