Comparison of TAGteach Error-Correction Procedures to Teach Beginner Yoga Poses to Novice Adult Practitioners

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Abstract

TAGteach is a multi-component intervention package involving the use of teaching with acoustical guidance (TAG), a teaching procedure that uses an auditory stimulus (e.g., click sound) to indicate that a desired behaviour has occurred (Fogel, Weil, & Burris, 2010). TAGteach has been found to effectively improve performance in sports (Fogel et al., 2010), dance (Quinn, Miltenberger, & Fogel, 2015), surgical techniques (Levy, Pryor, & McKeon, 2016), and walking (Persicke, Jackson, & Adams, 2014). An adapted alternating treatments design was used to compare the effectiveness and efficiency of the standard TAGteach error-correction procedure and a modified TAGteach error-correction procedure to teach four novice adult yoga practitioners beginner yoga poses. Results showed that both error-correction procedures were effective for all participants; however, the relative efficiency of these error-correction procedures remains unclear. Results are discussed in terms of limitations and considerations for future research.

Keywords: teaching with acoustical guidance, sport performance, yoga, error-correction

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The word *yoga* is a Sanskrit verb meaning "to yoke" or "to bind together" (Feuerstein, 2008). In this context, the word yoga can have different connotations such as the *union* of the body and mind or the *harnessing* of attention (Feuerstein, 2008). The practice of yoga is an ancient discipline dating back to approximately 2500 B.C. (Tran, Holly, Lashbrook, & Amsterdam, 2001) and is comprised of eight limbs or areas: universal ethics, individual ethics, physical postures, breath control, control of the senses, concentration, meditation, and bliss (Iyengar, 1976). Although the practice of yoga started in India, it has since moved west (Ross & Thomas, 2010). In fact, over 1.4 million Canadians practice yoga (Russell, Geshue, Richmond, & McFaull, 2016).

Practicing yoga offers numerous physical and mental health benefits. Recently, yoga has been used as a therapeutic tool for the treatment of a variety of physical disorders and diseases (Atkinson & Permuth-Levine, 2009; Birdee, Ayala, & Wallston, 2017; Cowen & Adams, 2005; Ross & Thomas, 2010). Yoga has been used to treat rheumatoid arthritis (Badsha, Chhabra, Leibman, Mofti, & Kong, 2009), type 2 diabetes (Innes & Selfe, 2015), chronic back pain (Groessl, Weingart, Johnson, & Baxi, 2012), symptoms associated with cancer (Buffart et al., 2012), and the side effects of pregnancy (Bonura, 2014). In addition to these physical benefits, yoga practitioners may also experience immediate and prolonged mental health benefits (Chong, Tsunaka, Tsang, Chan, & Cheung, 2011), such as the alleviation of depression and anxiety and an overall sense of well-being (de Manincor, Bensoussan, Smith, Fahey, & Bourchier, 2015; de Manincor et al., 2016).

There are also physical risks to engaging in the practice of yoga despite its demonstrated physical and mental health benefits (Atkinson & Permuth-Levine, 2009; Birdee et al., 2017; Chong et al., 2011; Cowen & Adams, 2005; Ross & Thomas, 2010). Penman, Cohen, Stevens, and Jackson (2012) assessed 2353 yoga practitioners and found that 21% of respondents reported sustaining a yoga-related injury. Yoga-related injuries may result in prolonged pain, discomfort, suffering, missed work, and financial loss (Russel et al., 2016). The exact causes (i.e., how yoga-related injuries occur) have not yet been empirically evaluated. Previous researchers have hypothesized that practicing more advanced postures (e.g., poses that require more strength, flexibility, and range of motion such as headstand or shoulder stand; Farhi, 2000) may lead to a greater risk of injury (Holton & Barry, 2014). Other possible contributing factors include practicing yoga on unsuitable surfaces (e.g., yoga mat) and inadequate distance between practitioners during class (Russell et al., 2016). Another factor that may contribute to the risk of injury to practitioners is *how* yoga is taught. Therefore, it seems prudent to evaluate teaching procedures that promote safe yoga practices to prevent yoga-related injuries. Behavioural coaching methods using auditory stimuli as feedback have been found to improve performance within a variety of sports and fitness activities, including football (Harrison & Pyles, 2013; Stokes, Luiselli, Reed, & Fleming, 2010), golf (Fogel, Weil, & Burris, 2010), and dance (Quinn, Miltenberger, & Fogel, 2015).

