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The effect of a reaction training system based on sonsic reaction training on improving the agility of beginner badminton athletes in China

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ABSTRACT

Agility is a crucial element in the movement performance of badminton players, as it requires the ability to make quick decisions to produce accurate motor responses. However, evidence regarding technology-assisted reaction training programs specifically designed to improve agility in beginner badminton athletes remains limited. The participants were 22 beginner badminton players aged 8–12 years from Tacheng, China, recruited through purposive sampling and divided into an experimental group (EG, n = 11) and a control group (CG, n = 11). The experimental group participated in an eight-week agility training program using the Sonic Reaction Training System twice a week for approximately two hours per session, while the control group continued their regular training program without the reaction-based intervention. the Six-Point Shuttle Run Test, a standardized field test that assesses multidirectional agility through repeated changes of direction before and after the intervention. The data were then analyzed using Shapiro–Wilk normality test, Levene's test for homogeneity, paired-samples t-tests, independent-samples t-tests, and Cohen's d effect size analysis to compare changes in agility performance between the two groups. The experimental group demonstrated a statistically significant change ($t = 2.850$, $p = 0.017$); however, the mean agility score decreased from 17.67 ± 3.23 at pretest to 15.98 ± 2.97 at posttest. In contrast, the control group showed a significant improvement, with the mean score increasing from 17.49 ± 4.52 to 20.42 ± 4.12 ($t = -4.621$, $p = 0.001$). Furthermore, a significant difference was observed between groups at posttest ($t = -2.904$, $p = 0.009$). These findings indicate that, under the conditions of the present study, the Sonic Reaction Training System did not produce the expected improvement in agility performance among beginner badminton players. Future studies should employ larger sample sizes, report effect sizes and statistical power, and optimize training protocols to further evaluate the effectiveness of technology-assisted reaction training.

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Introduction

The ability of modern badminton athletes to cope with the pressure of dynamic match-play situations through rapid and precise motor responses is crucial for performance success (Riaz & Ahmed, 2026; Tan et al., 2023). Agility which encompasses reaction speed, explosive power, and sudden change-of-direction control, is paramount for securing points in contemporary play, given that shuttlecock speeds can now exceed 300 km/h (Dos' Santos et al., 2022; Nimphius, 2017). Conventional training paradigms typically focus on developing aerobic and anaerobic capacities separately through linear, repetition-based training to support these physical demands. (Wee et al., 2016). Badminton is a sport that requires excellent aerobic and anaerobic abilities (Charee et al., 2022; Wee et al., 2017). This game is not difficult to play, especially hitting and receiving the shuttlecock, but to master the various strokes in badminton requires skill in holding the racket and efficient footwork to hit the shuttlecock correctly (Smith, 2026).

The speed of the shuttlecock, which can exceed 300 km/h, requires athletes to process visual stimuli quickly and produce accurate motor responses in a short time (Riaz & Ahmed, 2026), so that agility becomes a key factor in supporting sudden changes in direction, jumps, control of the field, and the effectiveness of striking techniques (Dos' Santos et al., 2022; Nimphius, 2017). Success in motor performance depends on the motor components of athletic skills and psychomotor performance (Inamdar et al., 2020; Romiszowski, 2013). The important factors in motor performance consist of six components: agility, balance, coordination, strength, speed, endurance, and reaction time (Joyokusumo et al., 2025). This includes speed, strength, endurance, power, agility, and performance. A systematic review confirms that agility training plays a very important role in improving movement quality, reaction time, and the ability to change direction quickly and efficiently, which are key requirements in the dynamic and high-intensity game of badminton (Hu et al., 2025; Shedge et al., 2024).

Agility is understood as a complex ability that involves responding to stimuli, visual perception, decision making, and adjusting direction and speed of movement in a short time, enabling athletes to move effectively across the field for both offense and defense. Improved agility also supports advanced technical mastery, movement efficiency, and precision in responding to rapidly changing game situations (Rizky et al., 2025). Agility is influenced by various factors such as biomotor components, body characteristics, age, gender, weight, and fatigue levels, so each athlete has different capacities. Therefore, comprehensive and integrated physical conditioning is an important foundation for improving playing skills, maintaining balance, and achieving optimal performance in badminton (Ma et al., 2025).

