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"You're wrong, I'll switch, I'm wrong, I'll stay": How task-switching strategies are modulated by a partner in a multi-task learning protocol

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ABSTRACT

Individuals given control over practice variables make practice decisions based on their current performance. When individuals practice in pairs, the question as to if and how a partner's performance impacts these decisions is of theoretical and practical interest. Here, we evaluated this question in a multi-task learning protocol, where individuals and dyads practiced three, differently timed keystroke sequences. Dyad participants alternated turns with a partner so we could study the immediate consequences of the partner's performance on practice choice. Only one of the partners had choice over the sequence order, the other partner practiced the sequences in either a predetermined blocked or random order. Practice with a partner that had a random-schedule promoted more task-switching in the other partner and had some benefit for retention accuracy. Distinct "own-error" and "partner-error" switching strategies were evidenced, with partners choosing to repeat the same sequence on their next turn when they performed poorly or when their partner performed well. These data show that an individual's practice decisions are influenced by their social context, particularly the practice schedule and patterns of errors in a partner's performance.

1. Introduction

Giving learners some control over their physical practice, such as the frequency of feedback or when to switch between practice of different skills, has positively (or at least not negatively) impacted the learning of a wide variety of motor skills (for reviews, see Sanli et al., 2013; Ste-Marie et al., 2020; Wulf & Lewthwaite, 2016). Most of the self-control learning research has focused on individual learners in isolated settings. There may be unique advantages (or disadvantages) associated with self-controlled practice in social settings, where observing another person's practice could influence how learners make decisions about their own practice, ultimately impacting their learning. Indeed, there is a significant body of research on what is termed "joint action", showing how performance effects observed in individual settings are significantly moderated when performing in social contexts (e.g., Eskenazi et al., 2012; Sebanz et al., 2003; Sebanz & Knoblich, 2021). Our aims were twofold; to determine how task-switching decisions, in a multi-task learning paradigm, are influenced by both a partner's task-switching schedule and the partner's performance (error) and to assess the impact of these decisions on motor learning outcomes and subjective perceptions of the practice experience.

Physical practice schedules often require periods of rest between attempts at a task. Not only have rest intervals been shown to be beneficial for motor learning (e.g., Baddeley & Longman, 1978; for reviews, see Donovan & Radosevich, 1999; Lee & Genovese, 1988), but there is evidence that these rest intervals can be optimized if filled with periods of observation (e.g., Larssen et al., 2021). Dyad practice, where partners alternate between physical practice and observation of one another, is one way to make efficient use of rest intervals as well as to promote learning of a *single* skill compared to practice alone (e.g., Granados & Wulf, 2007; Shea et al., 1999, 2000). However, there may be reason to suspect that inter-trial rest rather than filled intervals are important for practice of *multiple* skills, where inter-trial processing activities are critical for enhanced learning (e.g., Lee & Magill, 1983, 1985; Shea & Morgan, 1979; for a review, see Wright et al., 2016). Although attempts have been made to determine the effects of a partner during the learning of multiple skills (e.g., Karlinsky & Hodges, 2018a, 2019), it is not yet clear if observation of a partner impacts positively or negatively on another person's practice decisions and learning (enhancing or interfering with processing activities).

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1.1. Multi-skill practice organization

Understanding how observing a learner's practice can modulate a partner's practice choices is particularly important given the significant impact practice order has on the learning of motor skills. This practice order effect has frequently been shown in individual motor learning paradigms and is known as the "contextual interference" (CI) effect (for reviews, see Lee, 2012; Wright et al., 2016). This CI effect epitomizes the relationship between practice order and motor learning through comparisons of blocked and random practice schedules. In blocked practice, unique tasks or skills are practiced repetitively, such that information processing "interference" in practice is low. In random practice, these same skills are practiced unsystematically, increasing information processing demands and resulting in high between-trial interference. Blocked schedules typically aid performance at the time of practice but degrade learning as measured by delayed retention or transfer tests. Random schedules typically hinder current practice performance but enhance longer-term learning.

In social settings, observing a partner's practice to "fill" the inter-trial rest intervals could modulate the degree of interference within an individual's practice schedule. For example, preceding physical practice trials with demonstrations has affected both immediate motor performance and longer-term learning in sequence timing tasks where different sequences are practised (Lee et al., 1997; Simon & Bjork, 2002). Lee et al. (1997) provided computer-based models of performance before each trial of a random practice schedule, with the goal of reducing individuals' need for planning operations by providing the "solution" to the task. This method was expected to facilitate practice, because these demonstrations would "match" the upcoming skill, but impair retention, compared to typical random practice. This was exactly what the authors observed. In an extension of this work, demonstrations that "mismatched" the sequence required on the next trial degraded performance but improved retention for both blocked and random schedules (Simon & Bjork, 2002). These studies highlight the potential for periods of observation in practice to significantly impact the effectiveness of physical practice via the types of processing activities encouraged by watching others.

Interleaved periods of observation during physical practice were recently tested in a dyad learning context, where partners practiced two golf-putting skills in alternation (Karlinsky & Hodges, 2019). Partner groups performed the same skill ("matched" group) or different skills ("mismatched" group) on consecutive trials and were compared to a group who physically practiced the skills without alternating turns with a partner (just rested between trials). On an individual level, all matched and mismatched partners experienced the same degree of contextual interference and practiced in a semi-blocked schedule of practice (switching to a different putter every six trials). However, inter-trial interference would be higher for the mismatched partner group than the matched group. For overall error, there were no differences between these groups in practice or in retention. Matching or mismatching of skills by a partner in the inter-trial interval did not moderate learning outcomes, nor provide any benefits (or costs) in comparison to unfilled rest. Partners did, however, adapt their actions based on the shots of their partner, with ~70% of actions showing between-person error compensation (i.e., putting less far if a partner overshot or putting farther if a partner undershot). Therefore, although observing a partner's practice did not modulate learning outcomes, even when compared to pure physical practice, partners influenced performance. Partners adapted their actions (i.e., compensated for overshooting or undershooting of targets) based on the partner's trials, in a similar manner to how they corrected for their own errors.

1.2. Practice choices during multi-task learning

One way to assess practice decisions is to give learners control over how to practice. In multi-task learning protocols, this would be control over when or how much to switch between multiple tasks or skills. Although individuals have exhibited large variability in how often they choose to switch between tasks, they tend to adopt relatively low-CI practice, choosing to switch on approximately one third of acquisition trials or less (e.g., Hodges et al., 2011; Karlinsky & Hodges, 2014, 2018a; Wu & Magill, 2011). Despite the relatively low amounts of CI selected, allowing learners to make choices about how to practice has resulted in benefits in comparison to imposed schedules (e.g., blocked or yoked practice schedules, wherein the latter the order of practice is matched to those given choice; e.g., Keetch & Lee, 2007; Wu & Magill, 2011). These benefits of self-controlled practice have been attributed in part to the customized timing of task switches, with individuals generally choosing to switch to a different task following better (e.g., lower error, faster) performance (Hodges et al., 2014; Karlinsky & Hodges, 2014, 2018a; Keetch & Lee, 2007; Wu & Magill, 2011). This performance-contingent switching is also effective when learners' task switches are directed by a peer (Karlinsky & Hodges, 2014) and somewhat effective when determined by an algorithm (Porter et al., 2019; Simon et al., 2008).

