# Should we commit or should we switch? Aligning goals in sequential social decision-making

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**Abstract**

Coherent social coordination requires aligning not only actions in the moment but also goals over time. Yet it remains unclear how joint goals are selected when multiple options unfold sequentially, and how shared information—prior goals maintained in working memory versus newly available goals captured by perception—guides coordination. We examine how the temporal structure of interaction shapes goal selection. Across three experiments, pairs of participants performed Pac-Man–like coordination tasks in which an old goal persisted while a new goal appeared. When coordination required two players to align synchronically in real time, dyads converged on newly appearing goals. When coordination required players to take turns controlling a single agent, dyads persisted with old goals. Critically, manipulating the turn-taking interval revealed a graded transition: longer intervals strengthened bias toward the old goal, whereas shorter intervals eliminated this bias. Together, these findings show that joint coordination flexibly recruits perception- and memory-based mechanisms over time.

**Keywords:** social coordination; commitment; joint action; time

## Introduction

Human societies are built on coordination. From the mundane to the extraordinary, our success as a species depends on the ability to align our goals and actions with those of others (Tomasello, 2009). A fundamental challenge of goal alignment arises whenever multiple, equally desirable options are available (Chater, Zeitoun, & Melkonyan, 2022). Imagine a hunting party standing at the edge of a forest, where several promising paths lead to different prey. To succeed, the group must converge on a single target: if some hunters pursue deer while others chase boar, the hunt will fail.

Crucially, real-world coordination rarely unfolds in static settings. Goals often emerge sequentially in changing environments, such that new opportunities can arise while previously selected goals remain available. Under these conditions, coordination requires resolving a central challenge: how do humans converge on a joint goal and sustain coherent action over time? Humans, even in non-linguistic contexts, are capable of aligning goals and actions using largely visually grounded mechanisms that emerge early in evolution and development (Tomasello, 2010). These mechanisms rely on basic cognitive processes, including perception, which supports joint attention to potential goals (Siposova & Carpenter, 2019), and working memory, which supports maintaining commitments to a joint goal across time (Michael & Pacherie, 2015). Coordinating in dynamic environments therefore requires integrating information from these two sources: newly appearing goals are directly accessible through perception and provide salient cues for alignment, whereas earlier goals must be sustained in working memory, relying on prior commitments. Effective coordination thus depends on how individuals and groups balance perceptual access to new options against memory-based commitment to earlier ones.

While the roles of perception and working memory have been extensively studied in individual cognitive tasks, far less is known about how these processes jointly support social coordination when multiple goals unfold over time. By contrast, philosophers have long emphasized the temporal extension of coordination and the challenges it poses for maintaining coherent joint action (Bratman, 2014; Gilbert, 2017). In particular, they distinguish between synchronic coordination, which emphasizes alignment in the moment, and diachronic coordination, which emphasizes alignment across time (Bratman, 2018). However, these distinctions have rarely been operationalized in controlled cognitive tasks that allow direct comparison of how joint goals are selected as environments change.

In the current study, we translate philosophical discussions of temporal coordination into a behavioral task of social coordination. Using a sequential decision-making paradigm in which new goals emerge over time, we examine how perceptual access to newly appearing goals and memory-based commitment to previously intended goals jointly shape goal selection across time.

### Synchronic coordination: Aligning actions and intentions in the moment

Synchronic coordination occurs when individuals must align their actions and intentions in the moment, such as playing a duet on the piano, rowing a boat, or two pedestrians approaching each other and implicitly agreeing on which side to pass. Empirical studies on joint action typically employ tasks in which the goal is fixed in advance. Under these conditions, the central challenge is not deciding what to pursue, but coordinating how to act together. Consequently, synchronic coordination has largely been studied as a problem of sensorimotor alignment, where success depends on partners' ability to continuously adjust timing, force, and rhythm to remain in sync (Sebanz, Bekkering, & Knoblich, 2006; Sebanz & Knoblich, 2021).



