Bridging Temporal Divides:

Temporal Brokerage in Global Teams and its Impact on Individual Performance

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Abstract

Members of global teams are often dispersed across time zones. This paper introduces the construct of *temporal brokerage,* which we define as being in a position within a team's temporal structure that bridges subgroups that have little or no temporal overlap with each other. Although temporal brokerage is not a formal role, we argue that occupying such a position makes an individual more likely to take on more coordination work than other members on the team. We suggest that while engaging in such coordination work has advantages in the form of enhanced integrative complexity, it also comes with costs in the form of a greater workload relative to other members. We further argue that the increased integrative complexity and workload that result from occupying a position of temporal brokerage have implications that go beyond the boundaries of the focal team, spilling over into other projects the individual is engaged in. Specifically, we predict that being in positions of temporal brokerage on global teams decreases the quantity but increases the quality of an individual's total productive output. We find support for these predictions across two studies comprising 4,553 individuals participating in global student project teams and 123,586 individuals participating in global academic research teams, respectively. The framework and findings presented in this paper contribute to theories of global teamwork, pivotal roles and leadership emergence in global teams, and social network theory.

INTRODUCTION

Pierre re-read Sam's email to the global product development team with a sinking feeling. The members of the team were dispersed across the company's offices around the world: Pierre worked in Paris, Tanya in Tokyo, Sam in Singapore, Roberto in Rio de Janeiro, and Nina in New York. The email continued a conversation that had been ongoing for several days as the team was working to find a solution to a recent problem. This search had been complicated by the fact that each team member had a very different understanding of the problem itself. Earlier that day, Pierre had had a productive video call with Tanya and Sam, during which they had finally managed to get to the bottom of the issue. But Sam's email summary of their call could not fully convey the detailed understanding they had worked out together. Pierre checked the internal messaging system. It was 1 pm in Paris. Tanya and Sam had already finished their workdays and were offline. Roberto had just arrived in the office. Nina's day would not start for another hour. As soon as she was in, Pierre would ask Nina and Roberto onto a call to discuss with them what he had worked out with Tanya and Sam. When the project had started, Pierre had not expected that these coordination activities would become such a big part of his work on the team as they had. But who else could do what he did for this team? After all, he was the only one whose workday overlapped with everyone else's.

Global teams such as the one described in this scenario are becoming increasingly prevalent and important in today's knowledge-intensive organizations. Whether to capture relevant expertise or to reduce labor costs, more and more organizations— in industries ranging from professional services to software development— are assembling teams whose members are dispersed across different locations around the globe (Gibson and Gibbs 2006, Hinds et al. 2011, Jimenez et al. 2017). As illustrated in the scenario above, *temporal dispersion*— that is, the dispersion of team members across multiple time zones— is a critical challenge that global teams face. Because the waking and working hours of members in such teams are offset relative to one another, they have less *temporal overlap* with each other and, hence, limited opportunities for synchronous interaction, as illustrated in Figure 1. However, even though temporal dispersion is increasingly recognized as one of the key challenges faced by global teams (Jimenez et al. 2017), prior literature has bestowed relatively limited attention to it, focusing more on other challenges such as working virtually or working across geographies

(Hinds et al. 2011).

---- Insert Figure 1 about here ----

The relative lack of research examining temporal dispersion is not for lack of explanatory power: The few studies that have focused on this aspect of global teams have yielded important insights, showing that temporal dispersion impacts team functioning above and beyond spatial dispersion (Espinosa et al. 2012), and that as temporal overlap between members decreases, teams experience an increase in coordination problems, negatively impacting performance (Cummings et al. 2009, Espinosa et al. 2012, 2015). Although these prior studies provide an important foundation for examining temporal dispersion in teams, they share a critical blind spot in that they ignore differences between individual team members in terms of their temporal position within the team. That is, extant work on temporal dispersion has focused solely on examining the extent to which a *team* faces the challenge of temporal dispersion— conceptualized either as the average (e.g., O'Leary and Cummings 2007) or the maximum (e.g., Espinosa et al. 2012) temporal distance between members. Meanwhile, it has overlooked the possibility that different *individuals* who are part of a given team may be affected by the team's temporal dispersion in different ways. However, as our opening scenario exemplifies, individual members in a temporally dispersed team can indeed face markedly different constraints and opportunities, depending on their unique position within the temporal structure of the team. Thus, the lack of theory and empirical insight into the consequences of such differences, as well as the absence of a conceptual framework capable of rendering the *temporal structure* of a team visible, limits our understanding of how temporal dispersion impacts members of global teams.

The primary aim of this paper is to contribute to our understanding of temporal dispersion in global teams by introducing a conceptual framework that can capture the temporal structure of a team, and by using this framework to theorize about how occupying different positions in such a structure leads to different experiences and outcomes for individual team members. Specifically, we develop a conceptualization of a team's temporal structure as a network of temporal overlap between individuals. Building on network theory and communication theory, we then introduce the concept of *temporal brokerage*, which we define as being in a position of bridging subgroups that have little or no temporal overlap with each other. In our opening scenario, Pierre is in a position of temporal brokerage: Situated in Paris, he is the only member whose workday overlaps with that of all other members. Meanwhile, the other members fall into two subgroups whose workdays do not overlap with each other— Tanya and Sam on one side, Roberto and Nina on the other. We argue that being a temporal broker— that is, being in a position of temporal brokerage— makes one prone to taking on more coordination work than other members on the team. We suggest that while engaging in such coordination work has advantages in the form of enhancing the individual's capacity for complex reasoning, it is also costly, in that it is associated with a greater workload relative to other members. Further, we argue that these benefits and costs contribute to shaping an individual's performance on his or her entire *portfolio* of projects. Specifically, we predict that being in a position of temporal brokerage on global teams decreases the quantity of projects an individual can complete in a given time period, but increases the quality of the projects he or she completes. We find support for these predictions across two studies comprising 4,553 individuals participating in global student project teams and 123,586 individuals participating in global academic research teams, respectively.

This paper makes several theoretical contributions. First and foremost, by unpacking the *temporal structure* of teams, it contributes to theories of global teamwork and lays the foundation for a new line of research in this domain. In particular, we introduce the construct of *temporal brokerage* and illustrate that occupying such a position in a global team results in both benefits and costs for individual members. Furthermore, our framework to capture temporal structure also contributes to emerging structural perspectives on teamwork more broadly. Temporal offsets— while particularly salient in globally dispersed teams— are increasingly common in many modern teams due to changes in the nature of collaboration, such as remote work, shift work, and multiple team membership (Mortensen and Haas 2018). The conceptualization of a team's temporal structure as a network of temporal overlap presented in this paper can therefore provide a powerful framework for studying phenomena not only in global teams but also in other types of modern work arrangements. Second, the theory and findings presented here answer recent calls to identify pivotal roles in globally distributed teams (Maynard et al. 2017), with important implications for research on leadership emergence in global teams. Finally, the findings presented in this paper also hold implications for network theory. In particular, our finding of a causal relationship between being placed in a structural position of brokerage and the consequent engagement in a particular form of brokering behavior advances our understanding of how network structures shape individual behaviors.

TEMPORAL BROKERAGE IN GLOBAL TEAMS

Temporal Dispersion in Global Teams

Global teams are commonly defined as “temporary, culturally diverse, geographically dispersed, electronically communicating work groups” (Jarvenpaa and Leidner 1999, p. 792, Jimenez et al. 2017). Geographical dispersion is thus at the core of what defines a global team, and it is this dispersion that gives rise to the reliance on electronically mediated, rather than face-to-face, interaction. However, geographical dispersion is not a monolithic construct. Rather, it includes two aspects of distance: spatial distance and temporal distance. Spatial distance refers to separation in terms of physical distance between team members, whereas temporal distance refers to separation in terms of time zones (O’Leary and Cummings 2007). Both spatial distance and temporal distance exert structuring influences on the patterns of communication and collaboration within teams.

With respect to spatial distance, a long research tradition has documented the rapid fall in communication frequency— in particular, spontaneous and informal communication— with increasing distance between individuals’ places of work (Allen 1977, Catalini 2018, Fayard and Weeks 2007, Hoegl and Proserpio 2004, Lee 2019, Reagans 2011, Sommer 1959). Notably, however, this research tradition primarily focuses on teams whose members are rather proximate to each other (i.e., often within walking distance), examining the impact of being separated in terms of meters, floors, or buildings. Spatial distance in global teams, however, is on a different scale: Members of global teams are often separated by hundreds or thousands of kilometers. While spatial distance on this scale may still influence team functioning in terms of the financial and logistical costs of setting up face-to-face meetings, it arguably makes little difference for day-to-day collaboration (O’Leary et al. 2014, O’Leary and Cummings 2007). To take up our initial example again, even though Nina in New York is spatially closer to Pierre in Paris (5,834 km) than to Roberto in Rio (7,754 km), in her day-to-day work she will not rely any less on electronic channels when communicating with Pierre than she will when communicating with Roberto.

In light of this, temporal distance arguably plays a more powerful structuring force in global teams than does spatial distance. When members are located in different time zones, their waking hours and workdays are offset relative to each other (Espinosa and Carmel 2003). As a consequence, the more temporally distant two individuals are—that is, the more time zones there are between them— the fewer hours there are during the day in which both are active. Temporal distance is not simply another expression of spatial distance: While it is correlated with the east-west dimension on the globe, it is not correlated with the north-south dimension. For example, even though Nina in New York is spatially closer to Pierre in Paris than she is to Roberto in Rio, Nina shares more active hours with Roberto than she does with Pierre.