To determine if and how a partner's practice influenced the subsequent practice choices of their partner, we conducted a study where participants were paired with a blocked- or random-schedule partner and switched turns after each 9-trial block (Karlinsky & Hodges, 2018a). Blocks of trials were used to clearly convey the practice schedule of the partner. Learners who practiced with a random-schedule partner chose to switch between skills more frequently than those paired with a blocked- or a self-controlled partner, and this resulted in some benefits in retention. One of the issues with this study, however, was that this block-to-block form of turn-taking obscured the effects of observing a partner's turn on immediate practice choices and performance. We were unable to determine whether trial-to-trial practice decisions were influenced by the accuracy of their partner's turn in a similar way to their own accuracy. Our aim in the current study was to assess these practice decisions based on the errors in an individual's own performance as well as in a partner's performance and to evaluate the impact of these decisions on learning.

In the joint-action literature, individuals have been shown to monitor a partner's performance and adapt their own actions in response to observed errors, as if the errors had been their own (e.g., de Bruijn et al., 2011, 2012; cf. Picton et al., 2012). Such partner-related behavioral adjustments tend to be more prevalent in cooperative as opposed to competitive performance contexts, suggesting that this is not an automatic process (e.g., de Bruijn et al., 2008, 2012). However, adjusting behavior in response to a partner's performance can be detrimental to success at the task, suggesting that at least part of this behavior might be done without awareness, or at least without awareness of the consequences of partner-related adaptations (e.g., de Bruijn et al., 2008). Of particular relevance to the present multi-task study, the observed task need not be the same as the to-be-performed task for a partner's errors to affect an individual's subsequent performance (Wang et al., 2016).

1.3. Study aims and hypotheses

A dyad-practice paradigm was used, where partners alternated turns every trial. One of the partners had control over their practice and was paired with a partner who had either an imposed blocked or random task-switching schedule. Our aim was to determine if and how a partner's practice influenced the practice decisions of their partner, in terms of task-switching frequency and strategy, and ultimately their learning. An additional control group practiced alone and made their own practice choices. Of interest was how learners would choose to repeat or switch tasks with reference to their own previous trial, and/or with respect to their partner's preceding trial. We also hoped to replicate and extend our own previous work showing that partners generally adopt practice schedules that are aligned with their partner in terms of the degree of CI and hence frequency of task switching (Hodges et al., 2014; Karlinsky & Hodges, 2018a).

We predicted that learners paired with a random-schedule partner would exhibit more frequent task-switching than those paired with a blocked-schedule partner or who practiced alone. Although more frequent task-switching (higher CI) is typically better for learning, when individuals are given choice over their practice schedule switching frequency does not always correlate with learning outcomes (e.g., Karlinsky & Hodges, 2014; Keetch & Lee, 2007; Wu & Magill, 2011). We also predicted that there would be more repeating of a partner's sequence for participants paired with a random-schedule rather than a blocked-schedule partner (potentially to lower the amount of "interference," see Karlinsky & Hodges, 2018a).

We expected to see performance-contingent switching, where individuals choose to practice a different task following relatively good, low error trials (e.g., Hodges et al., 2014; Karlinsky & Hodges, 2014, 2018a; Keetch & Lee, 2007; Wu & Magill, 2011). In the dyad groups, we anticipated that this performance-contingent strategy would be modulated by the partner's errors and become less self-referenced (e.g., de Bruijn et al., 2011, 2012).

Participants were also asked to respond to questions designed to assess their practice experience to determine whether motivation-related experiences in dyad practice could be impacting any performance-related effects, independent of switching decisions (see Wulf & Lewthwaite, 2016).

2. Methods

2.1. Participants and groups

Eighty right-handed females ($M = 21.0$ years, $SD = 3.7$) with normal or corrected-to-normal vision volunteered to participate individually and were pseudo-randomly assigned to either a practice alone group or a dyad practice group (5 groups; $n = 16$/group). Sample size was based upon a similar study where blocked-schedule and random-schedule partners differed in their impact on a partner's self-controlled switching frequency and where medium to large group differences were shown in practice behaviors (Karlinsky & Hodges, 2018a).

Participants in the dyad groups did not know one another and were paired based on availability to come in for testing at the same time. Dyad group participants were randomly pre-assigned to be in either a blocked dyad group or a random dyad group. One of the partners was required to follow either a fully blocked or fully random schedule (we refer to individuals following these experimenter-determined practice schedules as Partner 1). The second partner in these dyads (Partner 2) was allowed to choose their own schedule of practice whilst being paired with a participant who completed the fully blocked or fully random schedule of practice. Determination of Partner 1 or Partner 2 status was also random. As such we had four dyad subgroups which we termed: blocked, blocked-self, random, and random-self (see Table 1). A fifth control group practiced alone and controlled their own practice schedule (self-alone group). The study was conducted in accordance with the ethical guidelines of the University of British Columbia and all participants provided informed written consent. Handedness was self-reported and confirmed using the Edinburgh Handedness Inventory (Oldfield, 1971).

Table 1
Summary of experimental groups and subgroups.

Group type	Group label	Subgroup labels	Practice schedule	Partner #
Dyad	Blocked dyads	Blocked	Blocked	1
		Blocked-self	Self-controlled	2
Dyad	Random dyads	Random	Random	1
		Random-self	Self-controlled	2
Alone	Alone	Self-alone	Self-controlled	N/A

Note. With the exception of the "practice" phase for the dyad groups, all testing phases were completed alone.

2.2. Task and apparatus

The experimental task was based on Lee et al. (1997) and Simon and Bjork (2001) and involved learning to execute three different, 5-keystroke sequences on a 9-digit computer keypad (Dell SD-8115) using only the right index finger (see Fig. 1). Each sequence consisted of a unique set of keys (so a new pattern of responses to learn) and distinct overall movement time (MT) goals (900, 1200, or 1500 ms). In the motor learning literature, there has been a historical precedence of considering different sequences with different order of components as unique actions or "generalized motor programs/GMPs". This distinction is based on Schmidt's schema theory and the idea that similar GMPs share in the order of components or in their relative timing/forces between components (Schmidt, 1972). Because we have unique sequences with different overall timing goals, we consider our three sequences to represent three different skills.

An LG computer and custom E-Prime 2.0 program (Psychology Software Tools, Inc., Sharpsburg, PA) were used to control stimuli presentation and record responses. Stimuli were presented on a monitor (ASUS HDMI 23 in) set in the middle of a desk. In dyad practice sessions, two chairs were placed side-by-side facing the monitor, with the keyboard fixed centrally on the desk. During individual sessions, there was only one centrally located chair.

2.3. Materials

2.3.1. Intrinsic motivation inventory

We administered two questionnaires. The Intrinsic Motivation Inventory (IMI) is a multidimensional tool designed for laboratory use, which measures participants' subjective, task-specific experiences (Inventory, n.d.). Participants responded to the following subscales of the IMI: interest/enjoyment (7 items), perceived choice (5 items), perceived competence (5 items), pressure/tension (5 items), and effort (5 items). The wording of the items was modified to the keystroke task. Pairs additionally responded to adapted versions of the perceived choice and perceived competence subscales (5 items/subscale), probing perceptions of their partner's choice over how they practiced and their partner's competence at the tasks, respectively (Karlinsky & Hodges, 2018a). These adaptations consisted solely of inserting references to the partner (e.g., "my partner is", "my partner did", "my partner's performance"). Participants rated the truthfulness of all subscale items using a 7-point Likert scale, where 1 = *not at all true* and 7 = *very true*. Some items were reverse coded, so that for all subscales a larger score reflected a higher rating for that construct.

