Diagnosing the Locus of Trust: A Temporal Perspective for Trustor, Trustee, and Dyadic Influences on Perceived…

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Diagnosing the Locus of Trust: A Temporal Perspective for Trustor, Trustee, and Dyadic Influences on Perceived Trustworthiness

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Extant trust research champions 3 different centers of action that determine perceptions of trust: the trustor (the individual rendering trust judgments), the trustee (the party being trusted), and the trustor-trustee dyad. We refer to the centers of action as loci of trust. Thus far, researchers have investigated determinants residing within each locus independently but have not concurrently investigated all 3 loci. Thus, the relative influence of each locus on perceptions of trust is unknown. Nor is it known how the influence of each locus changes with time. Where is the dominant locus of trust? And how does it change over time? We address these questions by examining the influence of trustors, trustees, and dyads on perceived ability, benevolence, and integrity. We find that trustor influence decreases over time while trustee and dyadic influences increase. We also find that the trustor is the dominant locus for perceived ability, benevolence, and integrity initially, but over time the trustee becomes the dominant locus for perceived ability and integrity. For perceived benevolence, the trustor remains the dominant driver over time.

Keywords: interpersonal trust, perceived trustworthiness, multilevel analysis, social relations model

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INTRODUCTION

What determines perceptions of trust? This question addressing the very foundation of trust research has produced three distinct theories on interpersonal trust development. Early work by Rotter (1971) focused on the trustor (the individual rendering trust judgments) and proposed that trust is a generalized expectation of others derived from childhood experience or heredity (Gurtman, 1992; Jang, Livesley, & Vernon, 1996). Thus, perceptions of trust are an individual difference unique to the trustor with a global effect on all of the trustor's relationships. Research emphasis shifted to the trustee (the party being trusted) with the seminal work of Mayer, Davis, and Schoorman (1995). While a trustor's dispositional trust is deemed important, the dominant driver of trust perceptions is the trustee's inherent level of trustworthiness that trustors can uncover (Dirks & Ferrin, 2002; Mayer & Davis, 1999; Mayer & Gavin, 2005). The third research stream focuses on trust as a property of the trustor–trustee dyad. Social exchange theory provided the early foundation for dyadic trust research, suggesting that perceptions develop from repeated dyadic exchanges (Blau, 1964). In recent years, dyadic trust research has expanded to include trust formed by social category membership, reciprocal relationships, and relational properties of the dyad (Brewer, 1979; Ferrin, Dirks, & Shah, 2006; Lawler, Thye, & Yoon, 2008). Together, these perspectives champion three different centers of action determining trust perceptions: the trustor, the trustee, and the dyad. We refer to these centers of action as loci of trust.

Research to date focuses on specific determinants within each locus of trust, such as propensity to trust (trustor locus), organizational citizenship behaviors (trustee locus), or social category similarity (dyadic locus; Ferrin et al., 2006; Levin, Whitener, & Cross, 2006; Parks, Henager, & Scamahorn, 1996). Indeed, empirical work provides ample evidence of the importance of specific determinants within a single locus, and a few studies have investigated determinants from multiple loci (Ferrin et al., 2006; Yakovleva, Reilly, & Werko, 2010). However, the focus remains on the determinants, not the comprehensive influence of the loci themselves. In this article, we shift our attention from the specific determinants to the broader loci. In doing so we propose a novel way of investigating trust by focusing on the comprehensive body of influence associated with the trustor, trustee, or dyad. When considered together, will trust perceptions be dominated by a trustor's disposition, trustee characteristics and actions, or the dyadic relationship between the two? Focusing on only one of the three loci inhibits a comprehensive understanding of factors influencing perceptions of trust and can lead to incorrect inferences about the importance of observed effects. Furthermore, focusing on any one locus alters the questions asked, the variables studied, and the research designs constructed. Thus, our knowledge of how trust develops may be incomplete without fully understanding how trust forms simultaneously across different loci.

Moreover, what if trustor, trustee, or dyadic influences on trust perceptions wax or wane over time? Time, a ubiquitous but frequently overlooked variable, is often found to play an important role in behavior in organizations (Albert, 1995). Trust researchers have theorized about the evolution of trust (Lewicki & Bunker, 1995; Mayer, Davis, & Schoorman, 1995; McKnight, Cummings, & Chervany, 1998; Rousseau, Sitkin, Burt, & Camerer, 1998), but they have not explicated the role of loci as trust emerges and evolves. In this article, we extend the conversation on the evolution of trust to include the relative influence of the trustor, trustee, or dyad over time. The influence of the trustor, trustee, and dyad may shift with time such that each may play an important role but at a different stage of the relationship. Consequently, the results may differ based on when data is collected. As such, the omission of time is particularly problematic given the cross-sectional nature of much trust research. Thus, neglecting the temporal context can result in incorrect generalizations about trustor, trustee, or dyadic influences on interpersonal trust. These concerns highlight the need to better understand the simultaneous influence of different loci of trust over time. They raise two central questions: What is the influence of the trustor, trustee, and dyad on interpersonal trust when examined concurrently? And how do their influences change over time?

To examine these questions, we conducted a longitudinal field study of undergraduate project teams and employed a social relations modeling approach (Kenny, 1994) that partitions variance into trustor, trustee, and dyadic variance at different periods of time. This approach, which is based on a crossed-observational design where each individual evaluates all other team members, enables us to simultaneously investigate the influence of multiple loci. It also allows us to examine how the influence of loci emerge and change over time, which has not been done in past trust research. The influence of a locus is based on variance attributed to it: The greater the variance attributed to a locus, the greater the influence of that locus's underlying characteristics. Unlike traditional analytic techniques, variance partitioning does not specify independent variables associated with the trustor, trustee, or dyad; instead, it estimates the combined influence of all characteristics unique to the trustor, trustee, and dyadic locus. Thus, in contrast to prior trust research which examines specific determinants associated with a certain locus, we shift the focus to the overall influence of the loci themselves. It also employs the logic of the ICC(1) statistic, which is used to characterize the influence of groups on individual actions as well as the influence of individual differences on repeated measures over time (Bliese & Ployhart, 2002; Rindskopf, 2013). We simply extend this logic to trust observations that have multiple grouping sources (trustor, trustee, and dyad) as well as repeated measures. Our focus on the loci liberates us to address the more fundamental question of where the locus of trust resides without needing to identify specific characteristics at each loci. We also add a temporal perspective to investigate not only *whether* different loci influence trust perceptions but *when* they are most influential.

Our study makes three important contributions. First, we increase our understanding of the locus of interpersonal trust. An amalgam of determinants inherent to trustors, trustees, and dyads concomitantly influence perceptions of trust. While knowledge of specific trust determinants is important, we suggest that understanding the influence of different loci helps frame the consequence of determinants in the broader context in which trust develops. Second, focusing on loci instead of specific determinants enables us to compare the influence of all underlying characteristics at each locus. Thus, we can explore where determinants may reside without specifying them. It can identify influential loci that may be underrepresented in trust research, highlighting promising areas for further study. Third, by investigating trustor, trustee, and dyadic influence over time we can intelligently frame the generalizability of cross-sectional trust research that is conducted at specific relational stages. Overall, our goal is to provide a more complete understanding of perceptions of trust.

THEORY AND HYPOTHESES

Perceived Trustworthiness

When discussing trust it is important to be explicit about its conceptualization (Bhattacharya, Devinney, & Pillutla, 1998; Fulmer & Gelfand, 2012; Rousseau et al., 1998). Trust can be divided into three concepts: trusting actions (i.e., risky behaviors indicative of trust; Kramer, Shah, & Woerner, 1995; Pillutla, Malhotra, & Murnighan, 2003); trusting intentions (i.e., willingness to be vulnerable; Colquitt, Scott, & LePine, 2007; Mayer et al., 1995); and trusting beliefs (i.e., positive expectations of trustworthiness; Ferrin & Dirks, 2003; Ferrin et al., 2006; Mayer et al., 1995). Each is used extensively in trust research and there exists a robust debate as to their merits. We do not seek to influence this debate, but we do wish to be explicit about what perspective this article adopts, why it is appropriate, and how it compares with the other conceptualizations of trust.

We focus on trusting beliefs in lieu of trusting actions or trusting intention. We conceptualize trusting beliefs as perceptions of trustworthiness, which are formed as a trustor observes, interprets, and ascribes motives to trustees' actions (Ferrin & Dirks, 2003; Korsgaard, Brodt, & Whitener, 2002; Mayer et al., 1995). We use the term *perceived trustworthiness* or the more general term *perceptions of trust* to denote this attributional judgment of another. Perceived trustworthiness is a multidimensional concept comprised of ability, benevolence, and integrity (Mayer et al., 1995). It aligns closely with trust based on cognition and affect (Colquitt, LePine, Zapata, & Wild, 2011; McAllister, 1995) and with trust conceptualized as positive expectations (Fulmer & Gelfand, 2012). Perceived trustworthiness is distinct from and precedes trusting intentions and trusting actions, and provides a basis to engage in these other constructs (Colquitt et al., 2007; McKnight et al., 1998). Investigating perceived trustworthiness enables us to conduct a more nuanced examination in which we compare and contrast the influence of trustors, trustees, and dyads across the three dimensions: ability, benevolence, and integrity.

Perceived ability is a trustor's assessment of a trustee's competence in a given domain. It is a judgment of a trustee's skills, expertise, and abilities that allow the trustee to perform at a certain level. Perceived benevolence is an assessment of a trustee's willingness to act in the best interest of the trustor, separate from motive for personal gain. It is a judgment of a trustee's empathy or concern for the trustor's welfare. Perceived integrity is an assessment of a trustee's propensity to adhere to principles regarded as right or moral by the trustor. It is a judgment of a trustee's moral fortitude to act in a way the trustor deems appropriate (Mayer et al., 1995).

These three dimensions combine to form the concept of perceived trustworthiness, but they are sufficiently distinct to merit individual consideration. Perceived benevolence is different from perceived ability and integrity due to its stronger affective foundation (Colquitt et al., 2011; McAllister, 1995) based on emotional bonds. In contrast, perceived integrity and ability have stronger cognitive foundations and do not presuppose an emotional investment. Perceived ability is distinct from perceived integrity because it is specific to a particular skill domain. Ability in one domain does not require ability in another domain, but integrity is evaluated globally across domains. Perceived integrity is distinct from perceived ability because of the differing impact of disconfirming information (Kim, Ferrin, Cooper, & Dirks, 2004). A single integrity breach can lead to negative evaluations across situations and over time, whereas consequences of a single ability breach may be more limited. Along with these conceptual differences, research findings indicate these facets of trust are empirically related, yet distinct (Colquitt et al., 2007; Dirks & Skarlicki, 2009). Moreover, trustee actions signaling these three dimensions of trustworthiness may vary, and the influence of a locus may emerge differently across dimensions. Thus, investigating the three dimensions of perceptions of trustworthiness provides a fertile testing ground to examine the influence of different loci over time.

Temporal Evolution of Trust

Multiple trust researchers have proposed theoretical models of trust development (Lewicki & Bunker, 1995; Rousseau et al., 1998; Shapiro, Sheppard, & Cheraskin, 1992). Together, they provide an organizing framework that centers around the different types of information used to assess trust as relationships evolve. Early trust is presented as a cognitive process model ranging from a rational choice to a social categorization heuristic. In the former, trustors analyze the costs and benefits of entering, remaining, or discontinuing a relationship (Lewicki & Bunker, 1995; Rousseau et al., 1998; Shapiro et al., 1992). This cost-benefit analysis need not be strictly rational as perceptual biases and individual desires can sway decisions (Weber, Malhotra, & Murnighan, 2004). In the latter, cognitive heuristics that use social categories influence initial judgments of trust (Levin et al., 2006; Williams, 2001). As relationships progress, the basis of trust switches to an information processing model (i.e., knowledge-based trust) whereby trustees behaviors and actions are observed and evaluated by trustors (Levin et al., 2006; Lewicki & Bunker, 1995; Shapiro et al., 1992). In mature relationships, trust is based on positive expectancies of the trustee based on repeated interactions, mutual understanding, and internalization of common values (Levin et al., 2006; Lewicki & Bunker, 1995; Rousseau et al., 1998; Shapiro et al., 1992). The deeper, unconditional trust that forms at this stage is associated with positive affect and is stable over time and across situations (Jones & George, 1998; Williams, 2001). While current models clearly elucidate pathways for trust development over time, they have yet to be tested using a longitudinal design.

These theories focus on different types of information used to form judgments of trust across time; however, they do not address the locus at which the information resides. The cognitive process models used to formulate early trust suggest two different influential loci. The rational choice model suggests influence emanates from the trustor locus. Biases, predispositions, and cost-benefit assessments based on prior experience are all factors that reside within the trustor. In contrast, heuristics based on social category delineation suggests that influence originates from homophily at the dyadic locus. The shift to an information processing model to assess trust as relationships progress suggests influence transfers to the trustee locus. Behaviors and actions indicative of competence, reliability and predictability all reside within the trustee. Lastly, trust based on mutual understanding, emergence of shared values and positive expectancies suggests ascending dyadic influence. Strong affective bonds, mutual understanding and reciprocal relationships, are all properties residing within the dyad. Thus, trustor, trustee, and dyadic loci may rise to prominence at different points as relationships evolve. Moreover, each loci may have different trajectories of influence as trust perceptions develop over time. The upcoming sections explore these three trajectories in greater detail focusing on the influence of each locus over time on perceived ability, benevolence, and integrity.

Trustor influence trajectory. Research focused on the trustor views interpersonal trust as a predisposition or expectancy held by the trustor (Gurtman, 1992; Rotter, 1971; Sorrentino, Holmes, Hanna, & Sharp, 1995). While trustor influence is most commonly operationalized as propensity to trust, it is actually a broader repository encompassing many different facets of the trustor, such as, personal experience (Kassin, 1979; Rotter, 1971), heredity (Gurtman, 1992; Jang et al., 1996; Sorrentino et al., 1995), cultural background (Ferrin & Gillespie, 2010), or socioeconomic status (Piff, Kraus, Côté, Cheng, & Keltner, 2010). Cognitive biases, such as those influencing perceptions of dependence and desire to believe in the trustee also serve as potential sources of trustor influence (Weber et al., 2004). Trustor effects are stable, within-individual factors that have a global effect on a trustor's willingness to trust others. Personality research also provides evidence of the stability and internal consistency of trustor influences as a facet of agreeableness, a dispositional variable subject to extensive research (Barrick & Mount, 1991; Costa & McCrae, 1992). These and potentially other trustor properties influence how trustors detect and evaluate the motives and actions of others—leading them to be cynical, skeptical, or sensitive to signs of betrayal on one side of the spectrum or to be undoubting and attune to signs of trustworthiness on the other side (Parks et al., 1996). In sum, the body of research above proposes that trust inheres in and spawns from the trustor.