While temporal distance does not preclude communication per se, it poses limits on the opportunity to engage in *synchronous communication*— that is, communication in real time and with a shared focus of attention (Dennis et al. 2008). Synchronicity is an important dimension of team virtuality (Kirkman and Mathieu 2005) and has critical implications for the effectiveness of different types of communication processes. More specifically, Media Synchronicity Theory (Dennis et al. 2008, Dennis and Valacich 1999) proposes that synchronous and asynchronous modes of communication are each suitable for different types of communication. Asynchronous modes of communication are particularly suitable for *conveyance* communication— that is, communication aiming to transmit information accurately from one party to another. Because asynchronous communication media such as e-mail allow for a more careful preparation of the message on the sender's side as well as its repeated perusal on the receiver's side, they facilitate accurate transmission and deep individual cognitive processing of the information (Maynard and Gilson 2014). Synchronous modes of communication, on the other hand, are more suitable for *convergence* communication— that is, communication aiming to collectively process information and arrive at a shared understanding of the situation. Because synchronous communication media such as instant messaging, phone calling, or video conferencing allow for faster turn-taking, feedback, and clarification, they facilitate collective sense-making processes, as well as the development of a shared understanding of the task and the required actions (Dennis et al. 2008, Maynard and Gilson 2014, Weick 1985). Such shared mental models are a critical foundation for effective team collaboration (Cannon-Bowers et al. 1993, DeChurch and Mesmer-Magnus 2010). Thus, we argue that temporal distance presents significant coordination challenges to global teams because it limits convergence communication and therefore impedes the development of shared mental models.

Prior research on temporal distance corroborates these arguments. For example, Cummings and colleagues (2009) found that, within global teams, pairs of members who had no temporal overlap experienced significantly more coordination problems— such as an increased need for clarification and rework— than pairs who had some temporal overlap. Further unpacking the mechanisms between temporal dispersion and team outcomes in an experimental study, Espinosa and colleagues (2015) found that a reduction in temporal overlap between members of dyads reduced convergence communication by reducing communication volume and, in particular, the rate of turn taking. This, in turn, negatively impacted the quality of the dyad's productive output.

These findings highlight the coordination challenges arising between pairs of individuals separated by temporal distance. Teams, however, are more than a collection of dyads (Simmel 1950). In teams in which multiple members are located across different sites, pairs of members within the same team can vary in the extent of temporal distance between them. Extant research at the team level conceptualizes temporal dispersion in teams as the average of the dyadic temporal distances (O'Leary and Cummings 2007) or as the maximum dyadic temporal distance (Espinosa et al. 2015). While these approaches capture important differences in the degree of temporal dispersion between teams, they mask structural differentiation between members *within* teams. To return to our example, although Nina and Pierre are both members of the same team and thus embedded in the same temporal structure, they clearly hold different positions in this structure. If we aim to capture such differences and theorize about their implications, we need a more nuanced conceptualization of temporal structure within global teams than prior research offers. In the following section, we introduce such a framework, rooted in the conceptualization of temporal structure as a *network* of temporal overlap among team members.

Temporal Structure in Global Teams: A Network Perspective

Consider again the global team from our opening example. If we were to visually map the work hours[1] of the team's members, we would arrive at a table such as the one included in Figure 1. In this table, we have marked the hours during which each team member is working in Coordinated Universal Time (UTC). As this figure shows, different pairs of members have different degrees of overlap in their work hours. For example, given the specific offset in time zones, Pierre and Tanya have two overlapping hours during their workdays; meanwhile, Tanya and Sam have nine overlapping work hours. Building on this, we conceptualize the temporal structure of global teams as a network in which individuals are connected by "ties" of overlapping work hours. Figure 2 illustrates the *temporal network* of our example team, mapping out the matrix of temporal overlap between each pair of members and the graphical representation resulting from it.

---- Insert Figure 2 about here ----

Using such a network lens provides a powerful conceptualization of temporal structure as it encompasses both between-team differences in temporal dispersion and, importantly, within-team structural differentiation. For example, the concept of average temporal distance as expressed in prior work (O'Leary and Cummings 2007) can be captured (inversely) as the density of a temporal network— that is, the average temporal overlap among all dyads that make up the team. Going beyond this, adopting a network lens also allows us to examine differences in individuals' positions within the temporal network and theorize about how the different positions that individuals occupy shape their behavior and outcomes.

It is important to recognize that a temporal network differs from more commonly studied networks defined by social relationships in two important ways. First, ties of overlapping work hours in a temporal network represent a structural *opportunity* for synchronous communication at the dyadic level— that is, the more overlapping work hours a pair has, the greater their opportunity to

[1] It is important to note that our theory is agnostic with regard to *how* pairs of team members come to have a certain amount of temporal overlap between them. For example, two team members could have an overlap of two hours because they each work on a ten-hour schedule starting and ending at the same local time while being separated by a time difference of eight hours. But they could also have an overlap of two hours while being separated by a time difference of *ten* hours because one of them shifts or extends their workday. Methodologically, because we do not have fine-grained information about individuals' schedules, we make an assumption about the most likely time window during which individuals are active – and we use the same assumption for our examples here. Specifically, following prior research on temporal dispersion (Cummings et al. 2009), we assume continuous ten-hour workdays. We discuss deviations from this assumption in our discussion section.

communicate in real time. The strength of ties in a temporal network is, however, distinct from the existence or strength of social relationships (Ren et al. 2014), actual flows of resources or communication (Balkundi and Harrison 2006, Zhang and Peterson 2011), or interdependencies in terms of goals or workflows (Crawford and LePine 2013, Soda and Zaheer 2012, Tröster et al. 2014). That is, the temporal structure of a team is a distinct dimension that overlays other structural dimensions characterizing the team (Humphrey and Aime 2014). Second, the structure of a team's temporal network is largely immutable. While the structure of a network of *social* relationships can change due to individuals' interpersonal behavior— for example, a person could introduce two people who were previously disconnected from each other (Obstfeld 2005, Quintane and Carnabuci 2016)— temporal overlap between team members can only change through the costly action of one or more members physically relocating from one time zone to another.

Temporal Brokerage and its Behavioral Consequences

Individuals' positions in a temporal network are defined not only by the temporal overlap that they share with other members of the team, but also by the pattern of temporal overlap among the other team members. In our opening example, Pierre shares hours with each of the other team members; yet this in itself is not what makes his position so unique. Rather, it is the absence of overlap between Nina and Roberto on one side with Tanya and Sam on the other side that renders Pierre's position so critical. In network terms, Pierre is in a brokerage position, spanning structural holes in the temporal network (Burt 1992). We therefore conceptualize *temporal brokerage* as occupying a position in the temporal network that bridges subgroups who have little or no temporal overlap with each other. Our example presents an extreme case of temporal subgroups that are completely disconnected from each other apart from the link through Pierre. In practice, however, temporal brokerage is a continuous construct, ranging from positions of greater temporal brokerage (such as Pierre's) to positions of lower temporal brokerage (such as Nina's).

While *brokerage* describes the position that an individual holds in a given network structure, *brokering* describes the behaviors that individuals engage in when acting as brokers (Halevy et al. 2019). Following Obstfeld and colleagues (2014), we conceive of brokering as behaviors "by which an actor influences, manages, or facilitates interactions between other actors" (p.141). Brokering activities can be harmful, aimed at dividing others and taking advantage from the separation between others as a *tertius gaudens* (Burt 1992), or helpful, aimed at facilitating collaboration between others. Among the helpful activities, prior research further distinguishes between a *tertius iungens* approach— that is, establishing or strengthening connections between others in order to facilitate direct collaboration between them (Obstfeld 2005)— and a *conduit* approach— that is, coordinating the transfer of information, knowledge, or other resources between others without attempting to connect them directly (Obstfeld et al. 2014, Soda et al. 2018). We argue that because of the characteristics of temporal networks outlined above, individuals who are in a position of temporal brokerage in a global team will be particularly likely to engage in conduit brokering.

A temporally dispersed global team sets several important contextual boundaries that have implications for what kind of brokering behaviors an individual who is in a position of temporal brokerage is able and likely to engage in. First, temporal brokerage exists within the context of a global *team*. The shared team membership among the actors implies that members have at least a basic knowledge or awareness of each other and, critically, that they are linked by positive goal interdependence as they share a common team goal (Kozlowski and Ilgen 2006). Thus, a member who is in a position of temporal brokerage may be positioned between *temporally* disconnected subgroups; however, these subgroups are interdependent and likely in communication with each other, even if this communication predominantly happens through asynchronous means (e.g., email). Given the positive goal interdependence among the team members, we argue that there is a strong incentive for temporal brokers to engage in helpful, rather than harmful, brokering activity.