In G. Boleda, I. Dautriche, M. Maldonado, C. Saldana and T. Torrent (Eds.), *Proceedings of the 48th Annual Conference of the Cognitive Science Society* 

A complementary line of research highlights that coordination can involve not only sensorimotor alignment, but also joint decision-making and the alignment of mental states (Higgins, Rossignac-Milon, & Echterhoff, 2021; Shteynberg et al., 2023; Tomasello, 2025). Drawing on philosophical accounts of agency, this work emphasizes the roles of shared intentions and joint commitments in successful coordination (Bratman, 2014; Gilbert, 2017; Michael & Pacherie, 2015; Searle, 2010). From this perspective, acting together involves establishing common ground—shared knowledge, attention, or cues that allow partners to identify a joint goal in the first place (Clark, 1996; De Freitas, Thomas, DeScioli, & Pinker, 2019). Once a joint goal is mutually recognized, coordination is further supported by forming a joint commitment to that goal, which structures expectations about how partners will act together over time (Bratman, 2014; Gilbert, 2017; Siposova & Carpenter, 2019).

In synchronic contexts, perception plays a central role in joint goal selection. In tacit coordination games, partners often converge on the most salient option—such as choosing the Eiffel Tower as a meeting spot in Paris—because its perceptual obviousness ensures common ground and facilitates joint commitment (Schelling, 1960). Experimental studies show that by age five, children already exploit perceptual salience as a focal point for successful coordination, even in the absence of verbal communication (Grueneisen, Wyman, & Tomasello, 2015). Moreover, once partners have converged on a joint goal, they typically remain committed to it despite environmental perturbations, highlighting the stabilizing role of joint commitment in synchronic coordination (Gräfenhain, Behne, Carpenter, & Tomasello, 2009; Hamann, Warneken, & Tomasello, 2012).

## Diachronic coordination: Aligning actions and intentions over time

An equally important aspect of human coordination is diachronic coordination, which requires aligning actions and intentions not only in the moment but also across time (Bratman, 2018). Such alignment arises when multiple individuals must sustain a sequence of interdependent goals across temporal gaps. Unlike synchronic coordination, which typically involves real-time alignment among multiple agents, diachronic coordination can also extend within a single individual, involving coordination between one's present self and future self.

A defining feature of diachronic coordination is the use of partial plans. People often commit to some aspects of a course of action in advance while leaving other details unspecified. For example, one might book flights and reserve a hotel for a trip months ahead without yet deciding how to get to the airport. Philosophers have argued that this capacity for partial planning is a core component of human agency (Bratman, 1987, 2018). By stabilizing intentions while preserving flexibility, partial plans support long-term coherence without overburdening cognitive resources, enabling coordinated action across time.

Importantly, the ability to commit to partial plans may first develop in social contexts, where individuals coordinate with others by aligning intentions and goals to achieve coherent joint action over time. Through processes of socialization and internalization, this socially grounded capacity may later be recruited to support coordination with one's future self (Cheng, Zhu, Zhou, Shen, & Gao, 2026; Tomasello, 2019).

Diachronic coordination therefore places particular demands on working memory capability. To sustain commitment to a partially specified future goal, individuals must maintain prior intentions in working memory and resist distraction by newly emerging alternatives. In this way, working memory serves as the cognitive substrate that allows intentions to persist across time, supporting both individual self-regulation and social coordination over extended sequences of action.

Recent work has begun to examine diachronic coordination empirically, primarily in individual decision-making contexts. Using sequential decision-making tasks, these studies show that adults often persist with prior goals even when equally attractive—or even more optimal—new options appear (Cheng et al., 2023; Zhai, Cheng, Moskowitz, Shen, & Gao, 2024). In their Pac-Man–like paradigms, commitment to an "old" goal is often formed before a "new" goal is revealed, leading adults and older children (six-year-olds), but not younger children (five-year-olds), to reliably stick with prior goals (Zhai et al., 2024). However, these findings are almost exclusively based on single-agent settings. Given that partial planning may originate in social coordination, it remains an open question whether—and how—such plan persistence extends to multi-agent contexts, where intentions and commitments must be aligned and maintained jointly across time.