Beginner badminton players at the Tacheng Yuyi Lunfei Club in China have not yet reached their full potential in terms of agility based on real-world field circumstances. Basic technical drills and traditional change-of-direction exercises still make up the majority of the training program, and the Six-Point Shuttle Run Test is typically used as the final outcome measure to assess agility performance. Athletes' ability to shift direction and speed can be enhanced by this method, although the gains are typically restricted to pre-planned movement patterns. As a result, the training results mostly show gains in athletes' physical performance rather than their capacity to react to stimuli unique to the game. Because of this, agility evaluation is based only on completion time and does not reveal how well athletes respond to visual and aural cues during training. Enhancing athletes' ability to perceive environmental cues, make quick judgments, coordinate neuromuscular reactions, and adjust to dynamic game situations in real time should all be prioritized in the development of badminton performance. In order to enable the assessment of athletes' performance growth, an efficient training system should incorporate workouts based on visual and aural stimuli and provide objective measurement data.

Prior research has mostly concentrated on improvements in Six-Point Shuttle Run Test performance after traditional agility training, despite the introduction of the Sonsic Reaction Training System as a training system capable of delivering real-time visual and auditory stimuli while objectively recording athletes' responses thanks to advancements in sports technology. There is currently not enough empirical data to determine whether the Sonsic Reaction Training System improves agility more than traditional training techniques while also giving objective data on athletes' reactions during training. This research gap serves as the foundation for the current study, which compares the agility performance of novice badminton players before and after taking part in a technology-based training program and assesses how well the Sonsic Reaction Training System improves agility. This research gap serves as the foundation for the current study, which compares the agility performance of novice badminton players before and after engaging in a technology-based training program and assesses how well the Sonsic Reaction Training System improves agility.

Based on these concerns, the purpose of this study is to investigate how the Sonsic Reaction Training System affects novice badminton players' agility as assessed by the Six-Point Shuttle Run Test. Additionally, by comparing athletes' agility performance before and after engaging in a training program based on the Sonsic Reaction Training System, this study aims to objectively assess the training system's efficacy using the

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application's measurement system. Additionally, it is anticipated that the measurement results will give coaches and athletes useful information about how agility performance is developing and will be used as a foundation for assessing the accomplishment of agility training goals in compliance with beginner athlete development guidelines. The novelty of this study lies in the use of the Sonsic Reaction Training System as a measuring tool in the context of badminton club coaching, which has rarely been studied.

Method

Research Design

This study used an experimental method because it tested a technology called the Sonsic Reaction Training System, which is a training technology that is still rarely used, especially in badminton. The research design used was a two-group pretest-posttest design (experimental and control group) (Creswell & Creswell, 2022).

Research Participants

With a population of beginner-aged children at the Tacheng Yuyi Lunfei Club, China, and a sample of 22 athletes selected based on specific inclusion criteria, including ages 8–12 years, regular training at least twice a week, male singles athletes, active training for at least three months, and no neurocognitive or visual impairments that affect reaction responses. The sampling technique was purposive sampling according to the characteristics of the research subjects (Fraenkel et al., 2022; sugiyono, 2018).

Research Instruments

The agility measurement instrument uses a six-point shuttle run test, while training data is obtained through the Sonic Reaction Training System application. The six-point shuttle run test is designed to measure agility through rapid movements and repeated changes of direction, and has been widely used in research to assess the effectiveness of training in improving agility, as in the study (Berdhika et al., 2021; Kuo et al., 2020; Tan et al., 2023). The treatment consisted of an agility training program using the Sonsic Reaction Training System, which was conducted for eight weeks with a frequency of twice a week and a duration of approximately two hours per session.