Given the broad swath of literature and evidence linked to the trustor, we expect a strong trustor influence initially across all three dimensions of perceived trustworthiness (Colquitt et al., 2007). The rational choice models used in the beginning stages of trust development suggests trust perceptions originate from the trustor (Lewicki & Bunker, 1995; Rousseau et al., 1998). Trustors conduct their initial cost-benefit analysis with little to no trustee information. As such, trustor perceptions, judgments, and biases are apt to prevail. Specifically, personal judgments of one's own competence are likely be reflected in perceptions of trustees' abilities (Kassin, 1979). Benevolence perceptions are apt to be biased by individual traits or station, such as one's agreeableness or socioeconomic status (Costa & McCrae, 1992; Piff et al., 2010). And integrity perceptions are apt to be driven by one's history or experience observing the moral conduct of others in similar situations. However, trustor influences are likely to change over time as additional information becomes available. Information processing models of trust formation predict that, as relationships progress, subsequent judgments of trustees' trustworthiness will be based on observations of or experience with trustees (Mayer et al., 1995; McKnight et al., 1998). Similarly, research investigating propensity to trust expects the prominence of trustor level determinants to wane as trustee information becomes available (McKnight et al., 1998). In this view, trustor dispositional characteristics remain stable, but their influence on trust judgments declines when trustee information is detected. Thus we predict:

Hypothesis 1a–c: Trustor influence on perceptions of ability (H1a), benevolence (H1b), and integrity (H1c) will decrease over time.

Trustee influence trajectory. Research by Mayer and colleagues (1995) shifted the focus of trust to emphasize trustee characteristics that inspire positive behavioral expectations. While the trustor makes these assessments, this body of research proposed that it is ultimately a trustee's characteristics, motives and actions that drive trustworthiness perceptions. The growth of this research stream coincides with a shift away from the prior research focused on individual differences, and it mirrors the transition from cognitive process models of trust to information processing models of trust. Scholars have used game theory and attribution theory to illustrate how past trustee behaviors impact perceptions of trustworthiness (Axelrod, 1984; Korsgaard et al., 2002; Lewicki & Bunker, 1995). Thus, trustors are not expected to have a similar level of trust for all trustees they encounter, but perceptions of trustworthiness can vary across trustees based on a myriad of trustee differences. Trustors gather information to uncover a trustee's inherent levels of trustworthiness. Cooperative trustee behaviors signal trustworthiness, whereas competitive, self-interested behaviors are deemed untrustworthy (Butler, 1995). Consistent with an attribution framework, trustee behavior is more likely to be diagnostic of trustworthiness if performed voluntarily and consistently over time and across situations (Kelley, 1973; Korsgaard et al., 2002). Trust, leadership and negotiation research all indicate that the behaviors and actions of trustees— be they coworkers, leaders, or negotiation partners—influence perceptions of trustworthiness (Butler, 1995; Dirks & Ferrin, 2002; McAllister, 1995).

All three dimensions of perceived trustworthiness—ability, benevolence, and integrity—are susceptible to trustee influence. Observing trustees over time and across multiple situations enables trustors to determine trustees' skills, competencies, expertise, and performance to render ability judgments. High-quality work and task accomplishments serve as important signals of trustee ability. In fact, ability is viewed as an individual property of the trustee (Yakovleva et al., 2010). Observations of trustee empathy, concerns for a trustor's well-being, or actions targeted to help the trustor all serve as important benevolence signals (Dirks & Ferrin, 2002; Ferrin et al., 2006; Mayer & Gavin, 2005). Trustee actions indicating the use of procedural and interactional justice are helpful when forming integrity assessments (Colquitt, Lepine, Piccolo, Zapata, & Rich, 2012; Colquitt & Rodell, 2011). In sum, trustee research suggests that trust is a property of the trustee to be discovered by trustors.

The required discover stage for trustee influence suggests that the trustee influence trajectory is opposite to the trustor trajectory. While research in this domain views trust as a property of the trustee, it can only be discovered by trustors over time, through multiple interactions across different situations. Thus, trustee influence is likely minimal early on, but will develop over time as more trustee information and actions are broadcast to all observing trustors.

> *Hypothesis 2a–c: Trustee influence on perceptions of ability (H2a), benevolence (H2b), and integrity (H2c) will increase over time.*

Dyadic influence trajectory. The sections above detail the independent influence of each individual in a trust relationship, but do not explain unique dyadic influence. Trustors are not merely passive observers of trustee attributes and actions, but are active participants engaging with trustees to generate jointly shared experiences (Jones & George, 1998; Lawler et al., 2008). Early social exchange research provided a foundation for dyadic influence by illustrating the role of mutual obligations on the evolution of dyadic trust (Blau, 1964; Whitener, Brodt, Korsgaard, & Werner, 1998). Researchers focusing on the quality of the trustor–trustee relationship expanded this work to illustrate the cyclical and reciprocal role of these exchanges (Ferrin, Bligh, & Kohles, 2008; Serva, Fuller, & Mayer, 2005). Voluntary cooperative behaviors such as organizational citizenship behaviors directed toward a trustor cause the trustor to reciprocate in kind resulting in an evolving cycle of trust unique to the dyad (Ferrin et al., 2008, 2006).

Dyadic influence can also arise from shared characteristics. Social categorization and social network research demonstrate that positive attributions and expectations of trust accrue to individuals categorized as ingroup members (Kramer et al., 1995; McPherson, Smith-Lovin, & Cook, 2001). Category distinctions occur early based on easily discernable characteristics, such as age (Burt, 1991; Marsden, 1988) and gender (Ibarra, 1992; Kleinbaum, Stuart, & Tushman, 2013). Dyads with shared category membership view each other as more honest, fair, and trustworthy compared with dyads lacking common membership (Brewer, 1979; Kramer et al., 1995). Dyadic similarity also provides an affective bond, which generates cooperation, empathy, mutual concern for others' welfare, and a motivation to provide assistance (Reagans & McEvily, 2003). Moreover, the same behavior exhibited by a trustee will be evaluated differently based on whether the trustee is viewed as an ingroup or outgroup member (Hewstone, 1990; Pettigrew, 1979). For example, moral transgressions will spawn more extreme negative reactions when committed by outgroup trustees than ingroup trustees (Kramer et al., 1995). Such outgroup trustee behavior is also considered more diagnostic of their innate character, eliciting stronger causal attributions than for ingroup trustees (Janis, 1983).

While social category distinctions can occur instantaneously, and have been found to influence initial trust judgments (Levin et al., 2006), they only result in a generic, depersonalized trust toward individuals in a given ingroup (Brewer, 1979). In contrast, strong dyadic influences require time to develop. As dyadic ties evolve over time, they create jointly shared experiences (both positive or negative) causing members of the dyad to develop similar perceptions, shared emotions, and consistent attributions that serve as important stimuli for both dyad members' perceptions (Lawler et al., 2008). As members interact they also experience global positive or negative emotions (Weiner, 1986) that, when attributed to the dyad, create dyadic attachment or detachment respectively. This attachment is likely to further strengthen the affective bond in dyads and increase mutual judgments of benevolence. In contrast, detachment due to negative interactions is apt to result in mutually lower judgments of benevolence over time. Regardless of the emotion experienced in the dyad, dyadic influence will increase with continued interaction. As affective states are known to inform other judgments (Schwarz, 2001; Williams, 2001), we expect that shared experiences will influence mutual perceptions of ability and integrity as well. Thus, we expect dyadic influence to increase over time.

> *Hypothesis 3a–c: Dyadic influence on perceptions of ability (H3a), benevolence (H3b), and integrity (H3c) will increase over time.*

Diagnosing the Locus of Trust Initially and Over Time

The hypotheses above predict trustor, trustee, and dyadic influence trajectories when each is examined independently. In this section, we compare across these three loci to determine the dominant locus for each of the three dimensions of trustworthiness both initially and across time.

We develop our arguments building on past research investigating specific determinants across multiple loci (Ferrin et al., 2006; Lau & Liden, 2008; Levin et al., 2006; Yakovleva et al., 2010). Findings indicate both the independent influence of specific determinants at the different loci and their comparative strength. However, these isolated determinants represent only a small fraction of the overall characteristics of each locus so that the comprehensive influence of each locus compared with the others is unknown. Moreover, the cross-sectional nature of this research limits inferences regarding the importance of each locus over time. Extrapolating from this disparate set of results, we find that determinants at the trustor locus appear to be stronger than those at the trustee locus (Yakovleva et al., 2010) which in turn appear to be stronger than determinants at the dyadic locus (Ferrin et al., 2006; Lau & Liden, 2008). Trust in these studies is conceptualized as integrity. In contrast, when trust is conceptualized as benevolence researchers have found that the importance of dyadic information overshadows trustee information at the initial and late stages of a relationship (Levin et al., 2006). To date, only one study examining interpersonal trust provides a descriptive table partitioning variance among the trustor and trustee (De Jong, Van der Vegt, & Molleman, 2007). While the results are cross sectional and the three dimensions of trust are combined into one measure, they do provide some comparative insight suggesting the trustor has greater influence on interpersonal trust than the trustee. Consequently, it is unknown whether this pattern is consistent or if this pattern varies across all three trustworthiness dimensions.

As we incorporate the above findings, the trustor appears to play a strong and dominant role for perceptions of ability, benevolence, and integrity. Integrating the theoretical research on trust development, we posit that this may be more applicable in the initial stages of relationships when the rational choice model is active (Lewicki & Bunker, 1995; Rousseau et al., 1998; Weber et al., 2004). Moreover, researchers have proposed that trustor dispositional factors may be more salient in new relationships and in ambiguous, novel, or unstructured situations, particularly when trustee information is lacking (Mayer et al., 1995; McKnight et al., 1998). Scale development research on trust lends support to these propositions (Glaeser, Laibson, Scheinkman, & Soutter, 2000; Johnson-George & Swap, 1982). So does experimental research using scenario studies that provide trustors with ambiguous trustee information (Gill, Boies, Finegan, & McNally, 2005). Specifically, the correlation between propensity to trust and trusting intentions was significantly higher when ambiguous ability, benevolence, and integrity information regarding a hypothetical coworker was provided than when consistently high or low trustworthiness information was provided. While this experimental research focuses on trusting intent instead of trusting belief, is not longitudinal and focuses only on a single trustor determinant, it does provide foundational ideas on which to build. Additionally, given the time required for dyadic relationships to develop and the repeated interactions necessary to obtain valid trustee information, it is unlikely that either the dyad or trustee loci will have a strong initial influence on perceptions of trustworthiness on any dimension. Thus we predict:

Hypothesis 4a–c: Initially, the trustor will exert stronger influence on perceptions of ability (H4a), benevolence (H4b), and integrity (H4c) than the trustee or dyad.

In contrast to the research streams converging to suggest initial trustor dominance, the research diverges when examining the influence attributed to each locus over time. In this section, we review and synthesize each of these streams to examine the influence of each locus in the later stage of trust development.

Individual difference origins of trustor-centered research suggest personality traits are stable and enduring forms of influence (Barrick & Mount, 1991; Costa & McCrae, 1992). Indeed, early trust research finds that propensity to trust—an important determinant residing within the trustor locus—is an individual predisposition with long-term implications for how trustors evaluate the motives and actions of others (Parks et al., 1996; Rotter, 1971). While our first hypothesis suggests a declining pattern of trustor influence over time, the decline may be small enough such that trustor influence will still exceed that of the trustee or dyad. As such it may continue to be the dominant source of influence across all three dimensions of perceived trustworthiness.

Alternatively, research emanating from the trustee stream suggests increasing trustee influence as information regarding trustee behaviors, motives, and actions emerges over time (Mayer et al., 1995). The information processing framework suggests credible trustee information obtained over repeated interactions is required for trust to develop (Axelrod, 1984). Similarly, attribution theory frameworks underlying much of trust research suggest trustee behavior is particularly diagnostic over time as trustors observe consistent behavior across multiple situations (Kelley, 1973; Korsgaard et al., 2002). Thus, as trustees have opportunities to express their competence, goodwill toward others and moral fortitude, they help trustors accurately and consistently judge their ability, benevolence, and integrity.

Lastly, as trust in mature relationships is based on mutual understanding and internalizing common values, the dyadic locus may rise to prominence over time (Jones & George, 1998; Lewicki & Bunker, 1995; Rousseau et al., 1998; Shapiro et al., 1992; Williams, 2001). Shared dyadic experiences, mutual obligations, and opportunities for reciprocal exchange provides the affective backdrop necessary for a deeper, unconditional trust which remains stable over time and across situations (Jones & George, 1998; Williams, 2001). Indeed, experimental research on trust spirals provides evidence of the growing influence of dyadic level determinants over time, particularly for benevolence (Ferrin et al., 2008). Thus, as dyadic relationships have an opportunity to evolve over time trustor and trustee influence is apt to decline.

Each of the contrasting arguments above has its own merits. As such, we propose the following research question:

Research Question 1a–c: Over time, which locus will exert the greatest influence on perceptions of ability (RQ1a), benevolence (RQ1b), and integrity (RQ1c)?

METHOD

We collected data at a large Midwestern university from five sections of a 15-week undergraduate class.[1] Each section had 50 students, primarily freshman and sophomores. At the start of the semester, students were assigned to five-person teams constructed to be diverse on gender and international student status. Thus, our sample consists of 250 students, each assigned to one of 50 teams. Team members worked together on a semester long project constituting 40% of their grade. The project required a coordinated set of activities, so task interdependence was high. The element of risk for subjects was also high as they needed to rely upon teammates'

[1] Data presented in this article were part of a broader data collection. This is the first publication of the data.

expertise and work together to produce a cohesive final product. If a team member failed to perform a given task or performed it poorly, the grades of all team members were in jeopardy.

Projects teams met weekly for an average of 50 min per week until their final projects were presented at the end of the semester. This research context mimics many conditions encountered by employees when formulating trust perceptions at work while simultaneously providing embedded controls. First, the setting offered a common start point for formulating perceptions of trust, a critical factor when investigating emergent phenomena (Kozlowski, Chao, Grand, Braun, & Kuljanin, 2013). For the most part, team members did not know each other prior to class. Data collected near the beginning of the semester indicated that only 1% of within-team relations consisted of friendship ties. Thus, prior relationships do not contaminate the results. Second, teams had similar levels of diversity, performed the same task over the same duration of time and under the same conditions, faced the same evaluation criteria, and had the same end date. These conditions provide inherent controls for factors normally impossible to control in other organizational settings. Lastly, it was vital to test the hypotheses in a team context so all trustors have the same opportunity to view all trustees when rendering judgments of trustworthiness. This ensures that trustor judgments of trustees are comparable.

Sample and Data

We collected perceptions of trustworthiness at three points in time using an online survey. We administered the first survey during Week 2 (project start) after teams had their initial team meetings, the second survey during Week 9 (project midpoint), and the third survey at the end of the semester (project end) after teams had completed their project presentations but before receiving their grades. Of the 250 students, 241 (96%) completed Survey 1, 240 (96%) completed Survey 2, and 222 (89%) completed Survey 3; 215 (86%) completed all three surveys. The sample contained 97 female (39%) and nine international (4%) students, which was representative of all students surveyed.