## The present study: Bridging synchronic and diachronic coordination

In real-world social interaction, coordination often requires the integration of both synchronic and diachronic processes. People must align actions in the moment while also sustaining shared plans over time, drawing on both perceptual salience and memory-based commitment. Prior research, however, has largely treated synchronic coordination in the context of social joint action and diachronic coordination in the context of individual planning.

The present study addresses this gap by asking how people resolve sequential social coordination problems in which multiple goals are available over time. Specifically, does the temporal structure of interaction determine how joint goals are selected? When coordination is dominated by continuous real-time alignment, do groups rely on perceptually salient options, as observed in synchronic social coordination tasks (Grueneisen et al., 2015)? Conversely, when interaction unfolds across temporal gaps, does coordination shift toward memory-based commitment to prior plans, as observed in in-

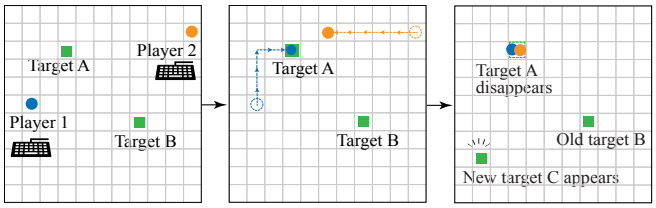


Figure 1: Cooperative Pac-Man (Experiment 1). Two players each control one of two agents, shown as blue and orange circles, to jointly reach a target (green square) on a 2D grid world. Once a target is reached by both players, it disappears, and a new target simultaneously appears at a different location.

dividual sequential decision-making tasks (Cheng et al., 2023; Zhai et al., 2024)? More broadly, does the contrast between perception-based and memory-based coordination reflect differences between individual and social tasks, or is it instead driven by the synchronic versus diachronic temporal structure of coordination itself?

To address these questions, we designed a series of Pac-Man–like coordination tasks that systematically varied the temporal structure of joint action. In Experiment 1 (Cooperative Pac-Man; Figure 1), we adapted an established individual Pac-Man–style sequential decision-making task (Zhai et al., 2024) to a cooperative setting. This design allows us to test whether joint coordination under real-time dynamic interaction is guided primarily by online perceptual salience, as observed in prior social coordination tasks (Grueneisen et al., 2015), or by commitment to previously selected goals, as observed in individual versions of this task (Cheng et al., 2023). In this task, two players control separate agents simultaneously and are required to converge on the same goal in real time. Once a goal is jointly reached, a new goal appears elsewhere on the map, with distances carefully controlled. Successful performance required continuous real-time alignment, emphasizing the synchronic demands of coordination.

In Experiment 2 (Relay Pac-Man; Figure 2), we preserve the multi-agent structure but remove the synchronic component of coordination. Instead of acting simultaneously, players take turns controlling a single agent. Comparing Experiments 1 and 2 allows us to examine the extent to which biases toward old versus new goals depend on the synchronic nature of the joint task.

Experiment 3 (Figure 3) transformed the dichotomy between synchronic and diachronic coordination into a continuous variable by manipulating the length of the handoff interval in Relay Pac-Man. Longer intervals emphasize diachronic planning, whereas shorter intervals increase synchronic pressure. This manipulation allows us to examine how perception- and memory-based coordination mechanisms interact along a temporal continuum.

Our primary behavioral measure is how participants resolved the sequential coordination problem by aligning their goal choices over time. Specifically, we examined (1) whether

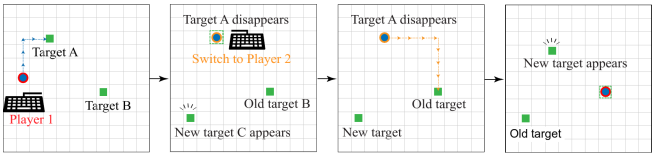


Figure 2: Relay Pac-Man (Experiment 2). Two players take turns controlling a single agent (blue circle) to reach a target on a 2D grid world. A red outline of the blue circle indicates Player 1's turn, while a yellow outline indicates Player 2's turn. Once the agent reaches a target, the target disappears, a new target appears at a different location, and the control switches to the other player.