Procedure for Gathering Data

A total of 22 beginner badminton athletes aged 8–12 years from Tacheng Yuyi Lunfei Club, China, were selected using a purposive sampling technique based on predetermined inclusion criteria. The participants were then assigned to either the experimental group or the control group. Prior to the intervention, all participants completed the Six-Point Shuttle Run Test to assess their baseline agility performance. The pre-test was conducted under identical environmental conditions, using the same equipment and standardized testing procedures for both groups to ensure measurement consistency. The study commenced by providing all participants with a detailed explanation of the research objectives, benefits, procedures, and the implementation of both the testing and training protocols. After obtaining informed consent from the participants, baseline agility was assessed using the Six-Point Shuttle Run Test. During the test, six markers were positi oned to represent the movement areas commonly used in badminton, namely the front-right, front-left, right-side, left-side, back-right, and back-left areas of the court. Participants started from the center of the court in a ready position. Upon the examiner's signal, they moved as quickly as possible to each designated marker in the predetermined sequence, returning to the center position before moving to the next marker. Completion time was recorded using a digital stopwatch with an accuracy of 0.01 s. Each participant performed two trials with a 3–5 min recovery period between trials, and the fastest completion time was recorded as the final score for analysis.

Following the pre-test, participants in the experimental group completed an agility training program using the Sonsic Reaction Training System for 8 weeks, with a training frequency of three sessions per week (24 sessions in total). Each training session lasted 45–60 min, consisting of a 10–15 min warm-up, 30–40 min of core training, and a 5–10 min cool-down. Each session comprised 4–6 sets, with 6–10 repetitions per set. Each repetition lasted approximately 10–20 s, with 30–60 s of rest between repetitions and 2–3 min of rest between sets. After completing the intervention, pre-test and post-test scores from both groups were collected, tabulated, and analyzed using IBM SPSS Statistics version 25 to evaluate the effectiveness of the Sonsic Reaction Training System in improving agility among beginner badminton athletes.

Data Analysis

Pretest and posttest scores from both groups were collected, tabulated, and prepared for statistical analysis using SPSS version 25 to determine the effectiveness of the Sonic Reaction Training System on improving agility in beginner badminton athletes (Creswell & Creswell, 2022).

Table 1 <Agility Training Program Based on Reaction Training>

Conference	Warm-up (±30 minutes)	Core Exercise (Item	Intensity (%)	Set	Rep	Rest
1	Stretching statis, dynamic stretching, jogging 60%, ABC drill	V-Agility, Six Point (Pretest), Agility T-Test, Two Point	100	3	3	1 minutes
2	Stretching statis, dynamic stretching, jogging 60%, ABC drill	Zig-zag Touch Pod, Four Point, Hit and Return, One Step Lunge, Agility T-Test	100	3	5	2 minutes
3	Stretching statis, dynamic stretching, jogging 60%, ABC drill	M-Run Touch Pod, Agility Box Test, AK Pendulum Test, Six Circle Drill, One Step Lunge, Front Court Reflex	100	3	5	2 minutes
4	Stretching statis, dynamic stretching, jogging 60%, ABC drill	V-Agility, Front Court Reflex, Six Point, Zig-zag Touch Pod, AK Pendulum	100	3	5	2 minutes
5	Stretching statis, dynamic stretching, jogging 60%, ABC drill	AK Pendulum, Agility T-Test, Agility Box Test, Six Circle Drill, One Step Lunge, Four Point	100	3	5	2 minutes
6	Stretching statis, dynamic stretching, jogging 60%, ABC drill	Hit and Return, V-Agility, Two Point, Four Point, M-Run Touch Pod, Zig-zag Touch Pod	100	3	5	2 minutes
7	Stretching statis, dynamic stretching, jogging 60%, ABC drill	M-Run Touch Pod, Agility Box Test, AK Pendulum, Six Point, Two Point	90	3	3	1 minutes
8	Stretching statis, dynamic stretching, jogging 60%, ABC drill	V-Agility, Four Point, Six Circle Drill, M-Run Touch Pod, Front Court Reflex, One Step Lunge	90	3	3	1 minutes
9	Stretching statis, dynamic stretching, jogging 60%, ABC drill	Six Point, V-Agility, Two Point, Zig-zag Touch Pod, Four Point	100	3	5	2 minutes
10	Stretching statis, dynamic stretching, jogging 60%, ABC drill	Six Point, Four Point, Two Point, One Step Lunge, Agility T-Test	100	3	5	2 minutes
11	Stretching statis, dynamic stretching, jogging 60%, ABC drill	M-Run Touch Pod, Agility Box Test, AK Pendulum, Six Circle Drill, V-Agility, Front Court Reflex	100	3	5	2 minutes
12	Stretching statis, dynamic stretching, jogging 60%, ABC drill	Six Point, Agility T-Test, One Step Lunge, Zig-zag Touch Pod, Two Point	100	3	5	2 minutes
13	Stretching statis, dynamic stretching, jogging 60%, ABC drill	V-Agility, Four Point, Six Circle Drill, M-Run Touch Pod, AK Pendulum, Hit and Return	100	3	5	2 minutes
14	Stretching statis, dynamic stretching, jogging 60%, ABC drill	Agility Box Test, Agility T-Test, Front Court Reflex, One Step Lunge, Six Point, Two Point	100	3	5	2 minutes
15	Stretching statis, dynamic stretching, jogging 60%, ABC drill	Four Point, M-Run Touch Pod, Zig-zag Touch Pod, Hit and Return, V-Agility, Six Circle Drill, AK Pendulum	100	3	5	2 minutes