Students were asked their perception of each teammate's ability, benevolence, and integrity. Because students responded to the same question for all team members, we used a single-item measure for each dimension of perceived trustworthiness. Single-item measures have been used by trust researchers in the past (Ferrin et al., 2006), and are appropriate when multiple-item measures are apt to cause respondent fatigue and when the item is constructed to be sufficiently narrow and unambiguous (Sackett & Larson, 1990; Wanous, Reichers, & Hudy, 1997). To ensure single-item measures of perceived ability, benevolence, and integrity were well understood, we combined phrasing from Mayer and Davis's (1999) often-used scales. For perceived ability, students were asked, "To what extent does [your teammate] have the ability to complete high-quality course work—do they have the knowledge and skills needed?" For perceived benevolence, they were asked, "To what extent is [your teammate] concerned for your welfare— someone who is looking out for you, who would go out of their way to help you, and who would not knowingly do anything to hurt you?" For perceived integrity, they were asked, "To what extent is [your teammate] fair and honest—do they stick to their word and use sound principles to guide themselves?" Students responded on a 5-point Likert scale (1 = *not at all*; 5 = *a great deal*) and could respond "Don't know" if they had not yet formed perceptions of trustworthiness toward teammates.

Responses from the sample were used to create a trustor– trustee–time– dimension panel dataset. A single team could have up to 180 observations if all five students rated four teammates in the three time periods for the three dimension of trustworthiness. If students responded, "Don't know," on an item, that item was dropped from the dataset. In total, the dataset contained 2,471 observations for perceived ability, 2,130 observations for perceived benevolence, and 2,250 observations for perceived integrity.

Single Item versus Multiple Items for Trustworthiness Dimensions

To confirm that the single item measures we developed were appropriate, we conducted an additional study using Amazon Mechanical Turk (MTurk). We surveyed 121 individuals and asked them to think about a specific work relationship (i.e., coworker, subordinate or supervisor) and then answer both the single-item measures of perceived trustworthiness and the multi-item measures developed by Mayer and Davis (1999) for their selected relationship. Question order was randomized to avoid ordering effects. Correlations between the single item measures for perceived ability, benevolence, and integrity and the corresponding composite multi-item measures were 0.72, 0.69, and .65, respectively. Further, we used confirmatory factor analysis (CFA) to see whether the single item measure loaded appropriately with the three latent perceived trustworthiness factors. The single-item perceived ability, benevolence and integrity measures were loaded with their corresponding items from the multi-item constructs. The construct items' and the single-item measure's factor loading estimates were very similar, and the fit indices for the CFA model indicated generally good fit (comparative fit index (CFI) = 0.96, TLI = 0.95, root mean square error of approximation (RMSEA) = 0.067). Overall, the MTurk study indicates that the single-item measures are appropriate substitutes for the multi-item constructs (see Table 1).

Variance as a Measure of Influence

To estimate the influence of the trustor, trustee, and dyad, we used variance analysis concepts from Kenny's (1994) social relations model. Social relations modeling uses variance as a measure of influence: the greater the variance of a factor (i.e., locus), the greater the influence of that factor's underlying characteristics. This technique exploits the benefits of multiple teammates rating one another to partition variance to the trustor, trustee, and dyad. Note, we do not use social relations modeling to examine specific independent variables associated with the trustor, trustee, or dyadic locus to predict perceptions of ability, benevolence, and integrity. Our predictions focus on the influence trajectories of each locus of trust over time and a comparison across loci. As such, the variance analysis captures the overall influence associated with all characteristics at each locus. This allows us to understand the more fundamental question of where the locus of trust resides without needing to identify a host of specific characteristics for each locus.

Partitioned variance is used to measure the influence of the loci because it captures disparities among trustors, trustees, or dyads. For example, if Trustor A was evaluating two teammates and perceived Trustee C to have high ability but not Trustee D, then the trustees themselves would likely be the cause of the divergent ratings. Moreover, if the trustees were driving perceptions, then other trustors would make similar judgments; for instance, Trustor B

Table 1. CFA for Single-item Measures of Perceived Trustworthiness

Item		Est.	S.E.	t-value	Corr.*
Perceived Ability					
Single-item	To what extent does [First Name] have the ability to complete high-quality work—does [he/she] have the knowledge and skills needed?	0.73	0.08	9.37	0.72
Multi-item	[First Name] is very capable of performing [his/her] job.	0.79	0.06	12.68	
	[First Name] is known to be successful at the things [he/she] tries to do.	0.76	0.07	11.72	
	[First Name] has much knowledge about the work that needs done.	0.78	0.07	11.51	
	I feel very confident about [First Name]'s skills.	0.71	0.06	11.35	
	[First Name] has specialized capabilities that can increase our performance.	0.77	0.07	10.93	
	[First Name] is well qualified.	0.80	0.07	12.35	
Perceived Benevolence					
Single-item	To what extent is [First Name] concerned for your welfare—someone who is looking out for you, who would go out of their way to help you, and who would not knowingly do anything to hurt you?	0.71	0.08	8.79	0.69
Multi-item	[First Name] is very concerned about my welfare.	0.81	0.07	11.91	
	My needs and desires are very important to [First Name].	0.72	0.07	10.72	
	[First Name] would not knowingly do anything to hurt me.	0.55	0.06	8.68	
	[First Name] really looks out for what is important to me.	0.87	0.07	12.92	
	[First Name] will go out of [his/her] way to help me.	0.75	0.06	11.87	
Perceived Integrity					
Single-item	To what extent is [First Name] fair and honest—does [he/she] stick to [his/her] word and use sound principles to guide themselves?	0.63	0.07	8.73	0.65
Multi-item	[First Name] has a strong sense of justice.	0.75	0.07	11.42	
	I never have to wonder whether [First Name] will stick to [his/her] word.	0.74	0.09	8.12	
	[First Name] tries hard to be fair in [his/her] dealings with others.	0.71	0.07	10.81	
	[First Name]'s actions and behaviors are very consistent.	0.58	0.06	9.07	
	Sound principles seem to guide [First Name]'s behavior.	0.75	0.07	11.59	

Note. $N = 121$. χ^2 (d.f.) = 229.0 (149); $p = .001$. Comparative fit index (CFI) = .96; TLI = .95; root mean square error of approximation (RMSEA), 90% confidence interval (CI) = .067 [0.049, 0.083]. All loadings significant at the $p < .001$.
* Correlation between single-item measure and composite score for multi-item measure.

would also judge Trustee C to have high ability but not Trustee D. As a result, variance in trustor perceptions would be small, but variance in trustee ratings would be large, indicating greater trustee influence. In contrast, if Trustors A and B made no ability distinction among trustees nor agreed on who was or was not high in ability, there would be little trustee variance and little evidence that trustees drove perceptions. Instead, the large discrepancies in trustor perceptions would indicate strong trustor influence. An important assumption for this analysis is that all trustors generally have the same opportunity to view all trustees, as was the case in our team context. If this were not the case, then differences in trustor perceptions could partly be due to other factors beyond trustor characteristics (e.g., different contexts).

These same principles apply to the dyad. Trustors J and K might diverge in their perceptions of Trustee L because of the dyadic characteristics they share with L. For example, Trustor J and Trustee L may have developed a close relationship, one that does not exist between

K and L. The dyadic characteristics would be manifest in this situation when J and L perceive each other as trustworthy, but K and L do not. Variance between dyads captures the influence of these underlying dyadic characteristics.[2]

Once the variance is partitioned into the trustor, trustee, and dyad, it can be compared across loci and over time to see where it primarily resides. The most influential locus is the one with the greatest variance.

ANALYSIS AND RESULTS

Descriptive statistics and correlations are presented in Table 2 and Figures 1 and 2. Table 2 indicates overall ratings for perceived ability and integrity (*Ms* = 4.00 and 4.05, respectively, out of 5) are higher than for benevolence (*M* = 3.16). The three trustworthiness dimensions are also significantly correlated with one another, as expected. Figure 1 illustrates that trustors had difficulty forming initial perceptions of benevolence and integrity. Half of all trustors were not able to form perceptions of benevolence and 46% were not able to form perceptions of integrity at project start. In contrast, only 31% of trustors were not able to form perceptions of ability initially. Over time, trustors were better able to form perceptions of all three dimensions, yet the pattern remained with 12% of trustors still unable to form perceptions of benevolence at project end in contrast to only 6% for perceptions of integrity and 2% for ability. Figure 2 shows that perceived ability remained quite stable over time, beginning at 3.99 and rising only to 4.04, and perceived integrity increased slightly from 3.94 to 4.15 on average. In contrast, perceived benevolence started much lower but increased more over time, from 2.89 to 3.35 on average. The steady increase of benevolence illustrated in Figure 2 suggests that greater caution was exercised, on average, when perceptions of benevolence were made in contrast to perceptions of integrity and ability.

Model Specification

We estimated the influence of each locus using a linear mixed-effects model (LMEM), which is particularly well suited for modeling social relations (Snijders & Kenny, 1999). LMEMs use both fixed and random parameters in a regression equation. Within each locus, the random parameters are assumed to vary randomly between subjects or dyads with a distribution that is multivariate normal (Fitzmaurice, Laird, & Ware, 2011). The effect of each locus is derived from the variance estimates of the random parameters. The definition of the random parameters and of the correlation (or independence) among them dictates the pattern for the sample's variance-covariance matrix. When analyzing variance, a critical decision is how best to pattern the variance-covariance matrix (Fitzmaurice et al., 2011)—particularly when multiple sources of clustering are present, as is the case in our sample with multiple loci as well as repeated measures. Choosing an appropriate variance-covariance matrix pattern is a question of balancing flexibility and parsimony (Nunez-Anton & Zimmerman, 2013). The aim is to adopt a matrix

[2] If Trustor J perceived Trustee L as trustworthy, but L did not reciprocate (L did not judge J as trustworthy), then the judgments would not be evidence of a mutual dyadic tie. Instead, it may be indicative of a trustor effect (if J judged all teammates as trustworthy) or a trustee effect (if all teammates judged L to be trustworthy), or it may fall into the error term (if the judgment does not correspond with any of the former patterns).

Figure 1. Percentage of trustors who had not formed perceptions of trustworthiness.

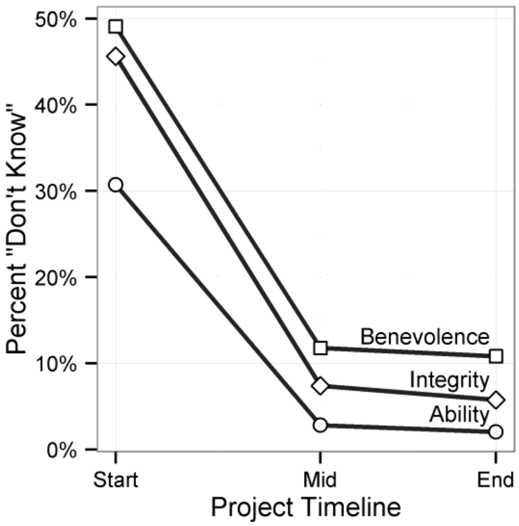


Figure 2. Average perceived trustworthiness over time.

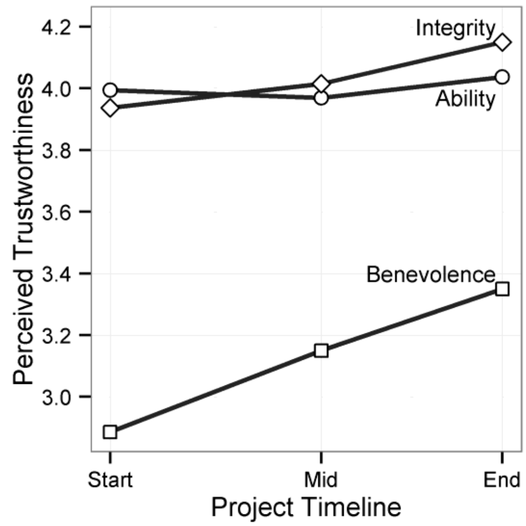


Table 2. Descriptive Statistics for Perceived Trustworthiness

				Correlation		
	N	Mean	St. Dev.	Ability	Benevolence	Integrity
Ability	2471	4.00	0.94	--		
Benevolence	2130	3.16	1.14	0.42**	--	
Integrity	2250	4.05	0.94	0.61**	0.51**	--

Note. St. Dev. = standard deviation.
** p < .01

pattern that is parsimonious enough to easily understand but flexible enough to accurately model the data.

To balance concerns of flexibility and parsimony and to best address our hypotheses and research questions, we present both a preliminary model and final model. Model 1 is our preliminary model; it is simpler with fewer random parameters and a straight forward variance-covariance matrix. It estimates the trustor, trustee, and dyadic variance for the different project time-points and perceived trustworthiness dimensions. (Using the social relations modeling nomenclature, dyadic variance refers to dyadic reciprocity, not the relationship component of a social relations model.) Model 1 mimics other social relations models that treat longitudinal data as independent snap shots (e.g., Kenny, Horner, Kashy, & Chu, 1992). Model 2 is the final model we use for hypothesis testing; it is more complex but adds additional insight not available in Model 1. Model 2 separates the total variance by the three loci as in Model 1, but it treats repeated measures differently. Instead of independent snap shots, longitudinal data is modeled as a continuing moving picture of the same participants that demonstrate enduring behaviors and judgments. In this way, Model 2 more accurately captures the actual project team experiences.

In Model 1, we assume the influence of trustors, trustees and dyads are independent across time. For instance, trustor judgments made in one time period have no relation to judgments made in the next, and trustee actions that influence such judgments are unrelated across time as well. The assumption allows us to simply estimate the variance at the beginning, middle, and end of the project for each locus and perceived trustworthiness dimension. Model 1 includes variance estimates (σ^2) for trustors, trustees, and dyads for each time period/trustworthiness dimension combination. The influence of a locus is calculated as the variance of the locus divided by the total variance for the given perceived trustworthiness dimension and time period. For instance, the trustor influence for a given trustworthiness dimension k at a given time period t is calculated as:

$$trustor\ influence_{kt} = \frac{\sigma^2_{trustor_{kt}}}{\sigma^2_{trustor_{kt}} + \sigma^2_{trustee_{kt}} + \sigma^2_{dyad_{kt}} + \sigma^2_{error_{kt}}}$$

The influence measure is a percentage of total variance, and it is commensurate with an ICC(1) calculation (Bliese, 2000; Rindskopf, 2013). An ICC(1) is considered a measure of effect size indicating the extent to which a judgment (in our case a trust judgment) is impacted by the grouping factor (such as a trustor in our case). The percentage of total variance creates a standardized comparison among the perceived trustworthiness dimensions, which is important because the overall variance of perceived benevolence is larger than that of perceived ability or integrity. In Model 2, we assume there is a linear growth pattern for trustors, trustees, and dyads instead of assuming loci are independent over time. Thus, a trustee may become more trusted over time as teammates become more familiar with him or her, or two teammates in a dyad may increase their trust in one another as they interact over time. For a different trustee or dyad trust could fall. Accordingly, each trustor, trustee, or dyad is modeled over time using a starting point (i.e., random intercept) and linear growth trajectory (i.e., random slope). The variance of these parameters are used to calculate each locus's influence at the different project time points for a given trustworthiness dimension. These growth patterns are not incorporated in Model 1. Indeed, they are important as attested by a comparison of the AIC statistics for Models 1 and 2, which indicate Model 2 has substantially better fit (Model 1 = 16,110; Model 2 = 15,296).