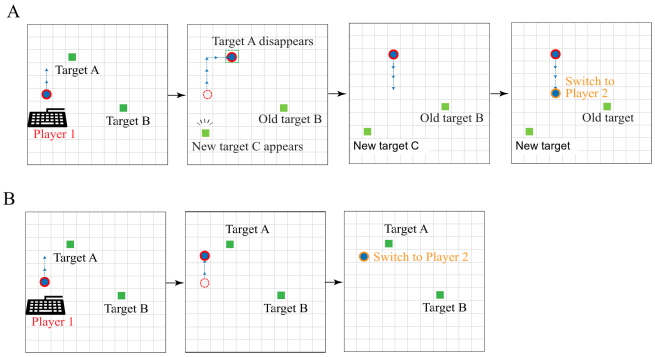


Figure 3: Relay Pac-Man with different time intervals (Experiment 3). Panel A: Large handoff interval, with control switching after a randomly selected interval between 20 and 30 steps. Panel B: Small handoff interval, with control switching after a randomly selected interval between 1 and 6 steps.

participants exhibited a systematic bias in goal selection, (2) the direction of this bias—toward the perceptual salience of newly appearing goals versus memory-based commitment to previously existing goals, and (3) whether this bias shifted as a function of task demands, particularly the temporal structure of coordination in Experiment 3. See Figure 4 for an overview of all experimental results.

## Experiment 1a: Cooperative Pac-Man

### Method

**Participants** A power analysis (power = .80, $\alpha$ = .05), based on the effect size reported in prior work (Cohen's $d$ = 0.51; Zhai et al., 2024), indicated that 20 pairs of participants ($N$ = 40) were sufficient. This power analysis is not repeated for subsequent experiments, as sample sizes were identical across studies. A total of 40 participants were recruited from the participant pool at Zhejiang University. Each participant received monetary compensation (approximately $3) for participation, as well as an additional bonus (approximately $0.50) for completing the task according to instructions. The experiment lasted approximately 20 minutes. Participants were recruited independently for each experiment, and no participant participated in more than one experiment.

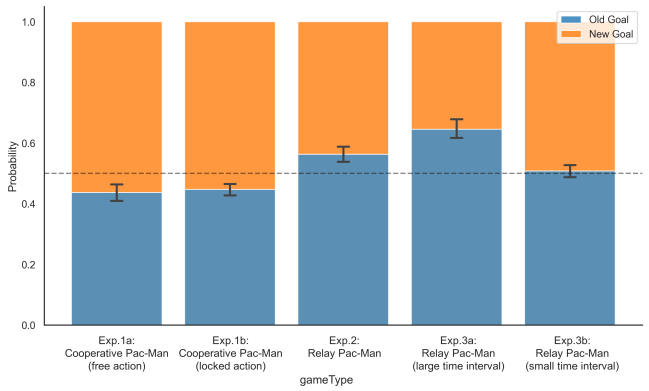


Figure 4: All experiment results. Proportion of dyad-trials selecting the old goal vs. the new goal across different experiments. Error bars indicate 95% confidence intervals.

**Design and procedure** On each trial, participants viewed a $15 \times 15$ grid map displaying two agents (blue and orange circles) and two goals (green squares). The map was presented on a 24-inch monitor at a visual angle of approximately $21° \times 21°$, viewed from a distance of 60 cm.

Participants were instructed that they would be playing a cooperative game in which each participant controlled one of the two agents, working together to reach a goal. A goal could only be collected when both players reached the same target. Their joint task was to collect as many goals as possible. Once a target was collected, a new target (the new goal) appeared at a different location, while the uncollected target remained available (the old goal).

The position of the new target was manipulated across seven distance conditions ($-5$, $-3$, $-1$, 0, $+1$, $+3$, $+5$), with 0 representing the condition in which the new and old goals were equidistant. Negative values indicated that the new goal was closer than the old goal, whereas positive values indicated that the old goal was closer. There were 30 trials per condition, yielding a total of 210 trials. Trials from the seven distance conditions were presented in randomized order for each dyad. The randomization was constrained so that each condition appeared 30 times across the experiment.