The Use of Auditory Stimuli as Feedback

Clicker Training. Clicker training involves the use of an auditory stimulus as a conditioned reinforcer to train animals to emit desirable behaviours (Pryor, 1999). A conditioned reinforcer is a previously neutral stimulus that becomes a reinforcer through repeated pairings with an established reinforcer (Catania, 2013). Clicker training was developed by Karen Pryor,

an animal trainer who first used this method to teach dolphins to perform novel behaviour (Pryor, Haag, & O'Reilly, 1969). In the first study of its kind, Pryor and colleagues paired a whistle (neutral stimulus) with the delivery of fish (reinforcer). After repeated pairings, the whistle acquired the capability to function as a reinforcer and was used to reinforce a variety of novel behaviors not a part of the dolphins' species-specific repertoire. Pryor (1999) conceptualized the auditory stimulus as a bridging stimulus between the performance of the behaviour and delivery of the unconditioned reinforcer (i.e., a stimulus that functions as a reinforcer without prior learning or conditioning; Catania, 2013). Clicker training has been successfully used in a wide variety of animal training applications, including marine mammal shows (Gillaspy, Brinegar, & Bailey, 2014; Pryor et al., 1969), zoo animal care (Lukas, Marr, & Maple, 1998), and dog training (Thorn, Templeton, Van Winkle, & Castillo, 2006). These studies highlight the efficacy of using conditioned reinforcers to teach complex behaviours to a variety of species. Recently, clicker training has been re-evaluated and repackaged for use with humans, particularly in sport and fitness performance (Fogel et al., 2010; Harrison & Pyles, 2013; Quinn et al., 2015; Stokes et al., 2010).

Teaching with Acoustical Guidance (TAG) and TAGteach. When applied to humans, clicker training is commonly referred to as teaching with acoustical guidance (TAG). TAG is a teaching procedure that uses feedback in the form of an auditory stimulus (e.g., a click sound; Stokes et al., 2010). This auditory stimulus may come to function as a generalized conditioned reinforcer through its pairing with another generalized conditioned reinforcer (e.g., social attention, money, tokens paired with a variety of reinforcers), a conditioned reinforcer (e.g., tokens paired with only one other reinforcer), or an unconditioned reinforcer (e.g., food, water; Catania, 2013). In typically developing individuals, this pairing procedure may not be necessary.

The auditory stimulus may become a generalized conditioned reinforcer through a process called *verbal analog conditioning* (Alessi, 1992). This process occurs in humans when a rule (e.g., "The click sound means you did it right") establishes a previously neutral stimulus (e.g., click sound) as a generalized conditioned reinforcer without any direct pairing with another reinforcer (Alessi, 1992). Once the auditory stimulus becomes a reinforcer, it is provided contingent upon correct performance of a skill to increase the likelihood of that skill in the future. One advantage of using an auditory stimulus versus conventional praise is that the auditory stimulus can be delivered at the *exact* moment the student correctly performs a target skill (Stokes et al., 2010). This is important because even brief delays in the delivery of reinforcement can impair the rate at which new behaviours are learned (Lattal, 2010). Another advantage of using an auditory stimulus is that it allows for the teaching session to progress rapidly without interruptions to discuss errors (TAGteach International, 2004).

TAGteach is a multi-component intervention package that also incorporates an auditory stimulus to "provide immediate feedback and reinforcement in close temporal proximity to the occurrence of behaviour" (Fogel et al., 2010). TAGteach International, the company that coined the term TAGteach, trains teachers and coaches (called *TAGteachers*) to provide positive reinforcement to students using a device called a *tagger*. The tagger emits an auditory stimulus called a *tag* (TAGteach International, 2004). To teach a skill, the TAGteacher first identifies the component steps involved in the composite skill and converts these steps into *tagpoints*. A tagpoint is a 2- to 5-word phrase used to help the student identify the target skill (e.g., "right toes forward"). These tagpoints are then taught in sequence. When the student performs the tagpoint correctly, the TAGteacher delivers a tag. A tag signals to the student that he or she performed the skill correctly and the absence of a tag signals that he or she performed the skill incorrectly, must

reassess his or her performance, and try again. Although TAGteach does not explicitly refer to this aspect of the intervention package as an error-correction procedure, it will be conceptualized as such in this study. TAGteach International designed this intervention package to be used by teachers and coaches in the general population who may or may not have experience implementing behaviour analytic principles. TAGteach International has trained TAGteachers in areas such as education, business management, medicine, and amateur and professional sports ("What is TAGteach?" 2016).

It is important to note the similarities and differences between TAG and TAGteach. Both identify observable goals, task analyze complex skills into their component parts, and provide immediate reinforcement for the desired behaviour with an auditory stimulus. TAGteach extends beyond TAG in several ways. First, TAGteach includes rules for creating tagpoints: (a) ask for what you want to see instead of what you do not want to see, (b) ask for one independent response at a time, (c) ask for an observable behaviour, and (d) use five words or less to identify the skill (TAGteach International, 2004). Second, TAGteach International recommends strategies for organizing teaching sessions. The TAGteacher first provides a broad lesson on the composite target skill then gives specific instructions on the component skill(s) that will be taught during that teaching session. Third, the TAGteacher works with the student to develop personalized tagpoints and teaches each tagpoint individually (TAGteach International, 2004). Fourth, TAGteach International recommends that TAGteachers end a teaching session with a correct tagpoint by using a tactic called *point of success.* Fifth, TAGteach International incorporates a *three-try rule*, which requires the TAGteacher to further break down the tagpoint into smaller components if the student does perform it correctly within three attempts. Finally, it is customary for students to successfully perform an incorrect tagpoint three times before progressing to the

next tagpoint in the sequence. TAGteach International acknowledges that requiring correct performance of incorrect tagpoints three times before progressing was arbitrarily determined and requires empirical validation to ensure that it is the most effective and efficient teaching strategy (A. Wormald, personal communication, September, 2016).