Second, the immutability of the temporal structure of a team puts constraints on the form that helpful brokering activity can take. A person in a position of temporal brokerage cannot facilitate collaboration within a temporally dispersed team by changing the temporal overlap among others. He or she can, however, facilitate collaboration by acting as a go-between or "conduit" between others. Prior work anecdotally describes the role of "temporal lynch pins" (O'Leary and Cummings 2007, p. 444)— temporal brokers in our terms— as transmitters of information between temporally separated sites. Building on Media Synchronicity Theory (Dennis et al. 2008), however, we posit that there is more to being in a position of temporal brokerage than simply to relay information. While all members can exchange information through asynchronous communication, we argue that the opportunity for synchronous interaction with the larger part of the team puts the temporal broker in the unique position to engage in coordination behavior, a manifestation of conduit brokering, that helps to align other members' mental models of the task.

Although shared mental models of the task are critical for effective team collaboration because they form the basis for developing strategies to reach the team's goal (Gurtner et al. 2007, Mathieu et al. 2000), temporally distributed teams are likely to experience divergence in task mental models because temporal dispersion limits the opportunity for synchronous interaction. As discussed earlier, the opportunity for synchronous interaction facilitates convergence communication and, consequently, the development of shared mental models of the task (Espinosa et al. 2015, Maynard and Gilson 2014). When team members are dispersed around the globe such that there are temporal subgroups that cannot easily synchronously communicate with each other, these subgroups are likely to develop separate "thought worlds"— divergent or even incompatible mental models that are based on different sets of assumptions about the task and team (Carton and Cummings 2012, Crawford and LePine 2013). As a consequence, even though team members pursue a shared team goal, temporally distant subgroups may develop different and potentially contradictory views on what needs to be done in order to get there.

In this context, a position of temporal brokerage makes it possible for a member to act as a conduit between temporal subgroups. Because temporal brokers share overlapping hours both with the subgroup to their east and with the subgroup to their west, they experience regular oscillation between being able to fully embed themselves first in one and then in the other subgroup within the course of each day (Burt and Merluzzi 2016). Such embeddedness in both subgroups is important as it provides deep access to the subgroups' knowledge and, thus, a deep understanding of emerging mental models within each subgroup (Tortoriello and Krackhardt 2010, Vedres and Stark 2010). This, in turn, exposes the temporal broker to potential emerging differences in mental models between the subgroups and highlights the need for coordination activities, such as integrating different perspectives emerging from the subgroups, clarifying potential misunderstandings between them, and shaping an overarching understanding of what the task entails and how the activities of the different members come together to reach the team's goal (Rico and Sánchez-Manzanares 2008). We expect that the salience of the need for coordination, coupled with the positive goal interdependence within the team, will lead to individuals who find themselves in a position of temporal brokerage to respond by engaging in more coordination behaviors. In sum:

> *Hypothesis 1 (H1). Individuals in positions of greater temporal brokerage within a global team will engage in more coordination behaviors in that team than individuals who are in positions of lower temporal brokerage.*

The Benefits and Costs of Occupying a Position of Temporal Brokerage

Prior work on network brokerage has shown that occupying a position of brokerage can have both positive (e.g., Burt 2004, Clement et al. 2018, Fang et al. 2015) and negative (Lee, Lee, et al. 2019, Lee, Ruiz, et al. 2019) consequences for the individual in such a position. Building on this framework, we argue that given the specific demands that a position of temporal brokerage places on the individual (namely, to engage in more coordination behavior), those who find themselves in a position of temporal brokerage are likely to experience specific positive and negative outcomes as a result.

On the one hand, we propose that a temporal broker's deep engagement with diverging mental models resulting from engaging in coordination behavior will stimulate the development of integrative complexity— the ability to recognize and integrate competing perspectives on the same issue (Maddux et al. 2014, Suedfeld et al. 1992, Tadmor and Tetlock 2006). Integrative complexity has been shown to have positive effects on both individual and team-level performance (Gruenfeld and Hollingshead 1993, Tadmor et al. 2012). Although early work on integrative complexity assumed it to be a relatively stable trait (e.g., Kelly 1955), more recent work has argued and found that it is malleable. In particular, researchers have theorized and found that engaging with divergent "thought worlds" can hone individuals' capacity for integratively complex reasoning. For example, prior research found that individuals who are exposed to conflicting sets of values— and, importantly, are motivated to engage with this value plurality— develop higher levels of integrative complexity (Tetlock et al. 1996). Similarly, other work has found that exposure to a paradoxical frame that prompts individuals to engage with contradictory elements in their environment and find ways to integrate them enhances integrative complexity (Miron-Spektor et al. 2011). Finally, a growing literature on multicultural experience demonstrates how individuals' engagement with different cultural frames can lead to lasting increases in their integrative complexity (Benet-Martínez et al. 2006, Maddux et al. 2014, Tadmor and Tetlock 2006).

Based on this earlier research, we expect that temporal brokers, who are exposed to diverging mental models emerging from the different temporal subgroups in their team, are likely to develop higher levels of integrative complexity as a result. Importantly, we argue the positive effect of being in a temporal brokerage position on integrative complexity is mediated by coordination behavior. As research on multicultural experience has repeatedly shown, while exposure to different cultures provides a context in which the development of integrative complexity is possible, it is the active engagement with the distinctions and contradictions arising from this context that results in integrative complexity growth (Maddux et al. 2014, Tadmor et al. 2012). Similarly, while being in a position of temporal brokerage sets up a context conducive to developing integrative complexity, we argue that it is the active engagement with the different assumptions and perspectives emerging from the different temporal subgroups and the attempt to reconcile and integrate these through coordination behaviors that will be the primary vehicle for integrative complexity growth. In sum, we predict:

> *Hypothesis 2a (H2a). Individuals in positions of greater temporal brokerage within a global team will experience a greater increase in their integrative complexity than individuals who are in positions of lower temporal brokerage.*

> *Hypothesis 2b (H2b). The effect of temporal brokerage on integrative complexity is mediated by coordination behaviors.*

On the other hand, acting as a link between temporal subgroups requires additional attention and time on top of what is needed for other tasks. However, because such coordination work is relational and typically not publicly visible, it is likely to fall into the domain of "invisible work"—that is, work that is often crucial for the smooth functioning of the team, but not recognized as commendable or desirable (Chan and Anteby 2016, Daniels 1987). Indeed, prior research has recognized helpful brokering, such as engaging in coordination activities to facilitate collaboration between others, as just such an example of invisible work that is often overlooked (Cross et al. 2002, Halevy et al. 2019, Obstfeld 2017). Because coordination work is to a large extent invisible, it is not work that teams will likely recognize and take into account when planning and allocating tasks (Staats et al. 2012). Consequently, temporal brokerage is unlikely to be a formal or agreed-upon role that could result in relief from other work. Rather, coordination work resulting from being in a temporal brokerage position is likely to be work that comes on top of other, more "formal", work. Thus, we expect that individuals in a position of temporal brokerage will end up with a greater workload than other members who are not in such a position.

> *Hypothesis 3a (H3a). Individuals in positions of greater temporal brokerage within a global team will have a greater workload on that team than individuals who are in positions of lower temporal brokerage.*

> *Hypothesis 3b (H3b). The effect of temporal brokerage on individual workload is mediated by coordination behaviors.*

The Effects of Temporal Brokerage on Individual Performance Across a Portfolio of Projects

Thus far, we have discussed how being in a position of temporal brokerage in a specific global team likely shapes an individual's activity and outcomes *within* that particular team. However, because project work is increasingly common in today's organizations, an individual's performance is often judged not based on a single project, but rather based on the performance of the entire *portfolio* of projects they complete over a given period of time (Edmondson 2012, Mortensen and Haas 2018). Furthermore, because it is becoming increasingly common to work on multiple projects at the same time (Cummings and Haas 2012, Mortensen and Gardner 2017, O'Leary et al. 2011, Wageman et al. 2012), individuals' contributions to the various projects they work on are not mutually independent. That is, what happens on one project can have implications for other projects that the individual is simultaneously working on (Incerti et al. 2020, Mortensen and Gardner 2017). This means, for instance, that when an individual occupies positions of temporal brokerage on some of their projects— and experiences greater workload but also a boost in integrative complexity as a result— this will have consequences for other projects in their portfolio. Therefore, in this section, we consider the implications of occupying positions of temporal brokerage for an individual's performance in terms of their overall portfolio of projects. Following prior research, we focus on two core dimensions of individual performance: the quantity and the quality of individuals' productive output (Hackman and Oldham 1976).