After receiving instructions, participants were seated at two separate monitors (Figure 1). They were not allowed to communicate with one another and had no visual access to their partner's screen or face. Each participant used a separate keyboard and could move their assigned agent freely using the arrow keys.

The task began with 10 practice trials to familiarize participants with the game mechanics. The formal experiment followed and was divided into five blocks, with short breaks between blocks. The first trial of each block was excluded from analysis because it always presented two newly appearing goals and therefore did not involve an old goal.

### Results and discussion

The unit of analysis was the dyad-trial. For each trial, we coded the dyad's final selected goal as old goal = 1 and new goal = 0. To test whether dyads showed a general bias in goal choice, we fitted a mixed-effects logistic regression with goal choice as the dependent variable and a random intercept for participant dyad, allowing baseline goal-choice tendencies to vary across dyads. The intercept of the model ($\beta = -0.236$, OR = 0.790, 95% CI [0.708, 0.881], $p < .001$) indicated a significant bias toward selecting the new goal. This pattern contrasts with findings from individual sequential decision-making studies (Cheng et al., 2023; Zhai et al., 2024), in which adults exhibited a bias toward persisting with old goals.

One potential concern is that, in Experiment 1a, the two players could move independently and at their own pace. Although this setup approximates natural social interaction, it may have encouraged a leader–follower strategy: if one player moved more quickly, their actions could effectively determine the dyad's choice, biasing the group toward whichever option was approached first. To address this possibility, Experiment 1b synchronized the players' actions so that each movement reflected a joint decision.

## Experiment 1b: Cooperative Pac-Man with synchronized movements

This experiment was identical to Experiment 1a except that the actions of the two players were synchronized. A joint move was executed only when both participants pressed their keys simultaneously, ensuring that each step reflected a coordinated joint action rather than unilateral movement by one player.

### Method

**Participants** Twenty pairs of participants ($N = 40$) were recruited from the participant pool at Zhejiang University. Compensation and procedure were identical to Experiment 1a. The experiment lasted approximately 20 minutes.

### Results and discussion

A mixed-effects logistic regression was fitted with goal choice (old goal = 1, new goal = 0) as the dependent variable and random intercepts for participant dyads. The intercept of the model ($\beta = -0.224$, OR = 0.799, 95% CI [0.735, 0.869], $p < .001$) again indicated a significant bias toward selecting the new goal. No significant difference was observed between Experiments 1a and 1b ($\beta = 0.022$, OR = 1.022, 95% CI [0.890, 1.174], $p = .756$).

These results replicate the findings of Experiment 1a and demonstrate that even when leader–follower dynamics were minimized through synchronized actions, dyads continued to favor newly appearing goals. This suggests that, under strong synchronic demands, joint coordination is guided primarily by salient, mutually observable cues rather than by persistence with prior goals.

## Experiment 2: Relay Pac-Man

Whereas Experiments 1a and 1b emphasized synchronic coordination by requiring real-time alignment of actions and goals, Experiment 2 focused on diachronic coordination. We designed a Relay Pac-Man task in which two participants took turns controlling a single agent. After one participant controlled the agent, control switched to the other participant.

In this setting, the need for real-time motor alignment was eliminated. Instead, successful coordination required participants to align with one another's prior actions and future intentions across time.

### Method

**Participants** Twenty pairs of participants ($N$ = 40) were recruited from the participant pool at Zhejiang University. Compensation and duration were identical to previous experiments.

**Design and procedure** The task was identical to Experiment 1a except for the following changes. First, only a single agent appeared on the map. Second, at any given time, only one participant controlled the agent while the other observed. Third, once the active player reached a target, control of the agent was transferred to the other participant. As a result, the task was explicitly sequential, with only one player acting at any moment.

### Results and discussion

A mixed-effects logistic regression was fitted with goal choice (old goal = 1, new goal = 0) as the dependent variable and random intercepts for dyads. The intercept of the model ($\beta$ = 0.255, OR = 1.291, 95% CI [1.157, 1.440], $p < .001$) indicated a significant bias toward selecting the old goal.