Conference	Warm-up (±30 minutes)	Core Exercise (Item	Intensity (%)	Set	Rep	Rest
16	Stretching statis, dynamic stretching, jogging 60%, ABC drill	V-Agility, Two Point, Six Point (Posttest), Agility T-Test	100	3	3	1 minutes
17	Stretching statis, dynamic stretching, jogging 60%, ABC drill	Combination reaction agility drill variations	100	3	5	2 minutes
18	Stretching statis, dynamic stretching, jogging 60%, ABC drill	Combination reaction agility drill variations	100	3	5	2 minutes

Results and Discussions

After obtaining the data, the author processed and analyzed it. The statistical description of the research data can be seen in Table 2.

Descriptive Statistics

Table 2 <Statistical Description>

Group	Test	N	Minimum	Maximum	Mean	Std. Deviation
Experimental	Pretest	11	11,75	22,87	17,67	3,23
Experimental	Posttest	11	10,00	20,00	15,98	2,97
Control	Pretest	11	10,75	25,85	17,49	4,52
Control	Posttest	11	14,81	26,65	20,42	4,12

Based on the descriptive statistics presented in Table 2, the experimental group showed a decrease in mean agility scores from 17.67 ± 3.23 at pretest to 15.98 ± 2.97 at posttest (mean difference = −1.69). In contrast, the control group demonstrated an increase from 17.49 ± 4.52 to 20.42 ± 4.12 (mean difference = +2.93). These findings indicate that the intervention group performed worse following the treatment, whereas the control group improved over the same period. This unexpected pattern suggests that the intervention did not produce the anticipated positive outcome and therefore requires further interpretation in the discussion section. To complement the significance testing, effect sizes (Cohen's d) were calculated to estimate the magnitude of the observed changes.

Results of the Normality Test

Table 3 <Normality Test>

	Group	Shapiro-Wilk Statistic	df	Sig.
Pre-test score	Experimental	.983	11	.981
	Control	.923	11	.345
Post-test Score	Experimental	.951	11	.655
	Control	.932	11	.430

The results of the normality test can be seen in Table 3. Using Shapiro–Wilk, it shows that the data in both groups are normally distributed because all significance values are greater than 0.05. In the experimental group, the pretest value had a significance of 0.981 and the posttest value was 0.655, while in the control group, the pretest value showed a significance of 0.345 and the posttest value was 0.430. Thus, it can be concluded that the research data meets the normality assumption so that further analysis can be carried out using parametric statistical tests. Next, the author conducted a homogeneity test, the results of which can be seen in Table 4.

Homogeneity Test Results

Table 4 presents the results of Levene's test for homogeneity of variance. The analysis yielded an F value of 1.421 with a significance value of 0.247 ($p > 0.05$), indicating that the assumption of equal variances between the experimental and control groups was satisfied. Therefore, the independent-samples t-test assuming equal variances was considered appropriate for subsequent analyses.