Above, we argued that occupying a position of temporal brokerage, through an increased engagement in coordination behavior, is associated with a greater workload for the temporal broker. Naturally, this increase in workload on one project has implications for the resources— such as time, attention, and energy— that the temporal broker is able to contribute to other projects in his or her portfolio (Incerti et al. 2020, Mortensen and Gardner 2017). That is, individuals who have to manage the additional unexpected workload on projects in which they are in a position of temporal brokerage will have less time, attention, and energy to bestow on the other projects in their portfolio. As a result, they may end up contributing less to these other projects, thereby causing delays that lead to fewer projects being completed overall within a given time period. They may also take on fewer new projects because their resources are bound by working off these delays, or they may even pull out of existing projects if their resources are stretched too thin as a result of these dynamics. Taken together, we expect that when an individual is placed in positions of greater temporal brokerage on some of his or her projects, the increased workload due to coordination work in these projects is likely to have a negative spillover effect onto this individual's broader portfolio of projects. As a result, we expect that taking up positions of greater temporal brokerage on projects will have a negative relationship with the total quantity of projects an individual can complete in a given time. In other words, we expect:

> *Hypothesis 4 (H4). Individuals in positions of greater temporal brokerage will complete fewer projects overall than individuals in positions of lower temporal brokerage.*

While we expect the coordination work entailed by temporal brokerage to be associated with a greater workload, we also argued above that it will result in enhanced integrative complexity. As with workload, we expect that the increase in integrative complexity gained from one project will have spillover effects onto other projects in the temporal broker's portfolio. At the individual level, integrative complexity has been found to lead to various performance benefits, such as enhanced creativity, more effective information search, and better decision quality (Benet-Martínez et al. 2006, Tadmor et al. 2012). Moreover, an individual with high integrative complexity may also help to enhance team functioning: Research has found that the presence of individual members who are able to accept and integrate divergent perspectives can be a catalyst to improved information processing, creativity, and performance in teams (De Dreu, Nijstad and van Knippenberg 2008, De Dreu, Nijstad, Baas, et al. 2008, Jang 2017, Perry-Smith and Shalley 2014, Shalley and Perry-Smith 2008). In sum, we posit that individuals whose integrative complexity is enhanced by the coordination activities associated with temporal brokerage on a given project will be able to provide a more valuable contribution to other projects in their portfolio, both in terms of their individual contribution and in terms of being a catalyst for better team functioning. As a result, we expect that the projects completed by individuals with more temporal brokerage experience will, on average, be of higher quality. More formally stated, we predict:

> *Hypothesis 5 (H5). Individuals in positions of greater temporal brokerage will complete projects of higher average quality than individuals in positions of lower temporal brokerage.*

In sum, Hypotheses 1, 2, and 3 revolve around how being in a position of temporal brokerage in a given team is associated with greater coordination activity on that specific team and the implications of this activity for the individual. Looking beyond the focal team, Hypotheses 4 and 5 revolve around how an individual's activity associated with being in a position of temporal brokerage on some of their projects shapes their individual performance in terms of the quantity and the quality of their entire portfolio of projects. Figure 3 presents our full theoretical model.

---- Insert Figure 3 about here ----

We tested our hypotheses in two studies of individuals working in global teams. In Study 1, we tested Hypotheses 1, 2, and 3 using an archival dataset from a global student collaboration project including 4,553 individuals. In Study 2, we tested Hypotheses 4 and 5 using an archival dataset of collaborative research publications in the social sciences comprising 123,586 individuals.

STUDY 1: TEMPORAL BROKERAGE IN GLOBAL STUDENT TEAMS

Study Setting and Sample

We tested Hypotheses 1, 2, and 3 using an archival dataset from a global student collaboration project (see Taras et al. 2013 for a detailed overview of the project and dataset). In this project, participating undergraduate and graduate students located in over 70 countries work over the course of eight weeks in globally dispersed teams to develop an international business plan for a company of their choice. This task requires intense reciprocal collaboration, as teams submit partial work every week and prepare a final integrated report by the end of the project period. Teams are composed to maximize national diversity. Within this general constraint, students are assigned into teams randomly, which results in an allocation of team members to structural positions in the temporal network that is independent of their individual characteristics or preferences. Thus, this setup provides a quasi-experimental setting to study the implications of different temporal network positions for individuals in a large number of global teams.

For this study, we analyzed data from four semesters in 2014 and 2015, as this subset of the full dataset contained all variables of our interest. We used objective data on participants' locations as well as data collected through surveys: Over the course of the project period, participants responded to up to eleven surveys, although the exact number and timing of surveys varied between cohorts. Because we are interested in the effect of different positions in the temporal network of temporally distributed global teams, we included only teams in which at least one member was in a different time zone from the others. This subset consisted of 5,521 individuals nested in 863 teams. After excluding observations with missing data on any of the used variables, our final dataset consisted of 4,553 individuals nested in 837 teams. On average, teams in our sample had 6.41 members and a balanced gender distribution (49 % male). Students in this sample were located in 49 countries spread across all continents. The largest subgroups were students from the USA (30 %), Colombia (7 %), India (6 %), Brazil (5 %), Pakistan (4 %), Italy (4 %), Canada (4 %), Malaysia (3 %), and the United Arab Emirates (3 %).

Variables

Temporal brokerage. First, we constructed the temporal network for each team within our sample. To do so, we identified the time zone of each team member based on the location of the university at which they were located at the time of the project. Following prior research indicating common workday lengths to be between nine and eleven hours (Cummings et al. 2009), we computed temporal overlap between each pair of members based on the assumption of a continuous ten-hour workday or window of availability. This procedure resulted in a valued matrix for each team, an example of which is presented in Figure 2. We also performed robustness checks with nine- and eleven-hour windows which yielded the same pattern of results. It is important to note that we constructed the temporal networks and computed the variables based on the temporal networks prior to any exclusions of individual members based on missing survey data. Because the location of the affiliated university is known for all students, we were able to construct the complete temporal network for each team and accordingly compute unbiased temporal network measures for each individual.

To measure temporal brokerage, we computed each member's normalized flow betweenness centrality in the temporal network (Freeman et al. 1991, Tröster et al. 2014). We use betweenness rather than Burt's constraint (1992) as our measure of temporal brokerage because betweenness captures an individual's position in the whole network of the team, whereas constraint focuses on the ego-network— that is, the immediate neighborhood of the individual. The flow betweenness measure is part of the betweenness family of measures, and specifically captures individuals' centrality in terms of their standing *between* others and, thus, their "ability to facilitate or inhibit the communication of others" (Freeman et al. 1991, p. 142). Unlike the more commonly used betweenness centrality measure (Freeman 1978), flow betweenness centrality is not restricted to binary ties. Rather, it is theoretically particularly well suited as a measure of our construct: It conceptualizes the value of a tie between two team members as the "capacity of the channel linking them" (Freeman et al. 1991, p. 145); that is, the value of a tie represents the opportunity for information to flow between two team members, with higher values representing greater opportunity. This mirrors our conceptualization of more overlapping hours providing a greater structural opportunity to engage in synchronous communication. Individuals who have high flow betweenness centrality in the temporal network of a team, then, are individuals who have a position similar to Pierre's in our opening example and illustrated in Figure 2: They have relatively greater opportunity for synchronous communication with fellow team members both to their east and to their west, while the team members on either side have relatively less opportunity for synchronous communication directly with each other. In short, the higher the flow betweenness score of an individual, the more structurally reliant the team is on this individual for information to flow freely. We computed normalized flow betweenness centrality using the *flowbet* function of the *sna* package for R (Butts 2008, 2016, R Core Team 2016).

Finally, we note that the position of temporal brokerage was not associated with any particular geographical location. Depending on the specific geographical configuration of the team, we found temporal brokers across the entire range of longitudes in our sample and on every continent.

Coordination behavior. Over the course of the team project, participating students repeatedly provided round-robin peer evaluations. To capture individual members' coordination behavior, we used the average peer ratings they received on the item "leadership and help with coordination". Ratings were given on a five-point Likert scale from "poor" to "excellent". Because the number and timing of surveys containing this question varied across semesters, we computed the average peer ratings received across all available survey time points.

Workload. Over the course of the team project, participating students also repeatedly reported their perception of the workload distribution within the team. This was expressed in percentages they allocated to each individual member, including themselves. We used each member's reports of their own workload as a measure of workload on the project. As before, given that the number and timing of surveys containing this question varied across semesters, we computed the average workload of each individual across all available survey time points.

We used peer reports on coordination behavior and self-reports on workload in order to reduce same-source bias. We note, however, that our results are robust to using self-reports on coordination and peer reports on workload, self-reports on both variables, and peer reports on both variables.

Integrative complexity. Over the course of the project, participating students were repeatedly asked to describe their experience in response to the following prompt: "Please describe your X-Culture experiences in the past week in your own words. Tell us how your team is doing. Have you experienced any problems? Have you learnt something new? Is there anything you are happy or disappointed about?". This prompt is relatively open-ended and students' comments cover a broad range of topics. Prompts were included in surveys administered between week three and week eight of the project, although the number and exact timing of the surveys differed by semester. Not all students provided a comment in response to each prompt; however, across all surveys, 88.5 % of the 5,521 students enrolled in the project in the focal semesters provided at least one response to the prompt. In total, we obtained 22,748 comments, which we coded for integrative complexity using Conway and colleagues' Automated Integrative Complexity system (Conway et al. 2014, Houck et al. 2014). This system is based on Suedfeld and colleagues' (1992) widely used integrative complexity manual and analyzes text for markers of differentiation and integration, producing integrative complexity codes that have reasonable correlations with those produced by human coders. Because most participants provided multiple comments between weeks three and eight of the project, we used the average of the integrative complexity scores attributed to each student over all provided comments as our measure of integrative complexity. As a robustness check, we also reran our models using only comments provided later in the project (between weeks six and eight rather than between weeks three and eight); all results remained unchanged.