In contrast to the Cooperative Pac-Man tasks, participants in the Relay Pac-Man task showed a robust tendency to persist with previously available goals. This pattern parallels findings from individual sequential decision-making studies (Cheng et al., 2023; Zhai et al., 2024) and suggests that when real-time synchrony is removed, diachronic mechanisms of plan persistence dominate joint coordination.

## Experiment 3: Manipulating the handoff interval of Relay Pac-Man

Experiments 1 and 2 represent two extremes of coordination: Cooperative Pac-Man emphasizes synchronic alignment, whereas Relay Pac-Man emphasizes diachronic planning. Experiment 3 examined the continuum between these extremes by manipulating the length of the handoff interval between players in the Relay Pac-Man task.

The two interval ranges were chosen to create qualitatively different temporal demands. In the small-interval condition, control switched after 1–6 steps, often before the current player could complete an approach to a target. This frequent handoff was intended to increase synchronic pressure, because each player had to continuously adapt to the partner's immediately preceding movements. In the large-interval condition, control switched after 20–30 steps, allowing one player to pursue a target for an extended period before handing control to the partner. This was intended to increase diachronic pressure, because the next player had to infer and maintain the prior player's goal over a longer temporal gap.

### Method

**Participants** Twenty pairs of participants ($N$ = 40) were recruited from the participant pool at Zhejiang University. Compensation and duration were identical to previous experiments.

**Design and procedure** The task was identical to Experiment 2 (Relay Pac-Man), with the exception that the number of steps each participant controlled the agent before a handoff was systematically manipulated. In the large-interval condition (Experiment 3a), control switched after a randomly selected interval between 20 and 30 steps. In the small-interval condition (Experiment 3b), control switched after a randomly selected interval between 1 and 6 steps.

### Results and discussion

In the large-interval condition, a mixed-effects logistic regression revealed a significant bias toward the old goal ($\beta$ = 0.607, OR = 1.835, 95% CI [1.591, 2.117], $p < .001$). In contrast, no reliable bias was observed in the small-interval condition ($\beta$ = 0.038, OR = 1.039, 95% CI [0.957, 1.128], $p$ = .366). When handoff intervals were short, participants were no more likely to choose old goals than new goals, indicating that increased synchronic pressure disrupted plan persistence.

Across all Relay Pac-Man data (Experiment 2 and both conditions of Experiment 3), we conducted an OLS regression predicting mean commitment ratio (bias toward the old goal) from the mean number of steps between control switches. Mean interval length positively predicted commitment ratio ($t(58) = 6.90$, $p < .0001$; see Figure 5), indicating that longer temporal gaps strengthened commitment to prior goals.

Experiment 3 demonstrates that the balance between synchronic and diachronic demands systematically shapes joint decision-making. When handoff intervals were long, dyads behaved similarly to individuals, exhibiting a strong bias toward old goals. When intervals were short, this bias disappeared, and coordination resembled the more flexible, salience-driven behavior observed in Cooperative Pac-Man. These findings support the view that synchronic and diachronic coordination operate along a continuum, with temporal structure determining which mechanisms dominate joint action.

## General discussion

The present study examined how people align goals in social interactions that unfold over time. Across three experiments, we show that temporal structure systematically shapes how joint coordination is achieved, by modulating the relative

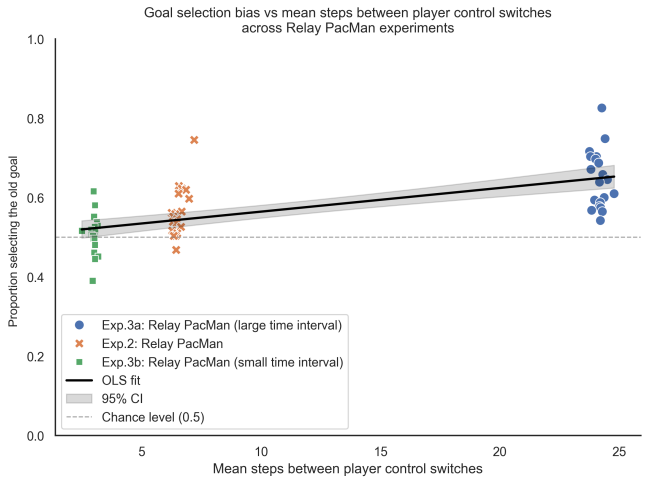


Figure 5: Time as a predictor for commitment bias in Relay Pac-Man. Goal-selection bias as a function of mean steps between player-control switches across Relay Pac-Man conditions. Solid line shows OLS fit; shaded band indicates the 95% confidence interval.