2.3.2. Dyad practice experience questionnaire

A set of four questions was used to probe partners' perceptions of the dyad practice experience (see Results, Table 5 for questions). Participants rated the truthfulness of the items using the same 7-point Likert scale as above.

2.4. Procedures

The study was conducted over two consecutive days. Day 1 was completed alone or in dyads, depending on group (see Table 1). Familiarization and pre-testing were completed individually and it was always the blocked-schedule or random-schedule Partner 1 who went first (whilst the self-controlled Partner 2 waited outside the room and completed the handedness questionnaire). For familiarization, participants were required to complete five successful trials of one 5-keystroke sequence. This familiarization sequence had a different keystroke pattern and goal MT to those of experimental trials. The unique goal MT for each sequence was displayed on the screen at the start of each trial for 3 s. The sequence was then presented on screen and after 1 s a beep sounded, indicating that the participant should enter the sequence. An "S" marked the start key of the sequence and black adjoining lines

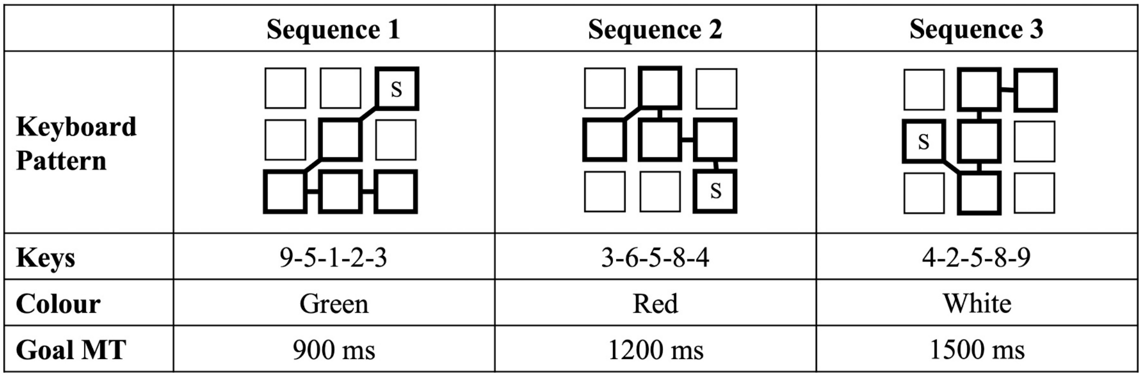

Fig. 1. Diagram of the three keypress sequences used in the current experiment, along with overall goal Movement Times (MT). These sequences were based on those of Simon and Bjork (2001). S = Start key.

identified the order in which to press the keys (see Fig. 1). The image of the sequence remained on screen during the trial, eliminating the need to memorize the pattern (i.e., participants only had to learn the timing, attempting to input the entire sequence in as close to the goal MT as possible). After five keys had been pressed, the sequence remained on screen for a further 3 s before feedback was displayed. The feedback screen was shown for 4 s and informed participants, (a) whether the keys were pressed in the "correct" or "incorrect" order, (b) total MT in ms, and (c) signed MT error in ms (i.e., constant error indicating if the MTs were too long, positive values, or too short, negative values). Throughout the experiment, a successful trial required only that the correct keys be pressed in the correct order.

Participants then completed a 9-trial, random-order pretest on the three sequences used throughout the remainder of the experiment (3 trials/sequence). Although participants were aware of the goal MTs, only feedback about whether sequence execution was correct was provided during the pretest. If a sequence was incorrectly executed (wrong key or key pressed too early), the trial was repeated at the end.

During dyad practice sessions, partners' seating arrangement (left or right) was counterbalanced. Partners were instructed to watch one another's practice but not to communicate. They were told that the goal of practice was to learn the goal MTs for the three sequences and that they would be tested without MT feedback.

All participants completed 24 correct trials of each sequence, such that the paired acquisition sessions consisted of 144 correct trials (72 trials/partner). The alone group's trials were spaced to approximate the inter-trial breaks of the dyad groups. Partners alternated turns starting with the blocked- or random-scheduled partner first (hereafter referred to as Partner 1). The blocked sequence order was counterbalanced within a group and all 24 trials of one sequence were completed before starting a new sequence. The random sequence order was the same for all participants but constrained not to repeat the same sequence more than twice consecutively. The self-control participants decided for themselves which sequence to practice at the start of each trial. If 24 trials for a sequence had been reached, the participant was prompted to choose a different sequence.

Images of the sequences and associated MT goals were posted above the monitor throughout practice, but MT goals were not shown on the computer monitor after the first three correct trials of each sequence (for each partner). After the trial and feedback, there was an inter-trial interval of 3 s after which an arrow pointing to the left or right was presented signaling whose turn was next (2 s). If a trial was "incorrect", it remained the same partner's turn on the next trial. The incorrect trial was recycled and either, (a) repeated at the end of the relevant sequence's set of trials (blocked-schedule Partner 1s), (b) repeated at the end of the practice trials (random-schedule Partner 1s), or (c) available to be chosen again (self-controlled schedules). After practice, participants independently responded to the IMI (Inventory, n.d.).

Retention testing was conducted alone the next day. There were four 9-trial retention tests (3 trials/sequence). MT goals were not shown. The tests varied in terms of sequence presentation order (random vs. blocked) and whether MT feedback (FB) was provided. The following test order was used for all participants: (i) random-order/no-FB; (ii) blocked-order/no-FB; (iii) random-order/FB; and (iv) blocked-order/FB. The no-feedback retention tests were always completed first to allow us to assess how well the keystroke sequence timing was retained whilst preventing further learning (see Table 1). The subsequent with MT-feedback tests matched the conditions of practice. At the end of retention, participants responded to questions probing their perceptions of practice. Participants were then debriefed and compensated for their time.

2.5. *Measures and analysis*

2.5.1. *Timing errors*

Timing errors were analyzed separately for each stage of the experiment (Day 1: pretest, practice; Day 2: four retention tests). Movement time (MT) was the time between the first and fifth keystrokes. For each trial, absolute timing error was calculated and converted to percent MT error (%MTE), based on the trial's associated MT goal. This percent transformation normalized the size of the error to the sequence's timing goal and enabled comparisons across the three sequences. We calculated %MTE for each trial as the trial's absolute error (AE) in ms divided by the goal MT in ms, multiplied by 100. For example, if the goal MT was 900 ms, and the individual inputted the sequence in 800 ms, being too slow by 100 ms, their %MTE would be 100 / 900 * 100% = 11%. Variable timing error (VE) was also calculated based on the variance in the signed MT errors.

Data were analyzed in two phases to: I) compare across the dyads only, primarily to determine practice schedule effects and influences of a partner on these, and II) compare practice decisions and performance across the three self-controlled groups. These analyses allowed us to use a fully factorial 2 (Schedule: Blocked vs. Random) X 2 (Partner-type: Predetermined vs. Self-controlled) between-subject design for Phase I analyses. For Phase II analyses, a 3 between-group ANOVA was used to compare the blocked-self, random-self, and self-alone groups only. For practice data, we included an additional repeated measure (RM) factor of Block (9-trial blocks) and linear trend analysis was conducted on the Block factor.