Control variables. In selecting control variables, we followed the recommendations put forward by Carlson and Wu (2012), identifying control variables that could help us to partial out potential spurious relationships. In particular, we controlled for several structural features of the team that can influence the likelihood that an individual will find him or herself in a position of high temporal brokerage and, at the same time, impact the overall coordination burden to be expected in this team. Following this logic, we controlled for the size of the team, as team size impacts both the flow betweenness centrality scores that are possible and the coordination load that is to be expected. We also controlled for the density and centralization of the team's temporal network given that the overall structure of the temporal network can influence both individual positions within the network and overall coordination demands. Density in the valued temporal network essentially corresponds to the average temporal overlap across all dyads (Wasserman and Faust 1994). Centralization captures the extent to which a team's temporal structure is centered around a temporal broker. The more centralized a team's temporal network is, the more its structure resembles a "bowtie" (see Figure 2) — two subgroups with relatively little temporal overlap between each other with a temporal broker overlapping in time with both subgroups. We computed centralization as the average difference between the flow betweenness centrality of the most central member and that of each other member (Freeman et al. 1991, Tröster et al. 2014). Similarly, the overall geographical setup of the team can influence the relationships we investigate, as increasing spatial distance makes temporal distance— and temporal brokerage— more likely, while also potentially posing additional coordination demands on the team. We therefore controlled for average spatial distance (expressed in the natural logarithm of the distance in 1000s km) between the members using geocoded longitude and latitude data for each member's location. Finally, temporal dispersion may also be associated with cultural diversity, which can create further coordination challenges for the team. To capture this, we controlled for nationality diversity using the Blau index based on participants' home countries (Blau 1977).

Because individuals were assigned to teams— and, consequently, to their positions in the team's temporal structure— quasi-randomly, there is no reason to assume that individual differences could co-vary with temporal brokerage and thus produce spurious associations between our variables of interest. We therefore did not include any individual-level controls, with one exception: Because we are specifically interested in the *change* in individuals' levels of integrative complexity as a function of their structural position in the team's temporal network, we included a control for prior integrative complexity. To capture this, we coded participants' self-descriptions, which they composed prior to start of the project responding to the following prompt: "Now please tell us about yourself, who you are, what do you do, and anything else you feel your team members should know about you". Participants responded in various ways to this open-ended prompt, often describing their cultural background, their family background, their study interests, their skills, their career aspirations, and their motivation for the project. We used the same Automated Integrative Complexity coding system (Conway et al. 2014, Houck et al. 2014) for coding these self-descriptions as we used for the coding of the weekly experience descriptions. Because this prompt is different from the prompts used for our measure of later integrative complexity, the absolute scores cannot be meaningfully compared; however, this variable allows us to capture and control for relative differences in individuals' prior integrative complexity.

Results

Table 1 presents the descriptive statistics and intercorrelations among the variables. Table 2 presents the results of Hierarchical Linear Models accounting for the nesting of individuals within teams. In addition, to test the mediation hypotheses H2b and H3b, we followed the multilevel structural equation modeling procedure described by Preacher and colleagues (2010).

In Model 1, we regress individual coordination behavior on the set of control variables and in Model 2, we add temporal brokerage. As predicted in Hypothesis 1, we find that individuals who occupy positions of greater temporal brokerage engage in significantly more coordination behaviors than individuals who occupy positions of lower temporal brokerage ($b = 0.746$, $SE = 0.113$, $t = 6.607$, $p < 0.001$).

In Model 3, we regress individual integrative complexity on the control variables; in Model 4, we add temporal brokerage; and in Model 5, we introduce coordination behaviors into the model. In line with Hypothesis 2a, we find that temporal brokerage is associated with increased integrative complexity ($b = 0.271$, $SE = 0.100$, $t = 2.711$, $p < 0.01$). Furthermore, consistent with Hypothesis 2b, we found a significant indirect effect from temporal brokerage to integrative complexity via coordination behaviors ($b = 0.070$, 95% CI = [0.038; 0.103]).

Models 6 to 8 present the same regressions with workload as dependent variable. Consistent with Hypothesis 3a, we find that temporal brokerage is associated with increased reported workload on the team project ($b = 7.697$, $SE = 1.384$, $t = 5.559$, $p < 0.001$). Furthermore, consistent with Hypothesis 3b, we found a significant indirect effect of temporal brokerage on workload via coordination behaviors ($b = 5.001$, 95% CI = [3.524; 6.479]).

---- Insert Tables 1 and 2 about here ----

STUDY 2: TEMPORAL BROKERAGE IN GLOBAL RESEARCH COLLABORATIONS

In Study 1, we examined how being in a position of temporal brokerage in a given team results in increased coordination activity and, consequently, an increased workload as well as increased integrative complexity. In Study 2, we now turn to how being a temporal broker on one or more projects shapes an individual's overall performance in terms of the quantity and quality of their entire portfolio of projects.

Study Setting and Sample

To test the effects of temporal brokerage on individual performance in terms of the quantity and the quality of their project portfolio (Hypotheses 4 and 5), we used an archival dataset available in the Scopus database, which comprises of global research collaborations for articles published between 2000 and 2009. We identified as our sample authors who, within this period, had published peerreviewed articles in the social sciences as members of temporally distributed global teams. We focused on the social sciences because the nature of the co-authorship relationship in this field tends to be more interdependent than in other fields, with authorship conventions typically requiring active co-writing of the publication (Bošnjak and Marušić 2012). We followed several steps to identify our sample. First, we used Scopus' All Science Journal Classification (ASJC) to delimit our sample to include all social science publications. This amounted to a total of 433,566 publications. Second, given our focus on how temporal structures affect individuals in global *teams*, we further limited our sample to only include publications with three or more co-authors (Levine and Moreland 1990, Simmel 1950). Third, in keeping with our focus on interdependent team work, we excluded very large teams from our analysis. To do so, we excluded the publications in the top five percent of the team size distribution, resulting in the inclusion of teams between three and eight members. Fourth, given our interest in the role of temporal dispersion in global teams, we excluded publications without any variation in time zones between co-authors, as such collaborations fall outside of our scope of interest. This procedure resulted in the identification of 70,447 co-authored publications. In the final step, we identified all individual authors who had contributed to at least one of these publications. This resulted in the identification of our final sample of 123,586 individuals.

Variables

To test Hypotheses 4 and 5, we constructed a panel dataset in which individuals' productive outcomes were observed repeatedly each year. Given that it usually takes several years of work to successfully publish a paper in the social sciences, we examine how publications in a given year are influenced by the cumulative degree of temporal brokerage across all temporally dispersed projects an individual participated in during the preceding three years, as these are likely projects he or she would have worked on in parallel with those projects published in the focal year. Specifically, to test our hypotheses, we modeled the quantity of completed projects and the average quality of completed projects in a focal year as a function of the cumulative temporal brokerage for all instances of temporally dispersed projects an individual engaged in during the preceding three years. While we assume that projects published in a given year were at least partially executed in parallel with those that have been published in the preceding three years, we explicitly use different sets of projects to construct our core independent and dependent variables to avoid a potential bias. The results we present are also robust to five-year windows.

Temporal brokerage. First, we constructed temporal networks for each publication following the same procedure as in Study 1, identifying the time zone of each co-author based on their affiliation geotagged using the GoogleMaps API. As in Study 1, we quantified temporal brokerage within a project team as each member's normalized flow betweenness centrality in the temporal network. For each focal year, we then operationalized individuals' previous temporal brokerage as the cumulative flow betweenness centrality of this individual across all projects (i.e., published articles) in the preceding three years in which at least one co-author was not located in the same time zone with others. We focus on the cumulative rather than the average temporal brokerage across all projects of the individual during the given time frame to capture the total amount of brokerage-related coordination work the individual will likely have had to engage in.

Quantity of completed projects in a focal year. We operationalize the quantity of completed projects in a focal year as the number of publications an individual published in a focal year. Because we are interested in the volume of productivity rather than specific collaboration arrangements, in counting the produced output we consider the full set of published work by the individual authors in our sample and do not place limitations on the team size, temporal configuration, or the domains of science in which the articles were published.

Quality of completed projects in a focal year. We operationalize the quality of completed projects in a focal year using the average number of citations the publications of the focal year garnered subsequently (Fleming 2001, Singh and Fleming 2010). As with the quantity of completed projects, we include all publications produced by an individual in a given year, regardless of specific collaboration arrangements and the scientific domain in which the articles were published. For our measure of average citation count, we use the number of citations as captured in the database in 2014. Our cut-off year is 2014, which is the point at which the citation data were collected in our dataset. We used the average rather than the total number of citations for our measure of quality given that the total number of citations would be affected by both the quality and quantity of completed projects.

Control variables. As in Study 1, we identified and included control variables that could help partial out potential spurious relationships between our independent and dependent variables (Carlson and Wu 2012). Because it can impact an individual's cumulative temporal brokerage over the last years as well as the quantity of completed projects, we controlled for the *number of an individual's prior publications* in the preceding three years, considering the full set of published work by the individuals in our sample without any restrictions. Furthermore, we controlled for individuals' collaboration style as expressed in the *number of first- or solo-authored articles* in the same three-year window because this can be related to the likelihood of being in a temporal brokerage position on the one hand and publication outcomes on the other hand.

We also controlled for several variables describing structural features of the teams an individual has worked in during the three years prior to the focal year as these can be related to the chance of being placed in a temporal brokerage position as well as publication outcomes. In particular, we controlled for *team size* as well as the average *density* and *centralization* of all temporally dispersed teams an individual has been part of over the preceding three years. In addition, because temporal distance is related to spatial distance and potentially also cultural distance— both of which can impact publication outcomes through, for instance, exacerbating coordination challenges— we control for the *average spatial distance in prior team publications* and for the *number of prior multinational publications* (i.e., publications with authors located in multiple countries) in the same time window.