Table 4 <Homogeneity Test Results>

Variabel	F	Sig.	Criteria	Interpretation
Agility	1,421	0,247	Sig. > 0,05	Homogeneous variances

Hypothesis Test Results

Table 5 <Hypothesis Test Results>

Hypothesis	t	df	Sig. (2-tailed)	Description
Hypothesis One (Effects observed in the experimental group)	2,850	10	0,017	There is a significant effect
Hypothesis Two (Effects observed in the control group)	-4,621	10	0,001	There is a significant change
Hypothesis Three (The difference in effects between the experimental group and the control group))	-2,904	20	0,009	There is a significant difference

The paired-sample t-test indicated statistically significant changes in both groups. However, statistical significance alone does not reflect the magnitude of the intervention effect. Therefore, Cohen's d effect size was calculated for each comparison. In the first hypothesis, namely the effect that occurred in the experimental group, the analysis results showed a t-value of 2.850 with a degree of freedom (df) of 10 and a significance value (Sig. 2-tailed) of 0.017. This significance value is less than 0.05, so it can be concluded that there is a significant effect on the experimental group after the treatment was administered. This shows that the exercise program implemented was able to bring about changes in the variables studied.

Based on the results of the second hypothesis, namely the effect that occurred in the control group, a t-value of -4.621 was obtained with df 10 and a significance value of 0.001. A significance value smaller than 0.05 indicates that there was a significant change in the control group. This change could have been influenced by factors such as regular training, natural adaptation of athletes, and external factors during the research period.

Based on the results of the third hypothesis, namely the difference in effects between the experimental group and the control group, the analysis results show a t-value of -2.904 with df 20 and a significance value of 0.009. A significance value smaller than 0.05 indicates that there is a significant difference between the two groups. Thus, it can be interpreted that the treatment given to the experimental group had a different effect compared to the control group, so that the exercise program implemented contributed to the improvement in the research results.

Table 6 <Effect Size>

Comparison	Mean Difference	Cohen's d	Interpretation
Experimental (Pre–Post)	-1.69	**0.54**	Moderate
Control (Pre–Post)	+2.93	**0.68**	Moderate
Between Groups (Posttest)	-4.44	**1.23**	Large

The effect size analysis demonstrated a moderate within-group effect in the experimental group (Cohen's d = 0.54), although the direction of change was negative because posttest scores decreased. The control group demonstrated a moderate positive effect (d = 0.68), whereas the between-group comparison yielded a large effect (d = 1.23), indicating a substantial difference between groups after the intervention. Nevertheless, the direction of this difference favored the control group rather than the experimental group.

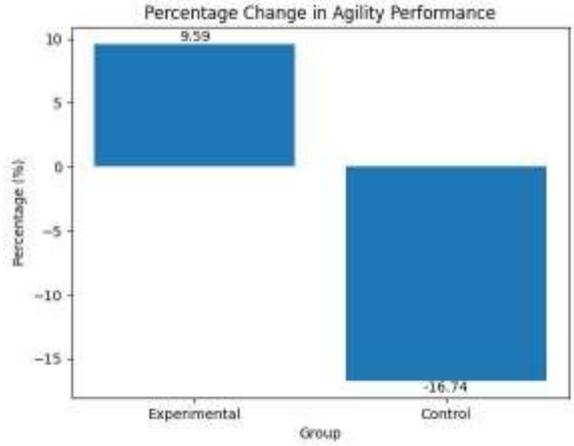

Figure 1 <Percentage Increase in Agility Ability of Beginner Badminton Athletes>

Considering the relatively small sample size (n = 11 per group), a post-hoc power analysis was performed to estimate the probability of detecting the observed effects. Using an alpha level of 0.05 and the obtained effect sizes, the statistical power was estimated to be below the recommended level of 0.80 for detecting moderate effects. Consequently, the findings should be interpreted cautiously because the limited sample size increases the risk of Type II error and reduces the generalizability of the results. Future studies should include larger samples to improve statistical power and the robustness of the conclusions.

Based on Figure 1, the percentage change shows that the experimental group experienced a 9.59% increase in agility, while the control group experienced a 16.74% decrease, proving that the reaction training-based exercise program had a positive effect on improving the agility of beginner badminton players.

Discussion

The goal of the current study was to determine whether the Sonsic Reaction Training System could help novice badminton players become more agile. The results showed that individuals in the experimental group improved their agility considerably more than those in the control group who received traditional training.

These findings indicate that incorporating technology-based reaction stimuli into agility training provides additional benefits beyond traditional movement drills by exposing athletes to unpredictable visual and auditory cues that require rapid perception and movement adjustment. Similar findings have been reported in studies demonstrating that perceptual-reaction training enhances change-of-direction performance and sport-specific agility in young athletes (Fadde & Zaichkowsky, 2018; Komarudin et al., 2024; Schack et al., 2020).