An additional Phase I analysis was conducted on the practice data to assess whether observing the same (matched) or different (mismatched) sequence before a practice attempt influenced timing error on the next trial, to determine whether a partner's demonstration immediately impacted subsequent performance. Demonstration-type (matched, mismatched) was thus included as an additional RM factor instead of block.

2.5.2. Self-controlled practice behaviors

We evaluated how an individual's own performance and the performance of their partner affected practice choices and errors. This was achieved two ways. First, we assessed task-switching *frequency*. This was the number of times self-controlled participants switched to practice a different sequence. If the switch was in comparison to their own previous trial this was referred to as self-referenced switching. If the switch was in comparison to their partner's preceding trial, this was referred to as partner-referenced switching. These data were analyzed as above for phase II analysis, but with "Reference-type" included as a RM factor (self-referenced or partner-referenced). Pearson's r correlations were additionally calculated to assess relationships between task-switching frequency and retention test outcomes.

The second method we used for assessing partner effects on behaviors was by assessment of participants' task-switching *strategy*, based on self-referenced or partner-referenced errors. With this analysis, we could test whether MT errors (i.e., AE) were on average higher on trials preceding a choice to repeat rather than switch sequences, based on either their own previously performed task or in reference to their partner (elsewhere referred to as matching or mismatching). We first identified "new sequence" or switch trials, where a different sequence was practiced compared to the previous trial, and recorded AE based on the trial immediately preceding the switch to a different sequence. Errors on these trials were then averaged to give the mean "switch error" (i.e., the average error leading to a decision to switch to practice a different sequence). The remaining trials were identified as "repeat" trials, where the next trial was a repeat of the same sequence (Keetch & Lee, 2007). The AE from these trials were averaged to give the mean "repeat error" (i.e., average error leading to a decision to practice the same task again). In addition to the factor of Reference-type (self-referenced or partner-referenced), Trial-type (repeat or switch) was included as an additional RM factor in these analyses.

2.5.3. Questionnaires

Participants' average score for each subscale of the IMI and the adapted partner-related choice and competence subscales was calculated. We used Cronbach's alpha to assess the internal consistency of items within each subscale. Across all participants, alpha values were good for the interest/enjoyment (α = 0.95), own-competence (α = 0.85), partner-related competence (α = 0.84), and pressure/tension (α = 0.90) subscales; however, the values were weak for the own-choice (α = 0.52), partner-related choice (α = 0.60), and effort (α = 0.65) subscales. Thus, these three latter subscales were omitted.

Analyses of the subscales above as well as responses to the dyad practice experience questions were conducted in two phases where appropriate. For the competence subscale, an additional factor of Reference (i.e., "self" or "partner" competence) was included.

Greenhouse-Geisser corrections were applied to the degrees of freedom for violations to sphericity. Significant effects and interactions were followed up with Tukey's HSD procedures (all $ps < 0.05$ reported). Partial eta squared (η_p^2) and Cohen's d values are reported as measures of effect size for ANOVAs and t-tests, respectively. Any correlations of medium effect size or greater ($r > 0.30$; Cohen, 1992) are reported, along with the associated p value.

3. Results

Trials that were performed incorrectly (i.e., wrong key or key pressed too early) were removed before analysis (1.7% of trials). Trials for which MT errors were greater than 1000 ms were considered errors and excluded from analysis (1.0% of all correct trials). One blocked pair was excluded from all statistical analyses due to the Partner 2 having average errors in the pretest of >100%MTE and concern during testing that this person had difficulty following the instructions. To have >100%MTE means that this individual's MTs were more than twice as long as required, compared to an average of 20% MTE across all other participants. This exclusion resulted in $n = 15$ for each of the blocked and blocked-self subgroups.

In Table 2 we have included a summary of the main statistically significant group-related effects for each of the measures.

3.1. Timing error

3.1.1. Comparisons across the dyads

For all groups, average %MTE for the pretest and practice phase is presented in Fig. 2a and average VE is presented in Fig. 2b. For both measures, there were no group effects in the pretest (all $Fs < 1.4$). For %MTE, pairs improved across practice, $F(4.38, 253.99) = 16.10$, $p < .001$, $\eta_p^2 = 0.22$, confirmed by a linear trend component to the block effect ($p < .001$). Consistent with the contextual interference effect, there was a significant Schedule effect, whereby the blocked dyads were more accurate ($M = 8.7\%$, $SD = 4.5$) than the random dyads ($M = 11.2\%$, $SD = 5.8$), $F(1, 58) = 8.66$, $p = .005$, $\eta_p^2 = 0.13$. Apart from a Schedule × Block interaction, $F(4.38, 253.99) = 2.90$, $p = .019$, $\eta_p^2 = 0.048$, due to decreasing differences between groups as practice progressed, there were no other significant effects or interactions ($Fs < 1$). These schedule and block effects were mirrored in the VE data (Fig. 2b). VE decreased across practice, $F(5.12, 296.68) = 9.23$, $p < .001$, $\eta_p^2 = 0.14$, confirmed by a linear trend component to the block effect ($p < .001$). The blocked pairs were more consistent in practice ($M = 124.4$ ms, $SD = 64.8$) than the random pairs ($M = 164.6$ ms, $SD = 78.8$), $F(1, 58) = 14.73$, $p < .001$, $\eta_p^2 = 0.20$, but there were no partner-related effects or interactions ($Fs < 1$).

During practice, observing a partner's trial facilitated immediate performance of the same task. Trials where the same sequence was observed in a partner before the practice attempt (matched demonstrations) were associated with lower error ($M = 9.6\%$, $SD = 3.3$) compared to trials where a different sequence was observed before the practice attempt (mismatched demonstrations) ($M = 10.7\%$, $SD = 4.2$), $F(1, 55) = 4.73$, $p = .034$, $\eta_p^2 = 0.079$. This error pattern did not depend on practice-Schedule, $F(1, 55) = 1.78$, $p = .19$ or Partner-type ($F < 1$).

Means for %MTE in retention are displayed in Fig. 3a. Comparisons of the pairs in retention did not yield group differences (as a function of either practice-Schedule or Partner-type) on the first random-order/no-feedback test ($Fs < 1$). Thus, the dyads did not show the typical CI effect for retention under these testing conditions. For the three other retention tests the random dyads did have lower %MTE than the blocked dyads, but only for the blocked-order/no-feedback test was the expected schedule effect statistically significant, $F(1, 58) = 4.61$, $p = .036$, $\eta_p^2 = 0.074$ (random dyads: $M = 12.3\%$, $SD = 4.9$; blocked dyads: $M = 15.0\%$, $SD = 4.8$). There were no interactions involving practice-Schedule for any of the tests. The only other significant effect was an effect of Partner-type for the final blocked-order retention test with feedback. Partner 1s (predetermined-schedule) had lower error ($M = 7.1\%$, $SD = 2.0$) than Partner 2s (self-controlled schedule; $M = 9.1\%$, $SD = 3.7$), $F(1, 58) = 6.47$, $p = .014$, $\eta_p^2 = 0.10$. This last effect was mirrored in the VE data (see Fig. 3b), with the Partner 1s being more consistent ($M = 105.2$ ms, $SD = 30.2$), than the self-controlled Partner 2s ($M = 140.2$ ms, $SD = 65.2$), $F(1, 58) = 7.15$, $p = .010$, $\eta_p^2 = 0.11$. There were no other practice-Schedule- or Partner-related effects for VE in retention (all $Fs < 1.3$).