We include fixed effects for each individual's yearly *focal publication field* to account for field-specific collaboration trends and publication norms using the most common field in which the individual's publication journals has been classified in during the focal year. We also include fixed effects for individuals' yearly *main country of residence* to account for location-specific collaboration trends and publication norms using the most common country affiliation for the individual during the focal year. Similarly, we include fixed effects for the *publication year* to account for broad productivity trends in science as the scientific endeavor becomes more or less crowded. Finally, in the analyses predicting citation counts, we control for the *number of years between the focal year and the year in which the citation count was captured*.

Finally, an alternative argument to the effect of temporal brokerage could be that temporal brokerage is a "side effect" of *relational brokerage*— an individual having had prior collaborations with different temporally dispersed co-authors and subgroups may end up in a temporal broker position when he or she brings them together for a shared project. Relational brokerage itself, in turn, can have performance implications for the broker (Burt 2004). To account for potential confounds, we therefore control for relational brokerage. To do so, for each project in the focal year, we constructed a network of prior co-authorships over the three-year time window preceding the focal year. We then compute each individual's betweenness centrality (Freeman 1978) in each author team and take the average of individuals' betweenness centrality in all authorship teams in the focal year as our measure of average relational brokerage.

Results

Table 3 shows the descriptive statistics and intercorrelations among all variables. Table 4 presents the results of our models. We estimate quasi-maximum likelihood Poisson (QML Poisson) count models for all our models with the number of completed projects and their citations as dependent variables. Because both of these variables are non-negative counts and over-dispersed, standard Poisson models that assume that the mean and variance of the variable distribution are equal would not be appropriate (Wooldridge 2010). We took the natural logarithm plus one for count variables whenever they entered the regression on the right-hand side to match count explanatory variables that underwent the same transformation on the left-hand side (Wooldridge 2010). Models 1 and 3 present the results of QML Poisson regressions, modelling the quantity of projects using the number of an individual's publications in a focal year and the quality of projects using the average citation count of these publications as a function of all control variables. Models 2 and 4 present the results of the same regressions, this time modelling both dependent variables as a function of all control variables and the independent variable— temporal brokerage.

---- Insert Tables 3 and 4 about here ----

As predicted in Hypothesis 4, the increased coordination work associated with temporal brokerage in the preceding years is associated with decreased productivity in the focal year: We find that individuals who have higher temporal brokerage values in a given three-year window publish significantly fewer articles in the subsequent focal year (b = -0.014, SE = 0.004, z = -3.79, $p < 0.001$).

Specifically, we find a decrease of 0.85%[2] in the number of completed projects for an increase from the 75th (temporal brokerage = 0.39) to 95th (temporal brokerage = 1) percentile for temporal brokerage. We calculate the effect size using the 75th and 95th percentile, since the temporal brokerage variable is extremely skewed to the right, such that the median value is zero.

However, temporal brokerage does not only lead to negative outcomes. Consistent with Hypothesis 5, we find that the articles of individuals who have had higher temporal brokerage scores in the preceding years garner significantly more citations over the following years ($b = 0.0165$, $SE = 0.003$, $z = 5.73$, $p < 0.001$). Specifically, we find a 1.01%[3] increase in forward citations for an increase from the 75th to 95th percentile for temporal brokerage.

In sum, we find evidence for the double-edged nature of occupying a position of temporal brokerage consistent with the within-team effects we observed in Study 1: While occupying positions of greater temporal brokerage leads to fewer completed projects in an individual's overall portfolio, it also increases the average quality of the portfolio of projects.

DISCUSSION

Across two studies of individuals working in temporally dispersed global teams, we find support for our hypotheses. In Study 1, we found that occupying a position of greater temporal brokerage in a global team is associated with engaging in more coordination work than occupying positions of lower temporal brokerage. We also found that, because of the increased coordination activity, individuals in positions of greater temporal brokerage developed higher levels of integrative complexity, but also shouldered a greater workload than individuals occupying positions of lower temporal brokerage. In Study 2, we found that these costs and benefits further spill over to other projects and shape an individual's performance in terms of the quantity and quality of their overall project portfolio: Individuals who occupy positions of greater temporal brokerage positions completed fewer projects, but the projects they completed were, on average, of higher quality.

Theoretical Contributions

[2] $effect\ size = \frac{e^{\beta_i \cdot 95th\ percentile}}{e^{\beta_i \cdot 75th\ percentile}} - 1 = \frac{e^{-0.014\cdot(1)}}{e^{-0.014\cdot(0.39)}} - 1 = -0.0085$

[3] $effect\ size = \frac{e^{\beta_i \cdot 95th\ percentile}}{e^{\beta_i \cdot 75th\ percentile}} - 1 = \frac{e^{0.0165\cdot(1)}}{e^{0.0165\cdot(0.39)}} - 1 = 0.0101$

This paper makes several important contributions to theory. First, we introduce a novel framework for conceptualizing temporal dispersion within global teams, which allows us to study the impact of temporal structures that were invisible with extant conceptualizations of temporal distance. Specifically, we introduce the construct of *temporal brokerage* and illustrate that occupying such a position in global teams has important consequences for individual team members. Although temporal brokerage is not a formal role, nor is it even a position that team members are likely to occupy knowingly, we find that it has important implications for the behaviors and outcomes of individuals in that position. Thus, the framework presented in this paper provides a compelling theoretical lens for understanding how the temporal structure of global teams shapes key individual outcomes. Although the present research focuses on temporal structures resulting from differences in team members' time zones, the framework we present is easily adaptable to the investigation of other factors that cause temporal offset between members. For example, organizations are seeing an increase in remote work, part-time work, shift work, and multiple team membership (Mortensen and Haas 2018, Wageman et al. 2012). All of these phenomena lead to situations in which team members' work times do not fully coincide. The framework provided in this paper can help to better understand the dynamics arising in such teams and their implications for individual outcomes and team functioning.

Second, our findings speak to recent calls to identify pivotal roles in globally distributed teams (Maynard et al. 2017), with implications for research on leadership emergence in such teams. Our finding that team members in positions of temporal brokerage are particularly likely to take up coordination roles highlights these positions as potentially critical for the functioning of global teams (Collings and Mellahi 2009). Arguably, a position of temporal brokerage and the associated involvement in coordination across time zones constitutes a strategic core role on global teams— that is, a role on the team that has greater exposure to the team's tasks and problems is more central to the workflow of the team (Humphrey et al. 2009). This, in turn, has important implications for theories of leadership emergence in global and virtual teams. Prior work in this domain has focused on the role of individual differences in personality and behavior in predicting leadership emergence (Charlier et al. 2016, Cogliser et al. 2012, Hoch and Dulebohn 2017, Yoo and Alavi 2004). However, our findings imply that the role of a team's structure— temporal structure in our case— cannot be ignored.

Specifically, they suggest that individuals engage in behaviors that distinguish them as emergent leaders not only as a function of their personal preferences or traits, but also as a function of the demands associated with their structural position in a team's temporal network.

Finally, this paper offers several insights to the broader literature on brokerage and brokering. First, our findings provide causal evidence for the postulated connection between being in a structural brokerage position, engaging in specific brokerage behavior, and outcomes. A long-standing debate in the brokerage literature has been regarding whether being in a position of brokerage actually leads to various outcomes or whether it is endogenously associated with those outcomes (Fang et al. 2015, Lee 2009, Podolny and Baron 1997). This is because it is difficult to cleanly isolate the effects of being in a position of brokerage from the factors that would lead one to occupy such a position in the first place. However, in our empirical context, occupying positions of greater or lesser temporal brokerage is not something that most team members would be consciously aware of, much less something they actively plan for when forming teams. Moreover, the quasi-experimental design of our Study 1 allows us to effectively sidestep the issues of endogeneity mentioned above. Thus, we provide initial evidence that occupying a position of temporal brokerage can indeed cause specific outcomes. Second, our paper answers recent calls to take a process perspective on brokerage (Halevy et al. 2019, Obstfeld et al. 2014) by theoretically unpacking the mechanism by which being in a brokerage position leads to both positive and negative outcomes for the broker, namely through eliciting a particular kind of conduit brokering by engaging in coordination behaviors. Third, this last insight also has important implications for our understanding of the relationship between the structural notion of brokerage and the behavioral notion of brokering more generally. Recent work on brokerage and brokering treats the structural position of brokerage as independent from an individual's behavioral pattern when they are in a brokerage position— e.g., whether they engage in a more collaborative or more dividing form of brokering (Soda et al. 2018). The argument is that "networks do not act" (Burt 2012, p. 544), but rather are the result of complex interactions among actors. However, we find a causal link between being placed in a brokerage position and engaging in a specific brokering behavior. In other words, while networks may not act, at least in our context, they seem to create pressures for individuals to act in specific ways. An intriguing avenue for future research that arises from this insight is to create a better understanding of how contextual conditions may shape the pressures that networks exert on individual behavior. In our setting, the team context arguably plays a crucial role as it implies positive goal interdependence and, therefore, calls for helpful rather than harmful brokering. Other contextual conditions may make other forms of brokering behavior more likely.