influence of perceptual salience and memory-based commitment to prior plans. When coordination was dominated by real-time alignment (cooperative Pac-Man; Experiments 1a and 1b), joint action was guided primarily by perceptually salient, newly appearing goals. When coordination was dominated by alignment across temporal gaps (relay Pac-Man; Experiment 2), joint action was instead stabilized by commitment to previously planned goals maintained in working memory. Crucially, these modes of coordination were not categorical but graded: systematically manipulating temporal structure (Experiment 3) produced predictable shifts in how groups resolved sequential coordination problems.

Together, these findings show that patterns previously identified in separate literatures extend across domains of coordination. Perception-based mechanisms, long known to support synchronic social coordination in the moment (e.g., Grueneisen et al., 2015), can also guide goal selection when multiple goals unfold sequentially over time (Experiment 1). Conversely, memory-based commitment—previously demonstrated in individual sequential decision-making (Cheng et al., 2023)—can likewise guide goal selection in relay-style social coordination contexts (Experiments 2 & 3a). Critically, these results indicate that the apparent divide between perception-based social coordination and memory-based individual commitment reflects differences in temporal structure, rather than a distinction between social and individual tasks. When coordination is dominated by synchronic demands, requiring continuous real-time alignment, joint action is guided primarily by perceptual salience and information available in the here and now. When coordination is dominated by diachronic demands, requiring coherence across temporal gaps, coordination shifts toward memory-based commitment to previously selected goals in coordination both with one's future self and with others. This pattern supports the view that individual and joint commitment share underlying cognitive mechanisms, supporting coordination both between oneself and others and, later, between one's present and future selves (Cheng et al., 2026).

Although memory-based commitment supports both individual and social coordination in sequential decision-making, perception-based coordination shows a striking asymmetry: it is robustly recruited in social coordination but plays a much weaker role in individual choice over time (especially among adults and older children; Zhai et al., 2024). This asymmetry suggests that social coordination engages distinctive constraints that make perceptual salience a particularly powerful organizing force. Our results illustrate this clearly in Experiment 1, where simply requiring coordination between multiple individuals was sufficient to reverse the direction of commitment: instead of persisting with previously selected goals, dyads reliably shifted toward newly appearing, perceptually salient goals. This reversal demonstrates that perceptual salience can override memory-based preferences that dominate individual decision-making, confirming the robustness of perception-based coordination (Grueneisen et al., 2015; Schelling, 1960).

We speculate that this asymmetry arises from the nature of common ground. Joint commitment requires a basis for coordination that is mutually accessible, trackable, and recognizable as shared (Clark, 1996), and joint attention to the contents of common ground provides the foundation of joint commitment: people commit to what they jointly attend to (Siposova & Carpenter, 2019). In non-linguistic contexts, even when participants have the same private memory states, it is difficult for such memory states to enter common ground or be selected by joint attention. In contrast, online perception has much easier access to common ground. As a result, when coordination requires simultaneous alignment, perceptual salience becomes a privileged input to joint commitment, highlighting social coordination as a distinctive—and potentially foundational—context in human cognitive development (Gilbert, 2017; Tomasello, 2014).

Several limitations point to promising directions for future research. First, our tasks minimize communication in order to isolate coordination mechanisms grounded in perception and working memory; allowing verbal or nonverbal signaling may reveal how communication supports or stabilizes memory-based joint commitments, even under strong synchronic demands. Second, our paradigm focused on dyadic interaction; extending this framework to larger groups could clarify how common ground scales with group size and how public versus private representations support coordination in more complex social systems. Finally, developmental work could further illuminate how sensitivity to temporal structure shapes the emergence and flexibility of joint commitment across development.

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