In Model 2, we also make a distinction between enduring characteristics of trustors, trustees, or dyads that lend themselves to growth over time and transitory characteristics that do not. Such a distinction is analogous to research that distinguishes between individual trait-like and state-like characteristics (e.g., Chen, Gully, Whiteman, & Kilcullen, 2000; George, 1991). For instance, trustors may be prone to trust more due to enduring characteristics such as agreeableness. The impact of these enduring characteristics on trustor judgments may increase, decrease, or remain constant over time as trustors become more familiar with their teammates. These enduring characteristics are captured by parameters that model the linear growth pattern. In contrast, transitory trustor characteristics such as mood may impact trust judgments but have no connection across time. Transitory, state-like characteristics are captured by a separate parameter that allows for a portion of the variance within a locus to be independent across time (i.e., no covariance). Transitory characteristics impact judgments but only ephemerally, and they also include idiosyncratic ways in which trustors interact with the survey at a given point in time. Thus, a good portion of the transitory trustor variance could be due to aspects of data collection and not theoretically interesting aspects of the trustor. Moreover, the central theoretical explanations for trustor influence within the literature and provided above in the trustor section point to persistent trustor characteristics. As such, it is important to separate persistent trustor characteristics from state-like characteristics. Indeed, trust scholars have appealed to researchers to take steps to reduce noise between measurement points that could confound results (Lewicki, Tomlinson, & Gillespie, 2006). Model 2 separates out trustor transitory characteristics and treats them as an additional form of error variance. The trustor variance, then, only includes variance due to enduring, trait-like characteristics. As detailed in the results below, a substantial portion of the trustor variance is due to transitory characteristics, indicating the importance of separating transitory characteristics from trait-like characteristics in Model 2. When we initially ran Model 2, we included parameters for transitory trustee and dyad characteristics, but the parameters were zero or very close to it. Therefore, we reran Model 2 without the transitory parameters for trustees and dyads. A likelihood ratio test indicated that the model fit did not significantly decline with the more parsimonious model (χ^2 = 3.56; d.f. = 6; p = *ns*). In other words, there is no evidence that transitory characteristics of trustees and dyads influence perceived trustworthiness; the delineation only appears for trustors.[3] The influence of each locus at a given time and trustworthiness dimensions is calculated as a percentage of total variance. Note, the trustor influence only includes the variance due to enduring characteristics in the numerator to coincide with our theoretical arguments for trustor influence.

We estimated Models 1 and 2 using the lme4 package (Bates, Maechler, Bolker, & Walker, 2014) in the R statistical environment (R Core Team, 2014). See Technical Appendix for greater detail concerning the specifications of Models 1 and 2. Online supplementary materials are also available. They include example R code ("APL_Shah_0505_supp_2.R.txt") and sample simulated data ("APL_Shah_0505_supp_trust_sample.txt"). Using those materials, one can generate results similar to the results presented here.

Loci Influence Results

Table 3 presents variance estimates and percentages of total variance for Models 1 and 2. The percentages of total variance are calculated for each perceived trustworthiness dimension and time period combination. We present only the project start and project end variances to simplify the discussion of our results. It is worth noting that Models 1 and 2 have comparable estimates of trustee and dyadic variance as well as residual error; however, there is a major distinction in trustor variance. For instance, the trustor percentage variance for perceived ability at project start is 45.9% in Model 1 versus only 25.7% in Model 2. The substantial difference can be reconciled by adding the trustor error percentage variance (19.1%) in Model 2 to the trustor percentage variance (25.7%). The combined trustor percentage variance for perceived ability at project start is 44.8%, which is comparable to the variance in Model 1. In essence, Model 1

[3] Given the team context needed for data collection, we also tested models similar to Models 1 and 2 that included variance associated with the team to assess team level influence. The models that included team level variance indicated that team-level influence ranged from nonexistent to quite small across time and perceived trustworthiness dimensions. Likelihood ratio tests comparing models with and without the team level indicated that there was no improvement in the fit by adding the team level (Model 1: χ^2 = 3.03, d.f. = 9, p = *ns*; Model 2: χ^2 = 3.90, d.f. = 9, p = *ns*). Thus, there was no evidence that the team level played a significant role in our sample. We do not conclude that teams play no role in trust development; we only suggest that team effects on trust are comparably smaller to other loci and may not be straightforward and compositional in nature.

Table 3. Variance Components for Perceived Trustworthiness

	Model 1				Model 2			
	Project Start		**Project End**		**Project Start**		**Project End**	
	Variance	% Var.	Variance	% Var.	Variance	% Var.	Variance	% Var.
Perceived Ability								
Trustor	0.36	45.9	0.35	36.2	0.21	25.7	0.20	19.9
Trustee	0.10	12.6	0.33	33.9	0.14	16.6	0.35	34.5
Dyad	0.00	0.0	0.05	4.8	0.03	3.0	0.07	6.5
Trustor Error	--	--	--	--	0.16	19.1	0.16	15.8
Residual Error	0.33	41.4	0.24	25.2	0.30	35.7	0.23	23.2
Perceived Benevolence								
Trustor	0.86	76.7	0.77	59.4	0.57	47.5	0.47	33.7
Trustee	0.00	0.0	0.14	11.0	0.02	1.5	0.15	10.6
Dyad	0.04	3.1	0.11	8.8	0.04	3.3	0.19	13.4
Trustor Error	--	--	--	--	0.36	29.8	0.36	26.1
Residual Error	0.23	20.2	0.27	20.8	0.22	17.9	0.22	16.1
Perceived Integrity								
Trustor	0.67	81.3	0.40	42.0	0.43	55.0	0.20	21.3
Trustee	0.00	0.0	0.28	29.0	0.01	1.2	0.28	29.6
Dyad	0.01	1.1	0.05	5.3	0.02	3.2	0.08	8.2
Trustor Error	--	--	--	--	0.19	24.1	0.19	19.5
Residual Error	0.14	17.5	0.22	23.7	0.13	16.5	0.20	21.4

Note: In Model 2, the variance of transitory trustor effects, labeled as trustor error, are separated from the variance for (enduring) trustor characteristics. See the Model Specification section and Technical Appendix 1 for more detail. Model 1 AIC = 16,110; Model 2 AIC = 15,296.

combines the two forms of trustor variance together, whereas Model 2 separates out trustor-centric disturbances from enduring trustor characteristics that influence judgments.

Both models indicate general trends in loci influence. First, the trustor is clearly the dominant locus at project start, which is evident from the trustor percentage variance being larger than the trustee and dyad percentage variance for perceived ability, benevolence, and integrity. Second, a comparison of project start and project end percentage variance indicates the trustor influence declines over time while the trustee and dyadic influence grow. Third, even with its decline in influence, the trustor remains a major influence on perceived trustworthiness. Model 1, which combines transitory trustor effects and enduring trustor characteristics, indicates the trustor remains the dominant locus. Model 2, which factors out transitory trustor effects, indicates the trustor influence falls below the trustee influence for perceived ability and integrity but remains dominant for perceived benevolence. We examine the significance of these trends when we test our hypotheses.

Hypothesis Tests

All hypothesis tests are based on differences between variance percentages in Model 2. A summary of the results for the hypothesis tests and research questions are presented in Table 4. We estimated the change in influence over time for each locus and trustworthiness dimension (H1 through H3) by subtracting the percentage variance at project start from project end. A positive change in percentage variance indicates an increasing influence trajectory whereas a negative change indicates decreasing influence. The comparison between loci (H4 and RQ1) was calculated by subtracting the percentage variance of one locus from another (i.e., trustor less trustee, trustor less dyad, and trustee less dyad) at both project start and project end. As H4 predicts greater initial trustor influence than trustee or dyadic influence, the trustee-dyad comparison is omitted from it.

For all comparisons, we used parametric bootstrapping to develop confidence intervals of the estimated differences. We present 90% confidence intervals along with the estimates as our hypotheses are directional. The confidence intervals provide a range of plausible values for the estimated differences (Cumming & Finch, 2005). See Technical Appendix for more details.

H1 posits that trustor influence will decrease over time for perceived ability (H1a), benevolence (H1b), and integrity (H1c; see Table 4). Trustor influence declined for all three trustworthiness dimensions, with perceived integrity demonstrating the largest decrease of 33.7 percentage points (confidence interval [CI] [-43.2, -24.2]; $p < .001$). Perceived benevolence decreased 13.8 percentage points, which is also significant (CI [-24.6, -3.0]; $p < .05$). Although perceived ability decreased 5.8 percentage points, the confidence interval suggests a minimal increase is also plausible (CI [-14.6, -3.1]; $p = ns$). Thus, H1b and H1c are supported, but not H1a.

H2 posits that trustee influence will increase over time for perceived ability (H2a), benevolence (H2b), and integrity (H2c). The results provide robust support for all three predictions. Perceived ability increased 18.0 percentage points (CI [11.3, 24.7]; $p < .001$), perceived benevolence increased 9.1 percentage points (CI [5.4, 12.9]; $p < .001$), and perceived integrity increased 28.4 percentage points (CI [23.1, 33.6]; $p < .001$).

H3 posits that dyadic influence will increase over time for perceived ability (H3a), benevolence (H3b), and integrity (H3c). The results do not support H3a, but they do support H3b and H3c. Perceived ability increased only 3.5 percentage points (CI [-0.9, 7.8]; $p = ns$), perceived benevolence increased 10.1 percentage points (CI [5.7, 14.6]; $p < .001$) and perceived integrity increased 5.1 percentage points (CI [1.1, 9.1]; $p < .05$).

H4 posits that initial trustor influence is greater than initial trustee and dyadic influence for perceived ability (H4a), benevolence (H4b), and integrity (H4c). At project start, the trustor influence on perceived ability was 22.7 percentage points greater than the dyadic influence (CI [14.1, 31.3]; $p < .001$), and the trustor influence on perceived ability was 9.1 percentage points greater than the trustee influence; however, based on the confidence interval, it is also plausible for the trustee to have more influence than the trustor (CI [-1.1, 19.3]; $p = ns$). Thus, H4a is partially supported. The trustor influence on perceived benevolence and integrity was significantly greater than that of the trustee or dyad. Trustor influence on perceived benevolence was 46.0 and 44.2 percentage points greater than the trustee (CI [35.1, 56.8]; $p < .001$) and dyadic influence (CI [32.7, 55.6]; $p < .001$), respectively. Trustor influence on perceived integrity was 53.8 and 51.8 percentage points greater than trustee (CI [44.4, 63.2]; $p < .001$) and dyadic influence (CI [42.0, 61.6]; $p < .001$), respectively. Thus, H4b and H4c are supported.

RQ1 leaves open the question of which locus has the greatest influence at the end of the project period. Model 2 in Table 3 indicates at project end, the trustee had the greatest influence on perceived ability at 34.5%, followed by the trustor at 19.9% and the dyad at 6.5%. The same order appeared for perceived integrity as well: The trustee accounted for 29.6% of the variance, the trustor accounted for 21.3%, and the dyad accounted for 8.2%. However for perceived benevolence, the trustor had the greatest influence at 33.7%, followed by the dyad at 13.4% and the trustee at 10.6%. The influence of each locus on each trustworthiness dimension are represented by the bar plots in Figure 3.

Table 4 presents pairwise comparisons of locus influence at project end. For perceived ability, the -14.6 percentage point difference between trustor and trustee influence was significant (CI [-25.2, -4.0]; $p < .05$). As was the 13.5 percentage point difference between trustor and dyad influence (CI [6.0, 20.9]; $p < .01$). Thus, for RQ1a, the trustee had significantly greater influence on perceived ability than the trustor, which in turn had significantly greater influence

Table 4. Summary of Empirical Tests using Model 2

Locus	Perceived Trustworthiness	Hyp.	Percentage Difference	Confidence Interval 5%	Confidence Interval 95%
Change Over Time: Project End – Start					
Trustor	Ability	H1a	-5.8	-14.6	3.1
Trustor	Benevolence	H1b	-13.8	-24.6	-3.0
Trustor	Integrity	H1c	-33.7	-43.2	-24.2
Trustee	Ability	H2a	18.0	11.3	24.7
Trustee	Benevolence	H2b	9.1	5.4	12.9
Trustee	Integrity	H2c	28.4	23.1	33.6
Dyad	Ability	H3a	3.5	-0.9	7.8
Dyad	Benevolence	H3b	10.1	5.7	14.6
Dyad	Integrity	H3c	5.1	1.1	9.1
Difference Between Loci: Project Start					
Trustor – Trustee	Ability	H4a	9.1	-1.1	19.3
Trustor – Dyad	Ability	H4a	22.7	14.1	31.3
Trustor – Trustee	Benevolence	H4b	46.0	35.1	56.8
Trustor – Dyad	Benevolence	H4b	44.2	32.7	55.6
Trustor – Trustee	Integrity	H4c	53.8	44.4	63.2
Trustor – Dyad	Integrity	H4c	51.8	42.0	61.6
Difference Between Loci: Project End					
Trustor – Trustee	Ability	Q1a	-14.6	-25.2	-4.0
Trustor – Dyad	Ability	Q1a	13.5	6.0	20.9
Trustee – Dyad	Ability	Q1a	28.1	21.6	34.5
Trustor – Trustee	Benevolence	Q1b	23.0	11.9	34.2
Trustor – Dyad	Benevolence	Q1b	20.2	8.9	31.5
Trustee – Dyad	Benevolence	Q1b	-2.8	-8.1	2.6
Trustor – Trustee	Integrity	Q1c	-8.2	-19.6	3.1
Trustor – Dyad	Integrity	Q1c	13.1	4.2	22.0
Trustee – Dyad	Integrity	Q1c	21.3	14.8	27.9