3.1.2. Comparisons across the self-control groups

In general, there were no group-related effects for either %MTE or VE. Regardless of group, participants improved across practice with respect to %MTE, $F(5.39, 237.06) = 7.14$, $p < .001$, $\eta_p^2 = 0.14$, and VE, $F(4.62, 203.29) = 5.60$, $p < .001$, $\eta_p^2 = 0.11$. There were no group differences in retention (blocked-order/no-feedback test: $F(2, 44) = 1.56$, $p = .22$; all other $Fs < 1.3$).

Table 2
Summary of primary main effects ($p < .05$) related to timing errors, switching measures, and experience-related questionnaires.

Measure	Practice phase	Retention tests			
		No-feedback		Feedback	
		Random-order	Blocked-order	Random-order	Blocked-order
1. Timing error					
%MTE	Blocked dyads < random dyads	n.s.	Random dyads < blocked dyads	n.s.	Exp < Self
	Matched sequences < mismatched sequences	n.s.	n.s.	n.s.	n.s.
VE	Blocked dyads < random dyads	n.s.	n.s.	n.s.	Exp < Self
2. Self-controlled switching					
Frequency	Random-self > blocked-self				
	Random-self > self-alone				
Type of switching	Partner-referenced > self-referenced				
Switching strategy	Low errors > high errors (self-referenced)				
	High errors > low errors (partner-referenced)				
3. Questionnaires					
Intrinsic Motivation Inventory					
Competence	Partner's competence > self competence				
Dyad practice experience					
Partner interfered	Blocked dyads > random dyads				
Desire to outperform partner	Random dyads > blocked dyads				

Note. The > symbol means higher/more than, and < means lower/less than. %MTE = % movement time error. VE = variable error. Exp = experimenter-determined (blocked or random) practice schedule. Self = self-controlled practice schedule. n.s. = not significant ($p > .05$).

3.2. Self-controlled practice behaviors

3.2.1. Switching frequency

3.2.1.1. Comparisons across the dyads. As predicted, for the dyad Partner 2s who controlled their switching frequency, switching was higher for participants paired with a random-schedule partner (~41 trials) than with a blocked-schedule partner (~22 trials), $F(1, 29) = 13.71$, $p = .001$, $\eta_p^2 = 0.32$. This schedule effect was large and independent of whether frequency was calculated in reference to one's own trials (self-referenced switching) or in reference to their partner's trial (Group × Reference interaction, $F < 1$, see Fig. 4). Participants did, however, switch sequences with reference to their partner's preceding trial (~37 switches) more often than with respect to their own (~26 switches), $F(1, 29) = 11.19$, $p = .002$, $\eta_p^2 = 0.28$.

3.2.1.2. Comparisons across the self-control groups. As shown on the left-side of Fig. 4 (self-referenced switching), the self-control groups showed a large difference in switching frequency, $F(2, 44) = 11.02$, $p < .001$, $\eta_p^2 = 0.33$. Post hoc testing showed that the self-alone group switched less frequently than the self-controlled group paired with a random-schedule partner only ($p < .001$; blocked-schedule vs. random-schedule partner; $p = .002$).

3.2.1.3. Relations between switching and retention outcomes. As shown in Table 3, in all no-feedback retention tests, the predicted negative correlations were shown between the number of self-referenced task switches and error for all groups (i.e., more switching during practice, the lower the error in retention). However, these correlations were small and not statistically significant (max $r = -0.27$). For the retention tests with feedback, negative correlations were still shown for the self-alone group, but the dyad groups showed low, and even positive correlations, particularly for the final blocked-order/feedback retention test.

Partner-referenced task-switching and %MTE in retention for the dyad groups yielded somewhat larger, more medium size correlations, particularly for the first retention test (see Table 3). For all but the random-self group, there were negative correlations between the amount of partner-referenced switching (i.e., mismatching the partner) and error in the random-order/no-feedback retention test (i.e., more partner-referenced switching/mismatching, the lower the error). Even though the predetermined-schedule partners did not choose when to switch, both groups (blocked- and random-schedule) tended to benefit in retention from (involuntarily) mismatching their partner's preceding trial. A similar pattern of results was seen in the blocked-order/no-feedback retention test, but these correlations were lower or not apparent when retention was assessed with feedback. The one exception again was a medium, positive correlation for the blocked-self group on the final, blocked-order/feedback retention test, $r(15) = 0.45$, $p = .09$; meaning matching a partner was related to lower error.

3.2.2. Switching strategy

3.2.2.1. Comparisons across the dyads. As predicted based on studies of individual learners, self-controlled participants chose to repeat the same task if they performed relatively poorly (i.e., higher error) and to switch to a different task if they performed relatively well. In contrast, they tended to repeat (match) their partner's task if it was performed relatively well and to switch to a different task (mismatch) if their partner performed relatively poorly. These data are illustrated in Fig. 5 and the effects were confirmed by a significant Reference (self- or partner-referenced) × Trial-type (repeat or switch) interaction, $F(1, 26) = 5.55$, $p = .026$, $\eta_p^2 = 0.18$ (but no main effects for either Reference or Trial-type). Although the 3-way interaction with Schedule was not significant, $F(1, 26) = 2.95$, $p = .10$, as seen in Fig. 5, mean differences between repeat and switch trials were more pronounced for the self-control participants paired with a random-schedule rather than blocked-schedule partner.

3.2.2.2. Comparisons across the self-control groups. There were no group differences when comparing across the three self-control groups (all $Fs < 1.53$). In general, participants switched tasks (rather than repeated) when they performed relatively well (low error), $F(1, 44) = 7.54$, $p = .009$, $\eta_p^2 = 0.15$.

3.2.3. Questionnaires

3.2.3.1. Intrinsic Motivation Inventory. Responses to the IMI are presented in Table 4. Comparing across the dyads, regardless of Schedule or Partner-type, a partner's competence was rated higher ($M = 5.0$, $SD = 0.9$) than self-competence ($M = 4.2$, $SD = 1.1$), $F(1, 57) = 28.42$, $p < .001$, $\eta_p^2 = 0.33$. There was no Schedule effect, $F(1, 57) = 1.80$, $p = .19$, $1 - ß = 0.26$, nor any other main effects or interactions ($Fs < 1$). Participants moderately enjoyed the task and reported relatively low perceptions of pressure/tension, regardless of practice-Schedule or Partner-type (all $Fs < 1.2$).