Limitations and Directions for Future Research

This work has several limitations, which point to opportunities for future research. First, although we chose two complementary archival data sources that provide us with valuable data on a large number of globally distributed teams, a critical limitation of this approach is that we are constrained by the variables available within the databases. In particular, the measure we chose for operationalizing coordination behavior in Study 1 is a single item measure with a certain degree of ambiguity, which limits its construct validity and reliability. Although the conceptually convergent results between Study 1 and Study 2 are reassuring in this regard, future studies could test these hypotheses using a more reliable and valid measure of this construct. Furthermore, in both studies, the location of each team member— and, accordingly, their position in the team's temporal network— is a proxy derived from the location of their institution. It is possible that individuals were located in a different place and time zone from their institution during at least some portion of the project. For example, students in Study 1 could have attended the course remotely and scholars in Study 2 could have been temporarily located away from the institution listed on their publications while being on sabbatical. In Study 1, we were able to confirm the robustness of our results by excluding teams with any students who were remotely attending the course in which the project was embedded; however, in Study 2, we had no information providing more detail on specific locations beyond our main proxy.

Another limitation of our analysis is the set of assumptions about individual workdays, which serve as the basis for the construction of the temporal overlap networks. Specifically, we assume workdays to be of a fixed length (i.e., without any variance over time), and uniform across all members. These assumptions are easily challenged in practice, however, with interesting implications for temporal networks. Many global teams require some or all of their members to stretch their workdays as needed— for example, to be available until late at night or start very early in the morning. Although this practice is possible and often used, it comes at a cost: When team members stretch their workdays on a regular basis to accommodate others, the continued sacrifice of their personal time takes a toll and— as recent work has shown— becomes unsustainable over time (Cristea and Leonardi 2019). Future work could leverage the framework we present here to examine the joint effects of structural positions and work practices to gain a deeper understanding of their interplay. Furthermore, individuals' schedules can differ due to individual preferences or local practices, including differences in observed public and religious holidays. Given that our framework is easily amenable to a more nuanced mapping of temporal structure, future research could gather more fine-grained data on individual members' actual schedules and calculate temporal overlap and temporal brokerage based on this, rather than on the basis of a uniform work schedule.

Finally, more work is needed to examine team-level outcomes of temporal structures or temporal brokerage. While in the present study we focused on structural differentiation within teams and its implications for individuals occupying different positions in a global team's temporal structure, our conceptualization of temporal structure as a network of temporal overlap can also inform future team-level research by providing a framework to capture specific structural differences between teams. The network literature puts forward three key dimensions on which networks can differ from one another: density, clustering, and centralization (Wasserman and Faust 1994). Density reflects the average temporal overlap within teams and logically corresponds to current approaches to capture average temporal dispersion (Cummings et al. 2009). Clustering reflects the extent to which team members can be separated in relatively clearly delineated and disconnected subgroups (Newman 2006). Finally, centralization reflects the extent to which one or few members occupy a more central position in the network than others (Freeman 1978). Using the explanatory power that such a network lens provides, future research can develop a richer theoretical and empirical understanding of the implications of temporal structure on global teams' processes and performance. In addition, more work is needed to examine how the individuals who occupy temporal brokerage positions influence team performance. For example, prior research has shown that individuals who occupy core roles have a disproportionate impact on team outcomes and, thus, their knowledge, skills, and abilities are particularly critical to team performance (Humphrey et al. 2009, Summers et al. 2012). To the extent that occupying a temporal brokerage position constitutes a core role in global teams, future research integrating this line of work with the framework proposed in the current paper could examine whether and how the characteristics of temporal brokers— for example, multicultural experience or virtual communication skills (Leung et al. 2008, Schulze and Krumm 2017)— shape team-level performance. Such studies would contribute to further advancing our understanding of how to compose, structure, and manage global teams.

Conclusion

Temporal distance introduced by time zone differences between team members is a key characteristic of global teams. However, existing frameworks have provided a limited view of the implications of time zone differences in such teams. This paper presents a novel perspective on temporal dispersion, highlighting temporal brokerage as a critical structural position in global teams that poses high demands and, at the same time, provides important opportunities to those individuals who occupy it. In doing so, our work contributes to a deeper and more nuanced understanding of global teams and how their temporal structures shape key outcomes for their members.

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Table 1. Descriptive Statistics and Correlations (Study 1)

		M	*SD*	1	2	3	4	5	6	7	8	9
1.	Team size	6.52	0.87									
2.	Nationality diversity	0.76	0.12	-0.03								
3.	Average distance (ln)	2.12	0.26	0.21	0.05							
4.	Temporal density	5.02	1.15	-0.17	0.01	-0.86						
5.	Temporal centralization	0.12	0.08	0.02	0.02	0.65	-0.73					
6.	Prior integrative complexity	1.92	0.86	-0.05	0.00	-0.02	0.00	0.00				
7.	Temporal brokerage	0.20	0.09	-0.30	0.02	-0.03	0.01	0.07	0.01			
8.	Coordination behaviors	3.82	0.84	-0.18	0.04	-0.11	0.08	-0.06	0.11	0.13		
9.	Integrative complexity	1.73	0.62	0.09	0.03	0.16	-0.12	0.11	0.11	0.01	0.05	
10.	Workload	18.32	8.61	0.01	0.01	0.06	-0.06	0.04	0.04	0.07	0.35	0.10

Table 2. Hierarchical Linear Model Results for the Effect of Temporal Brokerage on Coordination Behavior, Integrative Complexity, and Workload (Study 1)

	Coordination Behaviors		Integrative Complexity			Workload		
	1	2	3	4	5	6	7	8
Team level variables								
Team size	-0.141***	-0.118***	-0.006	0.002	0.010	-1.181***	-0.953***	-0.321
	(0.020)	(0.020)	(0.013)	(0.013)	(0.013)	(0.168)	(0.172)	(0.218)
Nationality diversity	0.298*	0.292*	-0.036	-0.039	-0.056	0.228	0.150	-1.324
	(0.123)	(0.124)	(0.078)	(0.078)	(0.079)	(1.048)	(1.044)	(1.351)
Average distance (ln)	-0.289*	-0.289*	0.042	0.042	0.060	0.931	0.934	2.585
	(0.122)	(0.122)	(0.079)	(0.079)	(0.080)	(1.061)	(1.058)	(1.332)
Temporal density	-0.044	-0.045	-0.009	-0.009	-0.007	-0.012	-0.015	0.195
	(0.029)	(0.029)	(0.019)	(0.019)	(0.019)	(0.256)	(0.256)	(0.322)
Temporal centralization	-0.427	-0.512	-0.082	-0.112	-0.080	-4.562	-5.424*	-3.931
	(0.276)	(0.277)	(0.178)	(0.179)	(0.181)	(2.398)	(2.395)	(3.025)
Individual level variables								
Prior integrative complexity	0.085***	0.085***	0.086***	0.086***	0.081***	0.430**	0.431**	-0.004
	(0.012)	(0.012)	(0.010)	(0.010)	(0.010)	(0.141)	(0.141)	(0.127)
Temporal brokerage		0.746***		0.271**	0.230*		7.697***	3.765**
		(0.113)		(0.100)	(0.100)		(1.384)	(1.211)
Coordination behaviors					0.058***			5.417***
					(0.012)			(0.159)
Semester fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	5.307***	5.038***	2.014***	1.916***	1.615***	26.746***	23.953***	-3.022
	0.435	0.437	(0.281)	(0.283)	(0.293)	(3.781)	(3.801)	(4.842)
Observations	4,553	4,553	4,553	4,553	4,553	4,553	4,553	4,553
Log Likelihood	-4,866	-4,844	-4,094	-4,091	-4,080	-16,063	-16,048	-15,639
Total variance explained	0.053	0.060	0.097	0.098	0.102	0.050	0.056	0.245

*p < 0.05, **p < 0.01, ***p < 0.001

Note. Total variance explained is calculated following Snijders and Bosker (2012, p. 112)

Table 3. Descriptive Statistics and Correlations (Study 2)

		M	*SD*	1	2	3	4	5	6	7	8	9	10	11
1	Prior publications (ln)	2.15	1.05	1.00										
2	Average team size (ln)	1.64	0.36	0.22	1.00									
3	First- & solo- authored articles (ln)	1.20	0.93	0.68	0.00	1.00								
4	Average distance (ln)	2.93	3.21	0.31	-0.01	0.21	1.00							
5	Multinational projects (ln)	1.39	0.47	0.70	0.15	0.44	0.34	1.00						
6	Average temporal centralization	0.01	0.03	0.11	-0.09	0.10	0.42	0.17	1.00					
7	Team density	3.22	3.19	0.48	0.09	0.32	0.59	0.33	0.14	1.00				
8	Publication year	2005.42	2.79	0.05	0.00	0.02	0.10	0.05	0.06	0.02	1.00			
9	Relational brokerage	0.03	0.12	0.09	0.05	0.06	0.14	0.07	0.04	0.20	0.01	1.00		
10	Temporal brokerage	0.20	0.41	0.23	-0.07	0.18	0.57	0.21	0.40	0.42	0.11	0.11	1.00	
11	Quantity of projects	6.60	13.52	0.51	0.15	0.39	0.08	0.18	0.03	0.17	0.06	0.01	0.06	1.00
12	Quality of projects	37.20	23.51	-0.05	0.04	-0.01	0.07	-0.02	0.01	0.07	0.07	0.04	0.05	-0.07