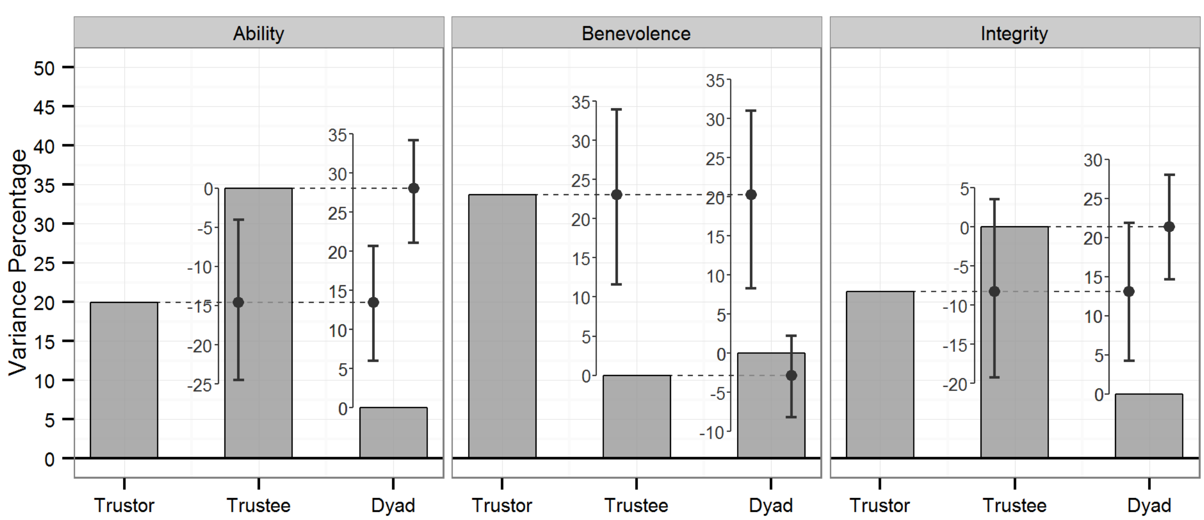
Note: In Model 2, the trustor variance does not include variance due to transitory trustor characteristics.

than the dyad. These significant differences are depicted by the error whiskers in panel 1 of Figure 3, which illustrates the reported confidence intervals. For perceived benevolence, the 20.2 percentage point difference between the trustor and dyad was significant (CI [8.9, 31.5]; $p < .01$), the 23.0 percentage point difference between the trustor and trustee was significant (CI [11.9, 34.2]; $p < .001$), but the -2.8 percentage point difference between trustee and dyad was not (CI [-8.1, 2.6]; *p* = *ns*). The differences between loci for perceived benevolence are depicted in panel 2 of Figure 3. It illustrates that, for RQ1b, the trustor was more influential than the trustee and dyad, which had comparable influence. For perceived integrity the -8.2 percentage point difference between trustor and trustee was not significant (CI [-19.6, 3.1]; *p* = *ns*), but the 13.1 percentage point difference between trustor and dyad (CI [4.2, 22.0]; $p < .01$) and the 21.3 percentage point difference between the trustee and the dyad (CI [14.8, 27.9]; $p < .001$) were significant. Thus, for RQ1c (panel 3 of Figure 3), the trustee and trustor had significantly more influence on perceive integrity than the dyad, but were not significantly different from each other.

Additional Analysis

"Don't know" analysis. While the survey response rate was high, the number of "don't know" responses, particularly at project start, reduced the total observations available. One concern is that missing observations within teams or dyads may alter the resulting estimates (Fitzmaurice et al., 2011). To address this concern we estimated two models that omitted teams and dyads with high "don't know" responses. We then compared estimates of the two subset models to Model 2 in Table 3. In the first model, we removed eight teams missing one third or more of their observations, leaving 42 teams. In the second model, we removed trustor responses toward a specific trustee if the trustor did not provide responses in all three time periods. Observations for the first and second model were reduced by 12% and 28%, respectively. The

Figure 3. Difference between loci at project end. Error bars represent the 90% confidence interval for the difference between the variance percentages of two loci (i.e., Trustor – Trustee, Trustor – Dyad, and Trustee – Dyad).



variance estimates for the models showed only small differences compared with Model 2. The consistent results provide some evidence that missing observations did not bias our results.

We further analyzed "don't know" responses to understand what loci are responsible for generating a "don't know" response. To do so, we regressed a dichotomous "don't know" variable (1 = don't know, 0 _ otherwise) onto the fixed and random effects as specified in Model 2. Not surprisingly, the majority of the variance in the model (53.8%) existed at project start when the number of "don't know" responses was high. When excluding the error variance, the proportion of variance at project start was even larger (72.4%). Of the variance at project start, 60.3%, 52.3%, and 62.1% of the variance was attributable to the trustor for perceived ability, benevolence, and integrity, respectively. The trustor percentage variance for "don't know" at project start was larger than the trustor percentage variance in Model 2 across all three trustworthiness dimensions. The trustor error and residual error accounted for most of the remaining variance (37.9%, 45.8%, and 36.2%, respectively) in the "don't know" model. The trustee and dyad individually accounted for between 0.2% to 1.8% of the variance across trustworthiness dimensions. The fact that the trustor was the primary driver of a "don't know" response at project start and accounted for a greater percentage variance compared to Model 2 suggests that the trustor influence in the beginning may be even larger than estimated in Model 2. By project end, "don't know" responses were primarily determined by error variance (accounting for 78.9% to 82.4% of the already small variance remaining), suggesting "don't know" responses lose consequence by project end.

Propensity to trust analysis. To help relate the overall influence of a locus to its underlying characteristics, we include additional analysis of one important trustor characteristic: propensity to trust. Trust theory points to propensity to trust as a central individual characteristic underlying the trustor effect (Mayer et al., 1995). Our dataset allows us to test this empirically by adding the trustor's propensity to trust as a fixed effect in our model and observing the reduction in trustor variance. The size of reduction is an indication of the degree to which the trustor influence is due to propensity to trust. A large decrease suggests that propensity to trust is the dominant reason for trustor influence while a small decrease suggests a more limited role.

To conduct the analysis, we estimated one model that included propensity to trust using a version of Rotter's trust scale (Rotter, 1967) and a second model that used agreeableness for the propensity to trust measure (Costa & McCrae, 1992). Both scales are frequently used in trust research to measure propensity to trust (Jarvenpaa, Knoll, & Leidner, 1998; Krasman, 2014; Lau, Lam, & Salamon, 2008; Mayer & Davis, 1999; Mooradian, Renzl, & Matzler, 2006; Yakovleva et al., 2010). Agreeableness is often used because trust propensity is one of the trait's subfacets (Colquitt et al., 2007; Costa & McCrae, 1992). Agreeableness was calculated as the composite score of nine items (coefficient α = .72) on a 5-point scale (1 = *strongly disagree*, 5 = *strongly agree*; John, Donahue, & Kentle, 1991). The Rotter scale (α = .65) included seven items on the same 5-point scale that were adapted from Mayer and Davis (1999) and Huff and Kelley (2003) for our context. The reliability of the Rotter measure was low, which has been similarly noted by others (Mayer & Davis, 1999; Schoorman, Mayer, & Davis, 2007), but we include it to provide a comparison with published research. In this analysis, we compared the models with propensity with trust to Model 2, which served as our baseline. We then calculated the average reduction in trustor variance across time from Model 2 to the new models.

With the Rotter scale, trustor variance decreased an average of 3.5% for perceived ability, 2.8% for perceived benevolence, and 0.9% for perceived integrity. These reductions in variance correspond with correlations of .16, .12, and .09 between propensity to trust and perceived ability, benevolence, and integrity, respectively, in our sample. These correlations fall between those reported by Gill, Boies, Finegan, and McNally (2005) and Mayer and Davis (1999) and below Yakovleva, Reilly, and Werko (2010). The three known studies have a weighted average correlation of .17, .20, and .16 for perceived ability, benevolence, and integrity, respectively, which is consonant with our findings. With the agreeableness scale, trustor variance decreased an average of 9.6% for perceived ability, 3.6% for perceived benevolence, and 3.8 for perceived integrity. Corresponding correlations between agreeableness and perceived ability, benevolence, and integrity were .24, .16, and .22, respectively, in our sample. Krasman (2014) and Lau, Lam, and Salamon (2008), who each used a composite measure of perceived trustworthiness, had correlations with similar strength (.21 and .29, respectively). Existing research corroborates the relationships we find between the two propensity-to-trust scales and perceived trustworthiness, suggesting the context we examine is consistent with other work contexts regarding trust. Moreover, these reductions in variance provide evidence that propensity to trust is an important aspect of the trustor effect, but not necessarily a dominant one. Other trustor characteristics appear to constitute the large majority of remaining trustor variance and drive the majority of the trustor effect. This suggests that examining the trustor locus is a fruitful area for further research.

DISCUSSION

This article began with two questions: Where is the dominant locus of trust? And how does it change over time? Rather than focus on specific determinants as done in the past, we focus on different loci where these trust determinants reside. Social relations analysis enables us to separate the influence of trustors, trustees, and dyads to simultaneously investigate their impact on perceptions of trust. Moreover, our temporal perspective uncovers when each locus is most influential on each dimension of perceived trustworthiness.

When all three loci are accounted for, the trustor is the dominant locus at the initial stage of trust formation, accounting for about 26% to 55% of the variance across the three dimensions of perceived trustworthiness. These results support theoretical models of trust development depicting early trust formation as a cognitive process based on trustors' perceptions and biases (Lewicki & Bunker, 1995; Rousseau et al., 1998; Shapiro et al., 1992). Moreover, the trustor remains the dominant locus for perceived benevolence over time, despite its declining influence trajectory. Our findings add credence to the importance of trustor-focused research that views interpersonal trust as a predisposition or expectancy held by the trustor (Gurtman, 1992; Jang et al., 1996; Sorrentino et al., 1995). The findings clearly illustrate that focusing on characteristics of the trustor is a promising area of further study. While past research has focused on propensity to trust, findings from the additional analysis indicate this plays only a small, albeit important, role when examining overall trustor influence. A host of other factors, including but not limited to individual differences, personal experiences, cultural background, and cognitive biases (Ferrin & Gillespie, 2010; Rotter, 1971; Weber et al., 2004), may play important roles. Other trustor characteristics— such as social class (Piff et al., 2010) or nonconscious cognitive processes (Huang & Murnighan, 2010)—merit continued exploration as well.

We also find that trustor error, which captures transitory trustor characteristics, has substantial influence on trust judgments. Indeed, approximately 15% to 30% of the variance across all three dimensions of trustworthiness is attributed to transitory trustor characteristics. In contrast to enduring trustor characteristics that evolve over time, transitory trustor characteristics are subject to random fluctuations, are ephemeral and may represent idiosyncratic trustor survey responses at a given point in time. The distinction between transitory and enduring trustor characteristics is important because trust theory has overwhelmingly argued that trust is derived from stable trustor traits (Costa & McCrae, 1992; Mayer et al., 1995; Rotter, 1971). Our results illustrate that erroneous conclusions can result if we do not separate transitory trustor effects from those that are enduring. When both are combined, as in Model 1, the trustor appears to be the prominent locus of influence for perceived ability and integrity over time. However, when they are separated as in Model 2, the results clearly illustrate that variance associated with enduring, stable trustor characteristics is actually less influential than that associated with trustee characteristics. In fact, trust scholars have advocated using longitudinal research designs and analytical techniques that reduce this type of noise between measure periods as it can confound results (Lewicki et al., 2006). Nevertheless, the transitory trustor characteristics are intriguing as they also capture trustor states that influence judgment in the short-term, which may include but are not limited to mood, ego depletion, and job stress. Albeit, research investigating these variables is limited, experimental research does find mood and ego manipulations alter one's tendency to trust (Ainsworth, Baumeister, Vohs, & Ariely, 2014; Lount, 2010). Thus, transitory trustor characteristics provide a promising research arena. Given the importance of both enduring and transitory trustor influence on perceptions of all three dimensions of trustworthiness, there is great potential in trustor-centric research.

The results also indicate a substantial increase in trustee influence over time, particularly for perceived ability and integrity. On those two dimensions, the trustee accounted for about one third of the variance by project end, surpassing the influence of the trustor to become the dominant locus of influence. Consistent with theories of trust development, the results illustrate trustee effects rising to prominence as relationships progress (Lewicki & Bunker, 1995; Rousseau et al., 1998). As individuals work together over time, trustors have access to greater information about trustees' characteristics, motives, and actions with respect to trust. This finding is important because it helps address the question of how long it takes before trustees can reasonably affect others' judgments of their trustworthiness. On the dimensions of perceived ability and integrity, we find that one project task is sufficient for the trustee to become the dominant influence. When comparing perceived ability and integrity, it appears that trustee influence on ability judgments is faster to take hold.

In contrast to the trustor and trustee influence on perceived trustworthiness, dyadic influence was quite modest. While we expected minimal dyadic influence in the early stages of trust formation, we were surprised that dyadic influence remained low over time even with an increasing influence for perceived benevolence and integrity. Past research suggests perceived benevolence grows out of reciprocal affective bonds, shared characteristics and experiences, all of which require time to evolve (McAllister, 1995). At first, our results appear to contradict research findings indicating a pattern of mutual obligations or cyclical evolution of trust in dyads (Ferrin et al., 2008, 2006; Serva et al., 2005; Whitener et al., 1998) and theoretical models of trust development suggesting strong dyadic level influence as relationships mature (Lewicki & Bunker, 1995; Rousseau et al., 1998); however, it is important to note that while the magnitude of dyadic influence is comparatively low, dyadic characteristics still predict perceived trustworthiness. The results do help frame the existing dyadic perspective on trust alongside trustor and trustee perspectives, something that past research has been unable to do. The dyad plays only a small role in determining perceived ability and it does not appear to grow with time, suggesting that ability may only be of minor importance in developing affective bonds. The slow and steady rise in dyadic influence on perceived benevolence and integrity suggest that dyadic influence may require more time to evolve than simply the course of one project task. Moreover, we examined dyadic influence in the context of assigned teams not voluntary dyadic ties formed based on mutual affinity or shared characteristics. Dyadic ties formed by the trustors' and trustees' own volition may be susceptible to stronger dyadic influence. In sum, dyadic influence is muted over the duration of a single project task when team membership is assigned.

A large body of psychological research using variance partitioning examines interpersonal perceptions not related to trust. When comparing our results to this research, we find similarly declining observer (i.e., trustor) variance and increasing dyadic effects over time (Kenny, 1994). However, prior research, which uses other methods of variance partitioning, has not directly compared dyadic variance (i.e., dyadic reciprocity) to trustor and trustee variance, relying instead on bivariate correlations (Elfenbein, Eisenkraft, & Ding, 2009; Kenny, 1994). Thus, our research provides a direct comparison of all three loci, which has not been done in the past. Additionally, the steady rise in trustee effects that we found differs from prior findings that are inconclusive concerning a rise in actor (i.e., trustee) influence over time (Kenny, 1994; Park, Kraus, & Ryan, 1997). This difference is likely due to fundamental differences in the type of perceptions investigated. Prior work focused on perceptions of objective characteristics of targets such as Big 5 traits. While little to no risk is involved when assessing an individual's Big 5 characteristics, trust is a relational construct entailing inherent risk. Inaccurate personality assessments result in minimal hazards while inaccurate trustworthiness assessments can be of grave consequence. As such, individuals are more likely to observe and be influenced by trustee actions and behaviors when rendering trust judgments.