Compared to practice alone, practice with a partner did not

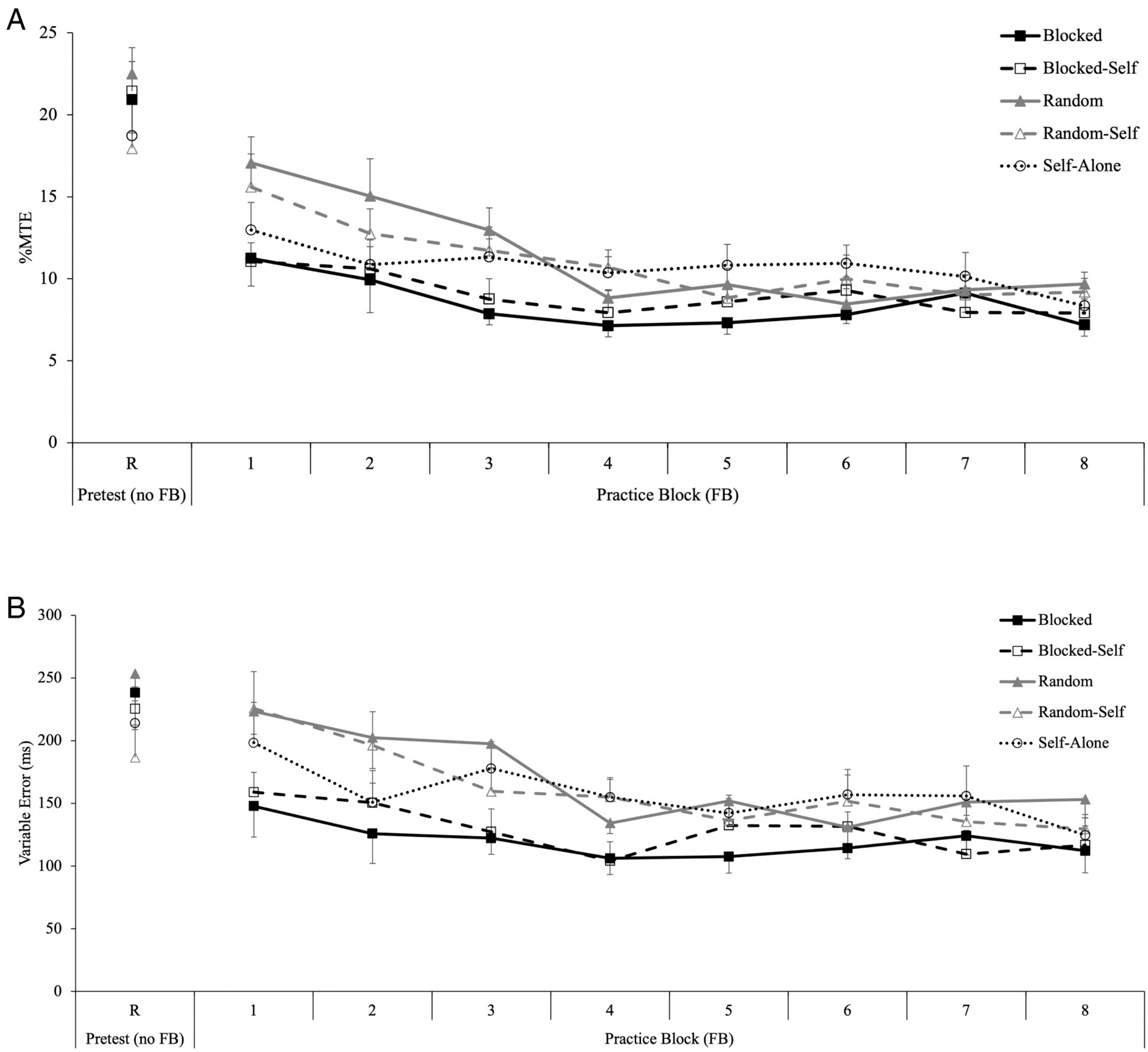

Fig. 2. (a and b) (a) Percentage movement time error (and *SE* bars) and (b) Variable error (and *SE* bars) for the pretest and practice blocks (1–8) as a function of predetermined or self-controlled practice schedules. FB = Feedback, R = random sequence presentation order.

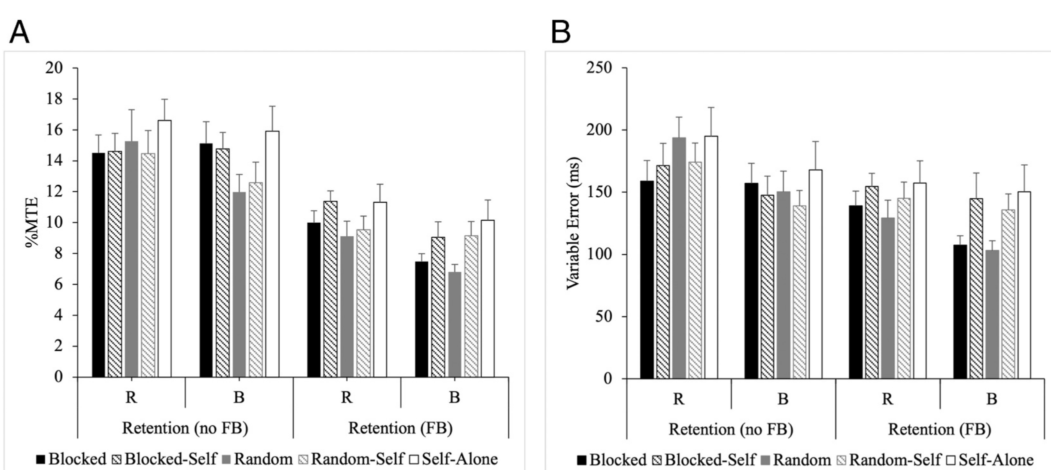

Fig. 3. (a and b) (a) Percentage movement time error (and *SE* bars) and (b) Variable error (and *SE* bars) for the retention tests as a function of predetermined or self-controlled practice schedules. FB = Feedback, R = random sequence presentation order, B = blocked sequence presentation order.

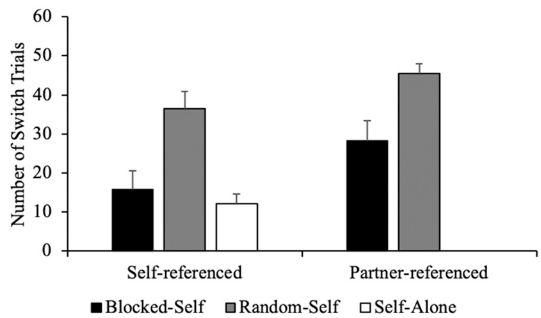

Fig. 4. Mean number of trials (and *SE* bars) where self-controlled participants switched to a different sequence with reference to their own or their partner's previous trial.

Table 3
Correlations between self- and partner-referenced task-switching frequency and mean percentage movement time error (%MTE) in retention for each group.

Switch type & retention test	Blocked	Blocked-self	Random	Random-self	Self-alone
Self-referenced switching					
Random-order/ no-FB		−0.19		−0.14	−0.12
Blocked-order/ no-FB		−0.15		−0.27	−0.11
Random-order/ FB		0.05		−0.15	−0.20
Blocked-order/ FB		**0.37**		0.14	−0.23
Partner-referenced switching					
Random-order/ no-FB	**−0.31**	**−0.39**	**−0.50***	0.29	
Blocked-order/ no-FB	−0.19	−0.26	**−0.41**	0.21	
Random-order/ FB	0.02	0.14	−0.09	0.14	
Blocked-order/ FB	−0.24	**0.45**	−0.16	0.25	

Note. Correlations of medium effect size or greater are bolded ($r > \pm 0.30$; Cohen, 1992). Significant correlations ($p < .05$) are indicated with an asterisk (*). FB = Feedback.