Table 4. Regression Results for the Effect of Temporal Brokerage on Number and Quality of Completed Projects (Study 2)

	1	2	3	4
	Quantity of Projects	Quantity of Projects	Quality of Projects	Quality of Projects
Prior publications (ln)	0.862***	0.862***	-0.077***	-0.078***
	(0.002)	(0.002)	(0.002)	(0.002)
Average team size (ln)	0.137***	0.136***	0.028***	0.029***
	(0.004)	(0.005)	(0.004)	(0.004)
First- & solo- authored articles (ln)	0.029***	0.029***	0.031***	0.031***
	(0.002)	(0.002)	(0.002)	(0.002)
Average distance (ln)	-0.004***	-0.003***	0.006***	0.005***
	(0.001)	(0.001)	(0.000)	(0.000)
Multinational projects (ln)	-0.411***	-0.411***	0.037***	0.037***
	(0.005)	(0.005)	(0.003)	(0.003)
Average temporal centralization	0.183***	0.234***	0.054*	0.012
	(0.048)	(0.048)	(0.033)	(0.034)
Team density	-0.015***	-0.015***	0.005***	0.005***
	(0.001)	(0.001)	(0.000)	(0.000)
Years between publication and citation capture			-0.024***	-0.023***
			(0.001)	(0.001)
Relational brokerage	-0.058***	-0.055***	0.054***	0.053***
	(0.010)	(0.010)	(0.008)	(0.008)
Temporal brokerage		-0.014***		0.017***
		(0.004)		(0.003)
Constant	-0.181***	-0.182***	4.006***	4.004***
	(0.062)	(0.062)	(0.079)	(0.079)
Fixed effects				
Focal publication field	yes	yes	yes	yes
Main country of residence	yes	yes	yes	yes
Publication year	yes	yes	yes	yes
N	296576	296576	296576	296576
Log likelihood	-744506.8	-744476.9	-2275730.4	-2275570.1
Standard errors in parentheses	*p < 0.05, **p < 0.01, ***p < 0.001			

Note. Variables marked by the (ln) transformation entered the regression in the natural logged form.

Figure 1. An Example of a Temporally Dispersed Global Team

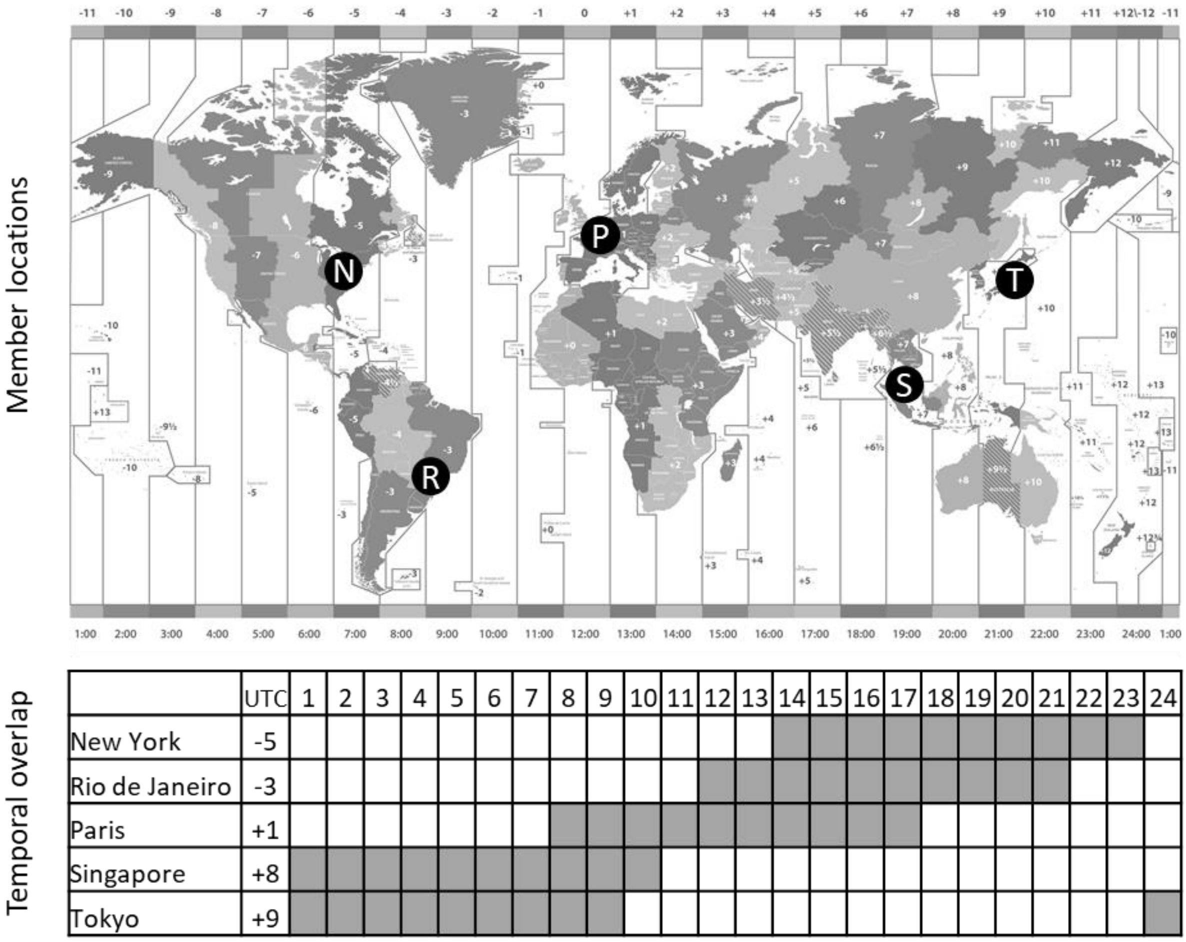
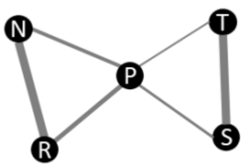


Figure 2. Constructing the Temporal Network of a Global Team

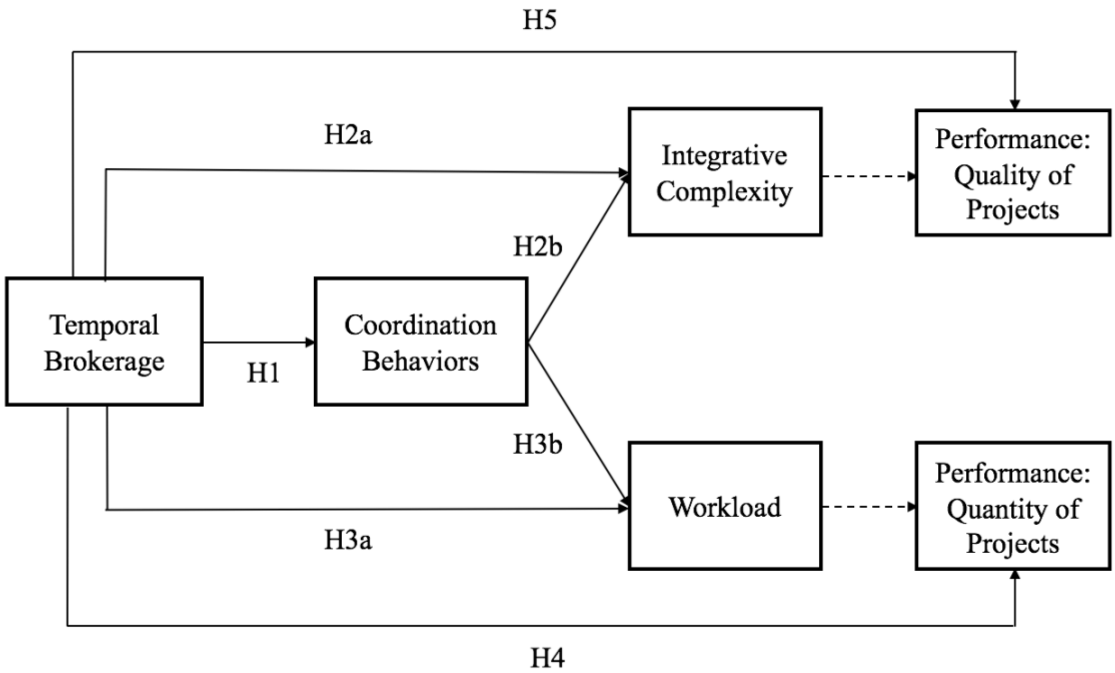
Pairwise overlapping hours

	N	R	P	S	T
New York	-	8	4	0	0
Rio de Janeiro	8	-	6	0	0
Paris	4	6	-	3	2
Singapore	0	0	3	-	9
Tokyo	0	0	2	9	-



Note. The matrix contains the *temporal overlap* between each pair of members, based on which we graphed the resulting temporal network.

Figure 3. Theoretical Model



Notes. Dotted lines denote relationships that are implied in our theoretical model, but not empirically tested in our studies. Quality and quantity of projects refer to an individual's entire portfolio of projects.