Lastly, our descriptive results provide insight into the development of trust perceptions over time. Recall that participants had the option of selecting "don't know" in any of our surveys if they had yet to form judgments of trustworthiness. As illustrated in Figure 1, the percentage of participants unable to form judgments of trustworthiness varied based on the trustworthiness dimension and across time. Participants had the least difficulty forming ability perceptions, albeit about 30% were undecided at the start of the project, compared with integrity and benevolence perceptions, which took longer to formulate. The results corroborate models of trust development over time that suggest initial trust is calculative, while trust forming later is relational (Lewicki & Bunker, 1995; Rousseau et al., 1998). The results also provide additional empirical evidence that cognitive trust precedes affective trust (McAllister, 1995).

Theoretical Implications

By simultaneously investigating trust across multiple loci, we advance our understanding of where and how trust perceptions are formed. This understanding equips trust researchers with an empirically tested backdrop that can help them better target their investigation of trust determinants. In the context of assigned teams, our research indicates the trustor initially serves as the dominant locus of trust and the trustee becomes the dominant locus over time for more cognitive dimensions of perceived trustworthiness. As such, focusing on determinants within these two loci at different relational stages are promising research areas, particularly for teams researchers. Moreover, nuanced trustor results in Model 2, reveal that both enduring and transitory trustor characteristics merit attention.

Further, our findings highlight the role of time in the formation and development of trust. They indicate that formulating perceptions of trust is a dynamic process in which the importance of the trustor may diminish over time, while that of the trustee and dyad increases. The finding that different loci have different magnitudes over time highlights a hazard in cross-sectional research on perceptions of trust. Research conducted at the early stage of trust formation may result in markedly different conclusions than that collected at the latter stages of trust development. While longitudinal research provides a more precise understanding of how trust perceptions develop, it is not always feasible. As such, our findings provide guidance for the direction of possible outcome bias for trust determinants depending on when data is collected. Consequently, time can no longer be ignored as a variable of interest in trust research.

Lastly, our findings provide unique empirical insight into trust as an emergent phenomena (Kozlowski & Klein, 2000). While we do not define the microprocesses within the team social system (Kozlowski et al., 2013) that generate trust, we do demarcate the actors and their relationships and follow the emergence (or decline) of their influence as teams progress. This study provides insights into the emergent influence of the generative loci of trust and offers a precedent for empirically considering other emergent phenomena as well.

Managerial Implications

Understanding how trust forms and develops across multiple loci and over time has important consequences for managerial practice. Our findings suggest that managers hoping to form collaborative partnerships may need to focus less on behaviors and actions they think are indicative of trustworthiness and more on their partner's perspective, particularly at the start of a relationship. Indeed, differences in trustors' personal experience, heredity, cultural background, socioeconomic status, or perceptions of dependence toward trustees (Ferrin & Gillespie, 2010; Gurtman, 1992; Jang et al., 1996; Piff et al., 2010; Rotter, 1971; Weber et al., 2004) may reflect variations in their trust judgments. Thus, rather than focusing myopically on themselves and their character, managers must also focus outwardly and manage the impressions of others with whom they want to build trust. Moreover, it is not sufficient to signal ones trustworthiness and assume recipients will receive the intended message as trustors may perceive signals differently. As such, managers may need to customize their trust building efforts from one person to the next, managing impressions uniquely in each relationship.

Second, managers need to be aware that the locus influencing trust perceptions is apt to vary over time. While initial judgments are influenced by the trustor, trustee effects emerge as trustees showcase their skills and integrity over time across different situations, and dyad effects emerge as relationships develop. Providing early and more frequent opportunities for trustee and dyad effects to emerge may be helpful. In a team context, it may also be beneficial to standardize and clearly articulate common expectations of team work. This both provides trustors a common basis for making trust assessments and provides trustees guidelines on which they may be judged. When fostering dyadic trust relationships among employees, it may be beneficial to provide opportunities for reciprocal exchange and create mutual interdependencies among pairs of employees (Ferrin et al., 2008, 2006).

Limitations and Future Directions

Limitations of this study suggest several avenues for future research. First, this study's focus was on multiple loci at which trust resides rather than specific determinants within these loci. Our analysis provides strong evidence of which loci are most impactful for different dimensions of trust and across time, but it does not address the underlying determinants of trust at these loci. Understanding factors at these loci (particularly the trustor) that influence perceptions of trust is an important continuation of this work. Second, whereas our use of undergraduate teams provides us with controls unavailable in a field setting, it does limit the generalizability of our findings. Teams were limited to one task which required no specialized skills; performance objectives were clearly defined and team members' backgrounds were relatively homogeneous. Our results were consistent with empirical findings in the field, yet natural variations in teams appearing in firms may alter the results. Third, the results could be impacted by the restricted time range. Teams often perform multiple tasks over longer periods of time. Trustee and dyadic influences might have continued to increase had the task not ended. Thus, the research timeline may have truncated the influence of these two loci on perceptions of trustworthiness. Moreover, trustee and dyadic influence may continue even after a team disbands resulting in even greater and more consequential influence over time as these loci influence perceptions of trustworthiness in the broader organizational context. Fourth, as indicated above in our discussion of transitory trustor effects, within-individual temporal fluctuations appear to play an important role in perceptions across all three dimensions of trustworthiness. Research focused on mood, ego depletion, stress, or other variables subject to temporal fluctuations will provide an important extension of this work. Field studies using an experience sampling methodology to capture within-individual fluctuations in mood or stress in vivo could be particularly informative. Fifth, as discussed in the introduction, we focused on trusting beliefs as they precede and provide the basis for trusting intentions and trusting actions. We expect that similar trajectories would appear across the three loci for these conceptualizations of trust. Yet, as we move from a trustor's judgment to her intentions to act and her express actions, even greater trustor effects may result due to idiosyncratic trustor attributes influencing the actions themselves. Additionally, as the conceptual space from observation to intention and to action is larger than the space from observation to judgment, the error term may also increase reflecting greater opportunity for random disturbances. Lastly, the variance analysis techniques outlined in this article may provide a template for generating insights into other research areas that are concerned with effective social interaction. For example, researchers investigating conflict could investigate whether it is resides within specific dyads or is a property of the team.

Conclusion

This longitudinal field study of project teams investigates different loci at which trust perceptions are formed. The results contribute to our understanding of trust determinants by illustrating that while trust forms simultaneously at multiple loci, the trustor has the strongest initial influence on perceived ability, benevolence, and integrity and continues to have the strongest influence on perceived benevolence even over time. In contrast, the trustee is the dominant influence on perceived ability and integrity at the later stages of trust formation. Moreover, the findings indicate time is an important variable to consider when investigating trust determinants as the importance of the trustor diminishes over time while trustee and dyad influences increase.

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Appendix

TECHNICAL DETAILS FOR MODEL SPECIFICATION AND VARIANCE ANALYSIS

This appendix details the specifications for Model 1 and Model 2, the method for capturing the variance estimates and the process for conducting the hypothesis tests. We use linear mixed-effects models (LMEMs) to estimate the influence trustors, trustees and dyads exert on perceived ability, benevolence and integrity at different project time periods. Both Models 1 and 2 use the standard linear mixed effects regression specification, given in matrix notation,

$$\boldsymbol{y} = \boldsymbol{X\beta} + \boldsymbol{Z\gamma} + \boldsymbol{\varepsilon}, \tag{1.1}$$

where $\boldsymbol{y}$ is an $n \times 1$ vector of response values, $\boldsymbol{X}$ is an $n \times p$ design matrix for the fixed parameters, $\boldsymbol{\beta}$ is a $p \times 1$ vector of fixed parameters, $\boldsymbol{Z}$ is an $n \times q$ design matrix for the random parameters, $\boldsymbol{\gamma}$ is a $q \times 1$ vector of random parameters, and $\boldsymbol{\varepsilon}$ is an $n \times 1$ vector of residual errors. The matrix dimension n is the number of observations in the sample, p is the number fixed parameters, and q is the number of random parameters.

The linear mixed-effects specification in (1.1) is very flexible, and it can support a wide variety of crossed and nested designs used in multi-level modeling, variance partitioning and growth modeling (Fitzmaurice et al., 2011; Snijders & Bosker, 2012; Snijders & Kenny, 1999). The multiple types of LMEMs are primarily differentiated by the internal specification of $\boldsymbol{Z\gamma}$ and its associated variance-covariance structure.

Following the usual assumptions for mixed-effects models, we assume the random effects and residual error are normally distributed with an expected value of zero and no covariance, such that

$$\mathrm{E}\left(\begin{bmatrix}\boldsymbol{\gamma}\\ \boldsymbol{\varepsilon}\end{bmatrix}\right) = \begin{bmatrix}\mathbf{0}\\ \mathbf{0}\end{bmatrix} \quad \text{and} \quad Cov\left(\begin{bmatrix}\boldsymbol{\gamma}\\ \boldsymbol{\varepsilon}\end{bmatrix}\right) = \begin{bmatrix}\boldsymbol{G} & \mathbf{0}\\ \mathbf{0} & \boldsymbol{V}\end{bmatrix}, \tag{1.2}$$

where $\boldsymbol{G}$ is a $q \times q$ variance-covariance matrix for the random effects and $\boldsymbol{V}$ is an $n \times n$ variance-covariance matrix for the error term. Usually $\boldsymbol{V} = \boldsymbol{I}\sigma_\varepsilon^2$, where $\boldsymbol{I}$ is an identity matrix of size n and σ_ε^2 is the residual error variance. Using this specification, $\boldsymbol{y}$ is normally distributed with mean $\boldsymbol{X\beta}$ and variance-covariance $\boldsymbol{\Sigma}$,

$$\boldsymbol{y} \sim N(\boldsymbol{X\beta}, \boldsymbol{\Sigma}),$$

where

$$\boldsymbol{\Sigma} = \boldsymbol{\Sigma}(\theta) = \boldsymbol{ZGZ}' + \boldsymbol{V}. \tag{1.3}$$

The variance-covariance matrix $\boldsymbol{\Sigma}$ is $n \times n$ and possesses a block-diagonal pattern of variance-covariance parameters, and θ is the unique set of variance-covariance parameters in $\boldsymbol{\Sigma}$.

The parameters in θ and $\boldsymbol{\beta}$ are estimated using restricted maximum likelihood (REML). These estimated parameters are then used to create the best linear unbiased predictors of the random effects in $\boldsymbol{\gamma}$. The model estimation produces $\widehat{\boldsymbol{\beta}}$, $\widehat{\boldsymbol{\gamma}}$ and $\hat{\theta}$, with $\boldsymbol{\Sigma}(\hat{\theta}) = \widehat{\boldsymbol{\Sigma}} = \boldsymbol{Z}\widehat{\boldsymbol{G}}\boldsymbol{Z}' + \widehat{\boldsymbol{V}}$. The estimated variance components are used to measure trustor, trustee and dyadic influence and are found on the diagonal of $\boldsymbol{Z}\widehat{\boldsymbol{G}}\boldsymbol{Z}'$.

Notation

The $n = 6851$ observations in our sample are grouped by trustor, trustee, dyad, trustworthiness dimension and time period. We use the following notation to address these groupings in our specifications:

- R refers to the set of trustors ($n_R = 248$), and r identifies any one trustor in R ($r \in R$).
- E refers to the set of trustees ($n_E = 250$), and e identifies any one trustee in E ($e \in E$).
- D refers to the set of dyads ($n_D = 499$), and d identifies any one dyad in D ($d \in D$). Dyads in D are symmetrical or reciprocal dyads, not asymmetrical or directional pairings.
- K refers to the set of perceived trustworthiness dimensions ($K = \{ability,\ benevolence,\ integrity\}$; $n_K = 3$), and k identifies any one element in K ($k \in K$). k_A, k_B and k_I specifically identify ability, benevolence and integrity, respectively, in K.
- T refers to the set of time periods ($T = \{0, 1, 2\}$; $n_T = 3$), and t identifies any one element in T ($t \in T$). t_0, t_1 and t_2 specifically identify time period 0, 1 and 2, respectively, in T.
- P refers to the set of trustor-time period combinations ($n_P = 667$), and $p = rt$ identifies any one element in P ($p \in P$). P refers to trustor error in Model 2.

The given notation is used in matrix and scalar subscripts and superscripts. For non-symmetric matrices (e.g., $\boldsymbol{Z}$ and $\boldsymbol{X}$) and vectors (e.g., $\boldsymbol{\beta}$ and $\boldsymbol{\gamma}$), subscripts refer to a subset of rows and superscripts refer to a subset of columns. For instance, $\boldsymbol{Z}_{red}^{R}$ refers to the rows in $\boldsymbol{Z}$ for a given trustor r rating trustee e that comprise dyad d and to the columns in $\boldsymbol{Z}$ that correspond to all trustors in R. For symmetric matrices (e.g., $\boldsymbol{G}$ and $\boldsymbol{V}$), superscripts refer to a subset of block diagonal rows and columns. For instance, $\boldsymbol{G}^{R}$ is the block diagonal variance-covariance for all trustors in R, and $\boldsymbol{G}^{r}$ is the block diagonal variance-covariance for any given trustor r. For scalars (e.g., σ^2), subscripts designate the groupings to which the scalars belong. For instance, σ_{Rkt}^2 is the trustor variance for any given dimension k and time t, and $\sigma_{Dk_Bt_0}^2$ is the dyad variance for perceived benevolence at time 0 (i.e., project start).

Model 1

For each locus in Model 1, independent variance estimates are calculated for all trustworthiness dimension and time period combinations, which we refer to as kt combinations. There are nine kt combinations: $KT = \{k_At_0, k_At_1, k_At_2, k_Bt_0, k_Bt_1, k_Bt_2, k_It_0, k_It_1, k_It_2\}$.