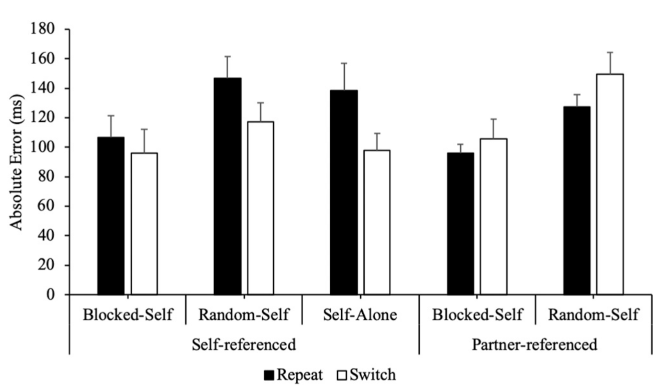

Fig. 5. Absolute error (and *SE* bars) for trials on which self-controlled participants chose to repeat the same sequence ("repeat" trials) or to switch to a different sequence ("switch" trials) with reference to their own or their partner's previous trial.

significantly modulate self-controlled learners' perceived competence ($F < 1$), interest/enjoyment, $F(2, 44) = 2.62$, $p = .084$, nor their perceptions of pressure/tension during practice, $F(2, 44) = 2.16$, $p = .13$. As apparent from the means in Table 4, the self-alone group had the highest ratings of interest/enjoyment and the lowest ratings of pressure/tension.

Table 4
Mean ratings (and *SDs*) for the Intrinsic Motivation Inventory subscales and customized partner-related competence subscale.

Subscale	Blocked	Blocked-self	Random	Random-self	Self-alone
Competence					
Own	4.3 (1.3)	4.3 (1.0)	3.9 (0.7)	4.2 (1.1)	4.2 (1.1)
Partner	5.1 (0.7)	5.3 (0.9)	4.9 (0.9)	4.9 (1.1)	N/A
Interest/ enjoyment	3.3 (1.5)	4.2 (1.4)	3.6 (1.3)	3.4 (1.4)	4.5 (1.5)
Pressure/tension	3.4 (1.4)	3.2 (1.5)	3.0 (1.3)	3.2 (1.5)	2.3 (1.1)

Note. Scales ranged from 1 to 7.

3.2.3.2. Dyad practice experience questionnaire. These data and results are presented in Table 5. Ratings were generally high in response to whether watching a partner helped their own performance/learning (4.9–5.7/7). This was not dependent on practice-Schedule, $F(1, 58) = 2.13$, $p = .15$ and there were no Partner-type related effects or interactions ($Fs < 1$). Complementing these high ratings for "helping", low ratings were given for the question as to whether watching a partner was interfering for their own performance/learning. This time there was a Schedule effect; the blocked dyads thought having a partner was more interfering ($M = 3.9$, $SD = 1.7$) than the random dyads ($M = 2.8$, $SD = 1.5$), $F(1, 58) = 7.08$, $p = .010$, $\eta_p^2 = 0.11$. Answers to this question did not vary as a function of Partner-type, $F(1, 58) = 2.17$, $p = .15$, and there was no interaction ($F < 1$). Overall, participants reported a moderate to high desire to be more accurate than their partner (4.5–5.9) and the random dyads ($M = 5.7$, $SD = 1.2$) experienced a greater desire to outperform their partner than the blocked dyads ($M = 4.9$, $SD = 1.8$), $F(1, 58) = 4.03$, $p = .049$, $\eta_p^2 = 0.065$. There was no effect of Partner-type, $F(1, 58) = 2.44$, $p = .12$, nor an interaction ($F < 1$). Scores were in the midpoint range for whether dyad participants would have preferred to practice alone (suggestive of no preference) and this did not vary as a function of practice-Schedule ($F < 1$) or Partner-type, $F(1, 58) = 3.02$, $p = .087$, and there was no interaction, $F(1, 58) = 1.33$, $p = .25$.

4. Discussion

We studied how partners in dyad learning contexts influence the practice decisions, experiences, and eventual learning outcomes of each other. Through the study of partners who alternated turns in a multi-task learning protocol, we were able to evaluate how the practice schedule and errors of a partner impacted practice decisions related to frequency of switching and when to switch, and ultimately learning outcomes. Complementing previous work, partners impacted self-controlled learners' practice choices in terms of the amount of switching, with

Table 5
Mean ratings (and *SDs*) to customized dyad practice experience questionnaire.

	Blocked	Blocked-self	Random	Random-self
1. Watching my partner helped my own performance	4.9 (1.5)	5.0 (1.4)	5.7 (1.3)	5.3 (1.6)
2. Watching my partner interfered with my own performance	3.5 (1.7)	4.2 (1.7)	2.6 (1.3)	3.1 (1.6)
3. I wanted to be more accurate than my partner	4.5 (1.7)	5.2 (1.9)	5.4 (1.3)	5.9 (1.2)
4. I would have preferred to practice alone	4.5 (2.1)	5.2 (2.1)	5.1 (1.5)	4.9 (1.4)

Note. Scales ranged from 1 to 7.

random-schedule partners promoting more switching than blocked-schedule partners (Karlinsky & Hodges, 2018a). In the current study, we also showed that partners also influenced when to switch between tasks, with more switching when a partner's error was (relatively) high, rather than low (opposite to what is seen when switching in reference to one's own average error). However, these practice choices only had small impacts on behavioral learning outcomes. Most notably, being paired with a random-schedule partner led to greater frequency of switching and significantly lower errors in the blocked-order, no-feedback retention test compared to being paired with a blocked-schedule partner. However, dyad groups did not perform differently in retention to the alone group and there was no indication that dyad practice was preferred over practice alone, but rather, it was perceived as less enjoyable.

4.1. Influence of a partner on practice decisions

Practice with a random-schedule partner promoted more task-switching in the partner compared to practice with a blocked-schedule partner or practice alone. When individuals are given choice over how to practice, the decisions they make about when to switch between tasks are not solely performance-dependent, but influenced by the practice context and practice experiences of peers. This result is consistent with research showing that prior exposure to random practice increases the task-switching behaviors of learners in later practice contexts, compared to exposure to lower contextual interference (CI) blocked and self-directed practice schedules (Hodges et al., 2014; Karlinsky & Hodges, 2018a). Considering that learners do not display good awareness as to what conditions of practice are most effective for learning (e.g., Simon & Bjork, 2001, 2002), strategic exposure to desirable practice principles through dyad learning contexts is potentially a useful way to encourage learners to adopt beneficial behaviors (here this was related to practice order, but it could be related to practice variation, feedback choices, or the amount of practice in general).

Across groups, participants in control of their practice chose to switch to a task different to their partner's more often than to switch to a task different to their own previous trial. This "mismatching" between what is observed and what is practiced on interleaved trials has previously been shown to enhance learning, when learners watched modeled demonstrations of perfect task performance (Lee et al., 1997; Simon & Bjork, 2002). This led to the hypothesis that trainees in applied settings, where inter-trial delays are often imposed (e.g., due to sharing equipment or physiological demands), would benefit more from watching another learner perform a different skill from the one they were about to perform, rather than the same (Simon & Bjork, 2002). Our data provide some support for this idea that the benefits of increasing contextual interference via interleaved observational practice extends to situations where demonstrations are provided by a practice partner. There were small negative correlations between partner-referenced task-switching (mismatching) and retention outcomes (i.e., more task switching led to better learning outcomes), although a significant correlation was only shown for the random-schedule partners on the random-order/no-feedback retention test.

For individuals who did not have choice over their practice decisions and followed predetermined blocked and random schedules, mismatching with their partner was also related to lower error on retention tests (particularly the first random-order/no-feedback test). Again, these data are consistent with the idea that partners can be a potentially useful source of "interference" in practice, potentially serving to augment the cognitive processes which occur between trials and that are thought to enhance learning (e.g., comparing and contrasting, forgetting and recall; Lee & Magill, 1983, 1985; Shea & Morgan, 1979). It is worth noting, however, that in a previous study where matched and mismatched practice schedules were imposed during the practice of two golf putting skills there were no benefits associated with mismatching (or matching; Karlinsky & Hodges, 2019). Therefore, further research is required to determine the conditions which are needed to bring about benefits associated with "interference" brought about by a partner. These conditions might be related to the difficulty of the skills, the amount of contextual interference at an individual level, as well as the relations between the skills themselves and competencies of the partners.