Agility in badminton extends beyond the physical ability to change direction rapidly; it also requires athletes to perceive environmental information, anticipate shuttle trajectories, and execute appropriate movement responses under time constraints (Phomsoupha & Laffaye, 2015; Sheppard & Young, 2006; Young et al., 2015). Therefore, the superior improvement observed in the experimental group suggests that integrating reaction stimuli into agility exercises may better replicate the perceptual and temporal demands encountered during competitive play than conventional drills based on predetermined movement patterns.

Several theoretical perspectives may explain these improvements. From the perspective of Implicit Learning Theory, athletes may have enhanced their movement performance by repeatedly responding to external stimuli without consciously focusing on explicit movement rules. Implicit learning promotes the development of automatic motor control and reduces dependence on conscious processing, allowing performers to maintain movement efficiency under pressure (Masters, 1992; Poolton et al., 2006). Likewise, the Constraints-Led Approach (CLA) proposes that motor behavior emerges through continuous interactions among individual, task, and environmental constraints (Davids, 2010; Newell, 1991). Because the Sonsic Reaction Training System presents unpredictable visual and auditory stimuli, athletes are required to continuously adapt their movement solutions, a process that is consistent with ecological dynamics and representative learning design.

Although these theoretical perspectives provide plausible explanations, the present findings appear to be more strongly supported by a neuromuscular coordination mechanism. Unlike implicit learning and the constraints-led approach, which primarily explain how movement behavior is acquired and adapted, neuromuscular coordination directly explains the physiological mechanisms responsible for improveme nts in rapid change-of-direction performance. Repeated exposure to reaction-based stimuli likely enhanced the synchronization of sensory input, central nervous system processing, and motor output, thereby reducing reaction time and improving the efficiency of muscle activation during multidirectional movements. Previous studies have shown that agility training involving rapid responses to external stimuli improves intermuscular coordination, motor unit recruitment, and movement efficiency, leading to superior change-of-direction ability (Lepley et al., 2017; Young et al., 2015). Since the primary outcome of the present study was agility measured by the Six-Point Shuttle Run Test, improvements in neuromuscular efficiency provide the most direct explanation for the observed performance gains.

The principle of training specificity further supports this interpretation. The visual and auditory stimuli generated by the Sonsic Reaction Training System closely resemble the perceptual demands encountered during badminton competition, requiring athletes to rapidly identify movement cues and execute appropriate directional changes. Such task-specific practice is known to facilitate adaptations that are highly transferable to sport performance (Bompa & Buzzichelli, 2019; Sheppard et al., 2006). Compared with conventional training, which typically emphasizes repetitive movement sequences, reaction-based training exposes athletes to continuously changing situations, thereby strengthening both perceptual processing and neuromuscular control.

The eight-week intervention period and somewhat small sample size restrict how far the results may be applied. To ascertain the relative contributions of neuromuscular adaptations, implicit learning processes, and ecological constraints to improvements in agility, future research should enlist larger sample sizes, prolong the duration of the intervention, and incorporate biomechanical, neuromuscular, and perceptual-cognitive measurements.

Overall, the results point to the Sonsic Reaction Training System as a successful technology-assisted training approach for enhancing agility in novice badminton players. The current evidence suggests that improvements are most consistently explained by improved neuromuscular coordination resulting from repeated exposure to sport-specific reaction stimuli, even though implicit learning and constraints-led theories offer complementary explanations regarding motor learning. As a result, including reaction-based technology into regular badminton training may enhance players' decision-making, response time, and movement preparedness while also encouraging physiological changes that support long-term athletic development.

Conclusions

From the research findings, it can be concluded that the agility training program using the Sonsic Reaction Training System has a significant positive impact on improving the agility of young badminton athletes, when compared to traditional training. This approach, which combines visual and auditory stimuli with the need for rapid changes in movement direction, has proven effective in improving neuromuscular coordination, accelerating decision-making processes, and optimizing movement patterns that are appropriate for the nature of badminton. Therefore, this reaction-based training method is recommended as an innovative option in early-age athlete development programs, although further studies with a larger sample size and longer intervention periods are needed to strengthen the validity of these findings more broadly.

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