In Model 1, a response by trustor r who rates trustee e (which comprise dyad d) for trustworthiness dimension k at time period t is specified as

$$y_{redkt} = \beta_{kt} + \gamma_{rkt} + \gamma_{ekt} + \gamma_{dkt} + \varepsilon_{redkt}, \tag{1.4}$$

where (within dimension k and time t) β_{kt} is the mean effect, γ_{rkt} is the effect of trustor r, γ_{ekt} is the effect of trustee e, γ_{dkt} is the dyadic effect of d and ε_{redkt} is the residual error. Because the kt combinations are assumed to be independent, the variance of y_{redkt} is

$$\begin{aligned} Var(y_{redkt}) &= Var(\beta_{kt} + \gamma_{rkt} + \gamma_{ekt} + \gamma_{dkt} + \varepsilon_{redkt}) \\ &= Var(\gamma_{rkt}) + Var(\gamma_{ekt}) + Var(\gamma_{dkt}) + Var(\varepsilon_{redkt}), \\ &= \sigma_{Rkt}^2 + \sigma_{Ekt}^2 + \sigma_{Dkt}^2 + \sigma_{\varepsilon kt}^2 \end{aligned} \tag{1.5}$$

where σ^2_{Rkt}, σ^2_{Ekt} and σ^2_{Dkt} are the trustor, trustee and dyad variance, respectively, for trustworthiness dimension k at time t, and $\sigma^2_{\varepsilon kt}$ is the residual error variance for the kt combination. These variance parameters are estimated via REML to determine the influence of the loci, which are calculated for each kt combination as

$$\begin{aligned} trustor\ influence_{kt} &= \hat{\sigma}^2_{Rkt}/(\hat{\sigma}^2_{Rkt} + \hat{\sigma}^2_{Ekt} + \hat{\sigma}^2_{Dkt} + \hat{\sigma}^2_{\varepsilon kt}) \\ trustee\ influence_{kt} &= \hat{\sigma}^2_{Ekt}/(\hat{\sigma}^2_{Rkt} + \hat{\sigma}^2_{Ekt} + \hat{\sigma}^2_{Dkt} + \hat{\sigma}^2_{\varepsilon kt})\ . \\ dyadic\ influence_{kt} &= \hat{\sigma}^2_{Dkt}/(\hat{\sigma}^2_{Rkt} + \hat{\sigma}^2_{Ekt} + \hat{\sigma}^2_{Dkt} + \hat{\sigma}^2_{\varepsilon kt}) \end{aligned} \tag{1.6}$$

While (1.4) to (1.6) provide a basic explanation of the specification of Model 1, it is also illustrative to detail Model 1's variance-covariance pattern for $\boldsymbol{G}$, $\boldsymbol{V}$ and $\boldsymbol{\Sigma}$, which hold the variance parameters. To do so, we describe the specification in (1.4) in matrix notation for the full sample, as in (1.1). By expanding the definition of $\boldsymbol{Z}$ and $\boldsymbol{\gamma}$ as

$$\boldsymbol{Z} = [\boldsymbol{Z}^R \quad \boldsymbol{Z}^E \quad \boldsymbol{Z}^D] \tag{1.7}$$

and

$$\boldsymbol{\gamma} = \begin{bmatrix} \boldsymbol{\gamma}_R \\ \boldsymbol{\gamma}_E \\ \boldsymbol{\gamma}_D \end{bmatrix},$$

Model 1 is specified as

$$\begin{aligned} \boldsymbol{y} &= \boldsymbol{X\beta} + \boldsymbol{Z\gamma} + \boldsymbol{\varepsilon} \\ &= \boldsymbol{X\beta} + [\boldsymbol{Z}^R \quad \boldsymbol{Z}^E \quad \boldsymbol{Z}^D] \begin{bmatrix} \boldsymbol{\gamma}_R \\ \boldsymbol{\gamma}_E \\ \boldsymbol{\gamma}_D \end{bmatrix} + \boldsymbol{\varepsilon} \quad . \\ &= \boldsymbol{X\beta} + \boldsymbol{Z}^R\boldsymbol{\gamma}_R + \boldsymbol{Z}^E\boldsymbol{\gamma}_E + \boldsymbol{Z}^D\boldsymbol{\gamma}_D + \boldsymbol{\varepsilon} \end{aligned} \tag{1.8}$$

The fixed parameter vector $\boldsymbol{\beta}$ is the mean response for all kt combinations such that

$$\boldsymbol{\beta} = \begin{bmatrix} \beta_{k_A t_0} \\ \vdots \\ \beta_{k_I t_2} \end{bmatrix}, \tag{1.9}$$

and $\boldsymbol{X}$ is an $n \times 9$ design matrix that assigns each parameter in $\boldsymbol{\beta}$ to the correct sample observations. The parameter vectors $\boldsymbol{\gamma}_R$, $\boldsymbol{\gamma}_E$ and $\boldsymbol{\gamma}_D$ are the random effects for trustors, trustees and dyads, respectively, with dimensions $n_R n_K n_T \times 1$, $n_E n_K n_T \times 1$ and $n_D n_K n_T \times 1$. Note $\boldsymbol{\gamma}$ has dimensions $q \times 1$, and $q = (n_R + n_E + n_D) n_K n_T$. The design matrices $\boldsymbol{Z}^R$, $\boldsymbol{Z}^E$ and $\boldsymbol{Z}^D$ have dimensions $n \times n_R n_K n_T$, $n \times n_E n_K n_T$ and $n \times n_D n_K n_T$. The residual error vector $\boldsymbol{\varepsilon}$ is $n \times 1$.

The variance-covariance matrix $\boldsymbol{G}$ in (1.2) is expanded for Model 1 as

$$\boldsymbol{G} = \begin{bmatrix} \boldsymbol{G}^R & \boldsymbol{0} & \boldsymbol{0} \\ \boldsymbol{0} & \boldsymbol{G}^E & \boldsymbol{0} \\ \boldsymbol{0} & \boldsymbol{0} & \boldsymbol{G}^D \end{bmatrix}, \tag{1.10}$$

where $\boldsymbol{G}^R$, $\boldsymbol{G}^E$ and $\boldsymbol{G}^D$ are the variance-covariance matrices for trustor, trustee and dyad random effects, respectively, with square dimensions of length $n_R n_K n_T$, $n_E n_K n_T$ and $n_D n_K n_T$.

With the expansion of $\boldsymbol{Z}$ and $\boldsymbol{G}$ in (1.7) and (1.10), the variance-covariance of $\boldsymbol{y}$ becomes

$$\begin{aligned}\boldsymbol{\Sigma} &= \boldsymbol{ZGZ}' + \boldsymbol{V} \\ &= [\boldsymbol{Z}^R \quad \boldsymbol{Z}^E \quad \boldsymbol{Z}^D]\begin{bmatrix}\boldsymbol{G}^R & \boldsymbol{0} & \boldsymbol{0} \\ \boldsymbol{0} & \boldsymbol{G}^E & \boldsymbol{0} \\ \boldsymbol{0} & \boldsymbol{0} & \boldsymbol{G}^D\end{bmatrix}\begin{bmatrix}(\boldsymbol{Z}^R)' \\ (\boldsymbol{Z}^E)' \\ (\boldsymbol{Z}^D)'\end{bmatrix} + \boldsymbol{V}. \\ &= \boldsymbol{Z}^R\boldsymbol{G}^R(\boldsymbol{Z}^R)' + \boldsymbol{Z}^E\boldsymbol{G}^E(\boldsymbol{Z}^E)' + \boldsymbol{Z}^D\boldsymbol{G}^D(\boldsymbol{Z}^D)' + \boldsymbol{V}\end{aligned} \tag{1.11}$$

The matrix $\boldsymbol{G}^R$ is defined as

$$\boldsymbol{G}^R = \begin{bmatrix}\boldsymbol{G}^{Rk_At_0} & \cdots & \boldsymbol{0} \\ \vdots & \ddots & \vdots \\ \boldsymbol{0} & \cdots & \boldsymbol{G}^{Rk_It_2}\end{bmatrix},$$

where $\boldsymbol{G}^{Rk_At_0}$ through $\boldsymbol{G}^{Rk_It_2}$ are $n_R \times n_R$ submatrices for all kt combinations. The submatrices have zero covariance based on the assumptions of Model 1. The diagonal of any given $\boldsymbol{G}^{Rkt}$ submatrix holds the variance for the trustors in R for dimension k at time t such that

$$\boldsymbol{G}^{Rkt} = \begin{bmatrix}\sigma^2_{Rkt} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \sigma^2_{Rkt}\end{bmatrix},$$

and the variance for trustor r is given as $\boldsymbol{G}^{rkt} = \sigma^2_{Rkt}$. Analogous variance patterns exist for $\boldsymbol{G}^E$ and $\boldsymbol{G}^D$.

The $\boldsymbol{Z}^R$ design matrix is defined as $\boldsymbol{Z}^R = [\boldsymbol{Z}^{Rk_At_0} \quad \cdots \quad \boldsymbol{Z}^{Rk_It_2}]$, where $\boldsymbol{Z}^{Rk_At_0}$ through $\boldsymbol{Z}^{Rk_It_2}$ are $n \times n_R$ design submatrices for all kt combinations that assign the trustor variance parameters to the observations. Analogous designs exist for $\boldsymbol{Z}^E$ and $\boldsymbol{Z}^D$.

In (1.11), $\boldsymbol{Z}^R\boldsymbol{G}^R(\boldsymbol{Z}^R)'$ is the $n \times n$ variance-covariance of $\boldsymbol{y}$ attributable to the trustor, and $\boldsymbol{Z}^E\boldsymbol{G}^E(\boldsymbol{Z}^E)'$ and $\boldsymbol{Z}^D\boldsymbol{G}^D(\boldsymbol{Z}^D)'$ are the variance-covariance of $\boldsymbol{y}$ attributable to the trustee and dyad, respectively. The trustor variance of trustor r who rates trustor e in dyad d is the diagonal of

$$\boldsymbol{Z}^R_{red}\boldsymbol{G}^R(\boldsymbol{Z}^R_{red})' = \begin{bmatrix}\sigma^2_{Rk_At_0} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \sigma^2_{Rk_It_2}\end{bmatrix},$$

where $\sigma^2_{Rk_At_0}$ through $\sigma^2_{Rk_It_2}$ are the trustor variance parameters for all kt combinations. Using the estimates of $\boldsymbol{G}$ and $\boldsymbol{\Sigma}$, the vector of influence measures for all kt combinations is defined as

$$\begin{aligned} trustor\ influence &= diag\left(\boldsymbol{Z}^R_{red}\widehat{\boldsymbol{G}}^R(\boldsymbol{Z}^R_{red})'\right)/diag\left(\widehat{\boldsymbol{\Sigma}}^{red}\right) \\ trustee\ influence &= diag\left(\boldsymbol{Z}^E_{red}\widehat{\boldsymbol{G}}^E(\boldsymbol{Z}^E_{red})'\right)/diag\left(\widehat{\boldsymbol{\Sigma}}^{red}\right). \\ dyadic\ influence &= diag\left(\boldsymbol{Z}^D_{red}\widehat{\boldsymbol{G}}^D(\boldsymbol{Z}^D_{red})'\right)/diag\left(\widehat{\boldsymbol{\Sigma}}^{red}\right)\end{aligned} \tag{1.12}$$

In Model 1 (and Model 2), we do not assume that the residual error $\boldsymbol{\varepsilon}$ will have variance-covariance $\boldsymbol{V} = \boldsymbol{I}\sigma^2_\varepsilon$. Instead, we assume $\boldsymbol{V}$ will have unequal variance across kt combinations and no covariance such that $\boldsymbol{V}^{kt} = \boldsymbol{I}\sigma^2_{\varepsilon kt}$, where $\sigma^2_{\varepsilon kt}$ is the residual variance for dimension k and time t and $\boldsymbol{I}$ is an identity matrix of length equal to the observations in the kt subset. That is,

$$\boldsymbol{V} = \begin{bmatrix}\boldsymbol{V}^{k_At_0} & \cdots & \boldsymbol{0} \\ \vdots & \ddots & \vdots \\ \boldsymbol{0} & \cdots & \boldsymbol{V}^{k_It_2}\end{bmatrix}, \tag{1.13}$$

where $\boldsymbol{V}^{k_At_0}$ through $\boldsymbol{V}^{k_It_2}$ are the residual variance-covariance for i.i.d. errors within each kt combination. To accommodate this error structure within the lme4 framework in R, we define

$\boldsymbol{\varepsilon} = \boldsymbol{Z}^F \boldsymbol{\gamma}_F + \boldsymbol{\xi}$, where F refers to the set of asymmetrical trustor-trustee pairs, $\boldsymbol{\gamma}_F$ is a $n_F \times 1$ vector of random parameters, $\boldsymbol{Z}^F$ is the associated $n \times n_F$ design matrix and $\boldsymbol{\xi}$ is a $n \times 1$ vector of homoscedastic, i.i.d. errors. We define $\boldsymbol{V} = \boldsymbol{Z}^F \boldsymbol{G}^F (\boldsymbol{Z}^F)' + \boldsymbol{I}\sigma_\xi^2$, where $\boldsymbol{G}^F$ is the variance-covariance matrix for $\boldsymbol{\gamma}_F$ that has zero covariance, $\boldsymbol{I}$ is an identity matrix of length n and σ_ξ^2 is the variance of ξ. The definition creates the error variance structure in (1.13).

Model 2

Model 2 drops the assumption that the influence of loci are independent across time. Instead, it models the influence of trustors, trustees and dyads as linear growth over time. It also accounts for transitory trustor effects, which we deem as trustor error and which occur independent of the enduring trustor effects captured by the linear growth.

To model linear growth in Model 2, a random intercept (designated by the subscript 0) and slope parameter (designated by the subscript 1) are included for each locus. A response by trustor r who rates trustee e (which comprise dyad d) on trustworthiness dimension k at time period t is specified as

$$\begin{aligned} y_{redkt} = \beta_{kt} + \gamma_{0rk} + time \cdot \gamma_{1rk} + \gamma_{0ek} + time \cdot \gamma_{1ek} + \\ \gamma_{0dk} + time \cdot \gamma_{1dk} + \gamma_{pk} + \varepsilon_{redkt} \end{aligned}, \tag{1.14}$$

where (within dimension k) γ_{0rk} and γ_{1rk}, γ_{0ek} and γ_{1ek} and γ_{0dk} and γ_{1dk} are the intercept and slope parameters for trustor r, trustee e and dyad d, respectively. The slope parameters are multiplied by the time period, $time = \{0,1,2\}$. The random parameter γ_{pk} captures the error in trustor r's response at time t for dimension k. The parameters β_{kt} and ε_{redkt} are the same as in (1.4). The variance of y_{redkt} for Model 2 is

$$\begin{aligned} Var(y_{redkt}) = \; & Var(\gamma_{0rk} + time \cdot \gamma_{1rk}) + Var(\gamma_{0ek} + time \cdot \gamma_{1ek}) + \\ & Var(\gamma_{0dk} + time \cdot \gamma_{1dk}) + Var(\gamma_{pk}) + Var(\varepsilon_{redkt}) \\ = \; & Var(\gamma_{0rk}) + 2 \cdot Cov(\gamma_{0rk}, time \cdot \gamma_{1rk}) + Var(time \cdot \gamma_{1rk}) + \\ & Var(\gamma_{0ek}) + 2 \cdot Cov(\gamma_{0ek}, time \cdot \gamma_{1ek}) + Var(time \cdot \gamma_{1ek}) + \\ & Var(\gamma_{0dk}) + 2 \cdot Cov(\gamma_{0dk}, time \cdot \gamma_{1dk}) + Var(time \cdot \gamma_{1dk}) + \\ & Var(\gamma_{pk}) + Var(\varepsilon_{redkt}) \\ = \; & \sigma_{0Rk}^2 + 2 \cdot time \cdot \sigma_{01Rk} + time^2 \cdot \sigma_{1Rk}^2 + \\ & \sigma_{0Ek}^2 + 2 \cdot time \cdot \sigma_{01Ek} + time^2 \cdot \sigma_{1Ek}^2 + \\ & \sigma_{0Dk}^2 + 2 \cdot time \cdot \sigma_{01Dk} + time^2 \cdot \sigma_{1Dk}^2 + \\ & \sigma_{Pk}^2 + \sigma_{\varepsilon kt}^2 \end{aligned}, \tag{1.15}$$

where (for dimension k) σ_{0Rk}^2 is the trustor intercept variance, σ_{1Rk}^2 is the trustor slope variance and σ_{01Rk} is the trustor intercept-slope covariance. The parameters σ_{0Ek}^2, σ_{1Ek}^2, and σ_{01Ek} and σ_{0Dk}^2, σ_{1Dk}^2, and σ_{01Dk} and analogous defined for trustees and dyads. The parameter σ_{Pk}^2 is the trustor error variance for dimension k, and $\sigma_{\varepsilon kt}^2$ is the same as in (1.5). Note the variance at any given time period is a function of the $time$ variable.