In addition to determining whether learners' practice choices were influenced by the types of tasks (same/different) and amount of task-switching in their partners, we also wanted to know whether partners attended to the errors in their partner's trials and adapted their own practice choices based on these errors. This behavioral modification of action based on a partner's errors has been demonstrated in the joint action literature (e.g., de Bruijn et al., 2011, 2012; Wang et al., 2016). We also know that individuals practicing alone and given choice over practice make performance-contingent switching decisions (e.g., Hodges et al., 2014; Karlinsky & Hodges, 2014, 2018a; Wu & Magill, 2011). This result was replicated in our current study, where self-controlled learners tended to repeat the same task again if they performed relatively poorly and switch to a different task if they performed relatively well. There are also notable parallels which could be made here to voluntary task switching in other, non-learning tasks, where individuals are encouraged to choose tasks randomly (e.g., Arrington & Logan, 2004; Mittelstädt et al., 2018). In these contexts, individuals show a bias to repeat an action or problem more often than would be expected due to chance, and this behavior has been explained in terms of avoidance of cognitive costs associated with actions that are more demanding and have actual performance costs (such as increased RTs; see for example, (Dunn et al., 2016; Mittelstädt et al., 2018; and Koch et al., 2018 for a review of task-switching effects). What is interesting, however, is that in our current study, these switch or repeat decisions were influenced by both current performance (i.e., personal costs) as well as the performance of the partner.

In terms of the partner's practice choices, rather than repeating trials when there were high(er) errors on previous trials—that is, avoiding switching to something else if the task was still difficult for the individual—trials were now repeated only when partners were relatively successful and had low(er) errors on previous trials. Here the partners made practice decisions that were potentially motivated to avoid costs seen in their partners. Thus, it appears that learners monitor a partner's performance and take this into consideration when making decisions in shared practice contexts. This result is also reminiscent of early observational practice research showing the need to include outcome feedback about the model's performance for beneficial practice-related effects to be seen in observers (Adams, 1986).

4.2. Influence of a partner on motor performance and multi-task learning

The blocked or random practice schedule of a partner influenced performance in acquisition, with the blocked dyads showing lower error than the random dyads, particularly in early practice blocks. This schedule effect was not dependent on whether the partner was restricted to practice in a particular way or whether they had choice over how to practice. The influence of the partner was also revealed based on the degree of matching (or mismatching) of the partner's previous trial. Trials that matched the observed task of a partner resulted in lower overall error in practice than successive trials that did not match. Similar results have been shown when demonstrations have been manipulated and provided in the inter-trial interval in individual learning contexts, at least for these simple keystroke timing tasks (Lee et al., 1997; Simon & Bjork, 2002; yet see Karlinsky & Hodges, 2019).

In terms of behavioral outcomes in retention, there was some evidence that the CI effect extends to dyad practice, but it appears to be significantly moderated. The random dyads showed lower error in the blocked-order/no-feedback retention test compared to the blocked dyads, but they did not significantly outperform the blocked dyads on the other tests (see also Karlinsky & Hodges, 2018a). This finding would suggest that for the predetermined-schedule partners that were required to practice in a blocked or random order, alternating with a partner served to bring a degree of interference into practice which moderated the typical effects seen with this type of task and these practice schedule conditions (e.g., Hodges et al., 2014; Lee et al., 1997; Simon & Bjork, 2001).

Comparisons between the dyad and individual self-controlled groups did not reveal any benefits (or costs) of practice with a partner, despite the partner clearly impacting practice-related behaviors. Why then, did this modulated behavior not ultimately translate into modulated learning? It is possible that the self-controlled switching frequency differences were not significant enough to yield behavioral differences when considered on a group level. Although the self-control group paired with a random-schedule partner showed higher switching frequencies than the other two self-control groups, this group was still only switching on average on ~40 trials, whereas the fully random-schedule group was switching on 71 trials. There were also no significant negative correlations between the amount of task-switching and error in retention (see also Hodges et al., 2014; Karlinsky & Hodges, 2014, 2018a; Wu & Magill, 2011).

Because there were clearly different goals associated with the sequences in this study, then the idea that we have tapped into "multi-tasking" is consistent with other definitions (e.g., Koch et al., 2018). However, we do acknowledge that the contextual interference effect has been predominantly (or at least most consistently) observed in sequence-type tasks that rely on the fast and accurate recall of components (e.g., Wright & Kim, 2020). As such, there may be issues in generalizability of these between-person effects when dealing with tasks that rely more on accuracy of the motor plan (cf., Karlinsky & Hodges, 2019). Further research is necessary to probe the generalizability of these partner-related effects when engaged in multi-skill learning.

4.3. Influence of a partner on perceptions of practice

Across groups, participants rated their partner's competence as higher than their own, despite there being no actual partner-related differences in timing accuracy or variability during acquisition (see also Karlinsky & Hodges, 2018b). The ratings of self-competence, however, did not differ across the dyad groups and the self-alone groups. This indicates that participants perceived their partners to be more competent than they really were, rather than perceiving themselves as less competent. It is possible that if pairs practiced with a collaborative goal, perhaps in competition with other dyads, that individuals' standards for a partner's performance and associated perceptions of their competence would be affected. Considering learners often have to make judgments about their own proficiency (contributing to decisions about what and how much to practice, to seek further instruction, etc.), it will be important in the future to consider how such self-assessments and associated decisions might be affected by social comparisons in shared physical practice settings.

Learners' perceptions of how a partner influenced their own performance/learning varied between dyad groups. Blocked pairs perceived watching a partner's practice as more interfering than random pairs. Experience dealing with higher amounts of contextual interference oneself might mitigate against perceiving a co-learner's practice as disruptive. Indeed, although not detailed in the results, when we looked at correlations between self-controlled learners' task-switching frequency and their ratings of how interfering/helpful watching a partner's practice was, more frequent task-switching was associated with lower ratings of a partner's interference, $r(31) = -0.33$, and higher ratings of their helpfulness, $r(31) = 0.43$, towards participants' own performance and learning.

In summary, practicing in a social context impacts self-controlled practice behaviors in a way that is dependent on the partner's practice schedule. Considering the pervasiveness of social motor learning settings (e.g., physical education classes, team sports), and the training time and financial savings that can be afforded by shared practice conditions (e.g., Shea et al., 1999), it will be important to continue such inquiries into when and why learners are susceptible to the behaviors of their peers, and how such factors can be harnessed to optimize physical practice and learning.

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Ethics approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Approval was obtained from the ethics committee of the University of British Columbia.

Consent

Informed consent was obtained from all individual participants included in the study.

CRediT authorship contribution statement

April Karlinsky: Conceptualization, Methodology, Formal analysis, Investigation, Writing – Original Draft, Writing – Review & Editing.
Brynn Alexander: Investigation, Writing – Review & Editing.
Nicola J. Hodges: Conceptualization, Methodology, Formal analysis, Writing – Original Draft,
Writing – Review & Editing, Supervision, Funding Acquisition.

Declaration of competing interest

The authors declare that they have no conflicts of interest.

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