If we define

$$\begin{aligned} \hat{\sigma}_{Rkt}^2 &= \hat{\sigma}_{0Rk}^2 + 2 \cdot time \cdot \hat{\sigma}_{01Rk} + time^2 \cdot \hat{\sigma}_{1Rk}^2 \\ \hat{\sigma}_{Ekt}^2 &= \hat{\sigma}_{0Ek}^2 + 2 \cdot time \cdot \hat{\sigma}_{01Ek} + time^2 \cdot \hat{\sigma}_{1Ek}^2 \, , \\ \hat{\sigma}_{Dkt}^2 &= \hat{\sigma}_{0Dk}^2 + 2 \cdot time \cdot \hat{\sigma}_{01Dk} + time^2 \cdot \hat{\sigma}_{1Dk}^2 \end{aligned}$$

then the trustor, trustee and dyadic influence is calculated as

$$\begin{aligned} trustor\ influence_{kt} &= \hat{\sigma}^2_{Rkt}/(\hat{\sigma}^2_{Rkt} + \hat{\sigma}^2_{Ekt} + \hat{\sigma}^2_{Dkt} + \hat{\sigma}^2_{Pk} + \hat{\sigma}^2_{\varepsilon kt}) \\ trustee\ influence_{kt} &= \hat{\sigma}^2_{Ekt}/(\hat{\sigma}^2_{Rkt} + \hat{\sigma}^2_{Ekt} + \hat{\sigma}^2_{Dkt} + \hat{\sigma}^2_{Pk} + \hat{\sigma}^2_{\varepsilon kt})\ . \\ dyadic\ influence_{kt} &= \hat{\sigma}^2_{Dkt}/(\hat{\sigma}^2_{Rkt} + \hat{\sigma}^2_{Ekt} + \hat{\sigma}^2_{Dkt} + \hat{\sigma}^2_{Pk} + \hat{\sigma}^2_{\varepsilon kt}) \end{aligned} \tag{1.16}$$

The specification in (1.14) can also be written in matrix notation for the full sample by expanding (1.1) such that

$$\begin{aligned} \boldsymbol{y} &= \boldsymbol{X\beta} + [\boldsymbol{Z}^R \quad \boldsymbol{Z}^E \quad \boldsymbol{Z}^D \quad \boldsymbol{Z}^P] \begin{bmatrix} \boldsymbol{\gamma_R} \\ \boldsymbol{\gamma_E} \\ \boldsymbol{\gamma_D} \\ \boldsymbol{\gamma_P} \end{bmatrix} + \boldsymbol{\varepsilon} \quad , \\ &= \boldsymbol{X\beta} + \boldsymbol{Z}^R\boldsymbol{\gamma}_R + \boldsymbol{Z}^E\boldsymbol{\gamma}_E + \boldsymbol{Z}^D\boldsymbol{\gamma}_D + \boldsymbol{Z}^P\boldsymbol{\gamma}_P + \boldsymbol{\varepsilon} \end{aligned} \tag{1.17}$$

where the parameter vectors $\boldsymbol{\gamma}_R$, $\boldsymbol{\gamma}_E$ and $\boldsymbol{\gamma}_D$ are the random intercept and slope parameters for trustors, trustees and dyads, respectively, with dimensions $2n_Rn_K \times 1$, $2n_En_K \times 1$ and $2n_Dn_K \times 1$. The matrices $\boldsymbol{Z}^R$, $\boldsymbol{Z}^E$ and $\boldsymbol{Z}^D$ are the respective design matrices for the trustor, trustee and dyad intercept and slope parameters. The parameter vector $\boldsymbol{\gamma}_P$ is the random trustor error with dimensions $n_Pn_K \times 1$, and $\boldsymbol{Z}^P$ is the associated design matrix. $\boldsymbol{X\beta}$ and $\boldsymbol{\varepsilon}$ are the same as in (1.8).

The $\boldsymbol{Z}^R$ design matrix is further defined as $\boldsymbol{Z}^R = [\boldsymbol{Z}^{Rk_A} \quad \boldsymbol{Z}^{Rk_B} \quad \boldsymbol{Z}^{Rk_I}]$, where each trustor design submatrix is $n \times 2n_R$. The pattern, which is repeated in $\boldsymbol{Z}^{Rk}$, for a given trustor r, trustee e, dyad d and dimension k is

$$\boldsymbol{Z}^{rk}_{redk} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 2 \end{bmatrix},$$

where the first column assigns the random intercept parameter and the second (which holds the time value) assigns the random slope to each observation across time. Analogous designs exist for $\boldsymbol{Z}^E$ and $\boldsymbol{Z}^D$.

The variance-covariance matrix $\boldsymbol{G}$ in (1.2) is expanded for Model 2 as

$$\boldsymbol{G} = \begin{bmatrix} \boldsymbol{G}^R & \boldsymbol{0} & \boldsymbol{0} & \boldsymbol{0} \\ \boldsymbol{0} & \boldsymbol{G}^E & \boldsymbol{0} & \boldsymbol{0} \\ \boldsymbol{0} & \boldsymbol{0} & \boldsymbol{G}^D & \boldsymbol{0} \\ \boldsymbol{0} & \boldsymbol{0} & \boldsymbol{0} & \boldsymbol{G}^P \end{bmatrix}, \tag{1.18}$$

where $\boldsymbol{G}^R$, $\boldsymbol{G}^E$, $\boldsymbol{G}^D$ and $\boldsymbol{G}^P$ are the variance-covariance matrices for trustor, trustee, dyad and trustor error random effects, respectively, with square dimensions of length $2n_Rn_K$, $2n_En_K$, $2n_Dn_K$ and n_Pn_K. The matrix $\boldsymbol{G}^R$ is defined as

$$\boldsymbol{G}^R = \begin{bmatrix} \boldsymbol{G}^{Rk_A} & \boldsymbol{0} & \boldsymbol{0} \\ \boldsymbol{0} & \boldsymbol{G}^{Rk_B} & \boldsymbol{0} \\ \boldsymbol{0} & \boldsymbol{0} & \boldsymbol{G}^{Rk_I} \end{bmatrix},$$

where $\boldsymbol{G}^{Rk_A}$, $\boldsymbol{G}^{Rk_B}$ and $\boldsymbol{G}^{Rk_I}$ are the $2n_R \times 2n_R$ trustor variance-covariance matrices for perceived ability, benevolence and integrity, respectively. We assume no covariance across trustworthiness dimensions in Model 2 to keep the model from becoming too complex. The trustor variance-covariance for a given trustor r and trustworthiness dimension k is

$$\boldsymbol{G}^{rk} = \begin{bmatrix} \sigma^2_{0Rk} & \sigma_{01Rk} \\ \sigma_{01Rk} & \sigma^2_{1Rk} \end{bmatrix},$$

where σ_{0Rk}^2 is the variance of the intercept parameter, σ_{1Rk}^2 is the variance of the slope parameter and σ_{01Rk} is the covariance of the intercept and slope parameters. Analogous variance parameters exist for $\boldsymbol{G}^E$ and $\boldsymbol{G}^D$. The matrix $\boldsymbol{G}^P$ is defined as

$$\boldsymbol{G}^P = \begin{bmatrix} \boldsymbol{G}^{Pk_A} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \boldsymbol{G}^{Pk_B} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \boldsymbol{G}^{Pk_I} \end{bmatrix},$$

where $\boldsymbol{G}^{Pk_A}$, $\boldsymbol{G}^{Pk_B}$ and $\boldsymbol{G}^{Pk_I}$ are the $n_P \times n_P$ trustor error variance-covariance matrices for perceived ability, benevolence and integrity, respectively. Further, $\boldsymbol{G}^P$ for dimension k is defined as

$$\boldsymbol{G}^{Pk} = \begin{bmatrix} \sigma_{Pk}^2 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \sigma_{Pk}^2 \end{bmatrix},$$

where σ_{Pk}^2 is the trustor error variance for dimension k. Note, σ_{Pk}^2 is stationary across time periods.

The variance-covariance of $\boldsymbol{y}$ in Model 2 is expanded to

$$\boldsymbol{\Sigma} = \boldsymbol{Z}^R\boldsymbol{G}^R(\boldsymbol{Z}^R)' + \boldsymbol{Z}^E\boldsymbol{G}^E(\boldsymbol{Z}^E)' + \boldsymbol{Z}^D\boldsymbol{G}^D(\boldsymbol{Z}^D)' + \boldsymbol{Z}^P\boldsymbol{G}^P(\boldsymbol{Z}^P)' + \boldsymbol{V}. \tag{1.19}$$

The trustor variance of trustor r's rating of trustee e in dyad d for dimension k is the diagonal of

$$\begin{aligned}\boldsymbol{Z}_{redk}^R\boldsymbol{G}^R(\boldsymbol{Z}_{redk}^R)' &= \boldsymbol{Z}_{redk}^{rk}\boldsymbol{G}^{rk}(\boldsymbol{Z}_{redk}^{rk})' \\ &= \begin{bmatrix} 1 & 0 \\ 1 & 1 \\ 1 & 2 \end{bmatrix}\begin{bmatrix} \sigma_{0Rk}^2 & \sigma_{01Rk} \\ \sigma_{01Rk} & \sigma_{1Rk}^2 \end{bmatrix}\begin{bmatrix} 1 & 1 & 1 \\ 0 & 1 & 2 \end{bmatrix} \\ &= \begin{bmatrix} \sigma_{0Rk}^2 & \sigma_{0Rk}^2 + \sigma_{01Rk} & \sigma_{0Rk}^2 + 2\sigma_{01Rk} \\ \sigma_{0Rk}^2 + \sigma_{01Rk} & \sigma_{0Rk}^2 + 2\sigma_{01Rk} + \sigma_{1Rk}^2 & \sigma_{0Rk}^2 + 3\sigma_{01Rk} + 2\sigma_{1Rk}^2 \\ \sigma_{0Rk}^2 + 2\sigma_{01Rk} & \sigma_{0Rk}^2 + 3\sigma_{01Rk} + 2\sigma_{1Rk}^2 & \sigma_{0Rk}^2 + 4\sigma_{01Rk} + 4\sigma_{1Rk}^2 \end{bmatrix}.\end{aligned}$$

Thus, the trustor variance for dimension k is

$$\sigma_{Rkt}^2 = \begin{cases} \sigma_{0Rk}^2, & time = 0 \\ \sigma_{0Rk}^2 + 2\sigma_{01Rk} + \sigma_{1Rk}^2, & time = 1. \\ \sigma_{0Rk}^2 + 4\sigma_{01Rk} + 4\sigma_{1Rk}^2, & time = 2 \end{cases}$$

The trustee and dyad variance are analogously patterned in $\boldsymbol{Z}^E\boldsymbol{G}^E(\boldsymbol{Z}^E)'$ and $\boldsymbol{Z}^D\boldsymbol{G}^D(\boldsymbol{Z}^D)'$.

The trustor error variance of trustor r's rating of trustee e in dyad d for dimension k is the diagonal of

$$\boldsymbol{Z}_{redk}^P\boldsymbol{G}^P(\boldsymbol{Z}_{redk}^P)' = \begin{bmatrix} \sigma_{Pk}^2 & 0 & 0 \\ 0 & \sigma_{Pk}^2 & 0 \\ 0 & 0 & \sigma_{Pk}^2 \end{bmatrix}.$$

The definition of $\boldsymbol{V}$ is the same as (1.13). The influence of the trustor, trustee and dyad loci are calculated the same as (1.12), with definition of $\boldsymbol{Z}$, $\boldsymbol{G}$ and $\boldsymbol{\Sigma}$ following (1.17) through (1.19).

Bootstrapping and Confidence Intervals

We used parametric bootstrapping to develop confidence intervals of the estimated differences between loci influence. Loci influence for a given kt combination was measured as the percentage of total variance as defined in (1.16). Model 2 was used for all tests. While nonparametric bootstrapping would be preferred over parametric bootstrapping, it is not feasible with the cross-nested nature of the data (van der Leeden, Meijer, & Busing, 2008). One thousand parametric bootstrap samples $\boldsymbol{y}_1^*$, $\boldsymbol{y}_2^*$, …, $\boldsymbol{y}_{1000}^*$, were created by resampling from the spherical distribution of random effects and residual error. The model was then reestimated for each $\boldsymbol{y}_b^*$, $b = \{1, \ldots, 1000\}$, and the variance-covariance estimates in $\widehat{\boldsymbol{\Sigma}}_b^*$ were extracted. The estimates were converted to percentage of total variance as in (1.16).

Let H be the set of hypothesized differences between percentage variance estimates calculated for the original sample $\boldsymbol{y}$ and h be any given difference in H ($h \in H$). For instance, h can be the difference between trustor percentage variance at project end and project start for perceived ability (H1a), or it can be the difference between trustor percentage variance and trustee percentage variance at project end for perceived benevolence (RQ1b). The differences H_b^* were calculated for each $\boldsymbol{y}_b^*$. Then we calculated the standard deviation $\hat{\sigma}_h$ for the set of bootstrap estimates h_1^*, h_2^*, …, h_{1000}^*. The $\hat{\sigma}_h$ statistic is a bootstrap estimate of σ_h, the standard error of the difference between percentage variance in the population (Efron & Tibshirani, 1986). We then constructed confidence intervals as

$$5\%\ C.I. = h + \hat{\sigma}_h z^{(.05)}$$
$$95\%\ C.I. = h + \hat{\sigma}_h z^{(.95)},$$

where $z^{(.05)} = -1.645$ and $z^{(.95)} = 1.645$ from a standard normal distribution. We also estimated the bootstrapped confidence intervals following the bias-corrected approach (Efron & Tibshirani, 1986), which resulted in nearly identical confidence interval estimates.