Teaching with Acoustical Guidance (TAG) Research. Two studies have evaluated the effectiveness of TAG on sport performance, both of which included additional intervention components. Stokes et al. (2010) used a multiple baseline across participants design to compare the effectiveness of three behavioural coaching methods to teach high school football players an offensive line pass-blocking drill. Each player's baseline performance of the drill was assessed under typical coaching conditions that included reminders about technique and focus, praise to acknowledge good performance, and reprimands and modeling following poor performance. During the experimental phase, the researchers compared acquisition of a 10-step task analysis of the drill using descriptive feedback alone; descriptive feedback with video feedback; and a combination of descriptive feedback, video feedback, and TAG. The authors found that player performance using descriptive feedback with video feedback produced greater improvement than descriptive feedback alone. When TAG was added to descriptive feedback plus video feedback, further improvements in offensive line pass-blocking were observed. However, the specific effects of TAG could not be determined due to the increasing trend prior to the implementation of TAG. Social validity data indicated that four of five participants preferred descriptive feedback with video feedback, with the fifth participant preferring TAG. Further, performance was found to generalize from practice sessions to live games; however, the skill did not maintain from the end of one season to the beginning of the next, suggesting that these procedures were not sufficient to maintain performance to the following football season. Overall, the results of

this study support the use of behavioural coaching methods that include the use of TAG to enhance the performance of football skills. However, TAG's role in the improved performance observed in this study remains unclear.

To further investigate the use of TAG with high school football players, Harrison and Pyles (2013) used a multiple baseline across participants design to evaluate the effectiveness of verbal instruction and TAG within a shaping procedure. The researchers taught three high school football players to safely and effectively perform a defensive tackle using a 4-step task analysis. During baseline, the researchers did not provide any instruction or feedback on the players' performance of the tackling drill. During the shaping phase, the researchers gave verbal instructions for each step of the task analysis and delivered an auditory stimulus (a beep from a megaphone) when each player performed the drill correctly at walking speed. The researchers asked the players to perform the drill at progressively faster speeds, from a walk to a run, and found that the combination of verbal instruction and TAG was effective for improving the tackling performance of all three participants. This skill also generalized to safe and effective tackling with a live ball carrier running at full speed during a tackling drill; generalized performance during live games was not assessed. Taken together, both studies found that multi-component intervention packages that included a TAG component were effective at improving offensive and defensive football skills. Because both studies consisted of numerous intervention components, the separate and combined effects of TAG and other behavioural coaching methods remains unclear.

TAGteach Research. TAGteach as an intervention package has been empirically studied with a wider variety of skills than TAG. Fogel et al. (2010) used a multiple baseline across skills design to evaluate the efficacy of a multi-component intervention package consisting of

TAGteach sessions, independent practice sessions outside of experimental visits, and completing practice logs to teach a golf swing to a novice female golfer. These researchers developed a task analysis for each of the five components of a golf swing (grip, address, alignment, pivot, arm positions). During baseline, the researchers did not provide any feedback on the participant's performance. During the experimental phase, the researchers conducted teaching sessions at a driving range, asked the participant to practice a minimum of three times between sessions, and keep a log of those practices. This packaged intervention was effective in teaching four of the five target skills at the driving range and that these skills generalized to a different golf club. Although the participant's performance was not assessed during a game of golf, the researchers assessed two socially valid by-products of an improved golf swing, ball path and ball distance. Although there was little improvement in ball distance, the researchers found that the ball path became straighter and more consistent following the introduction of the packaged intervention.

Unlike previous articles assessing TAGteach, Quinn, Miltenberger, and Fogel (2015) used a multiple baseline across behaviors design to investigate the effectiveness of TAGteach alone. The researchers taught two dance teachers to implement the TAGteach procedure to teach four female participants (ages 6 to 9 years old) three different dance skills: a turn, a leap, and a kick. During baseline, the dance teachers asked the participants to perform each of the three skills and did not provide feedback on their performance. During the experimental phase, the dance teachers implemented TAGteach with their students before or after regularly scheduled dance classes. The dance teachers reviewed the TAGteach rules, assessed the dancers' understanding of the tagpoints by having the dancer tag the teacher's performance of the skill, then taught the skill using TAGteach. The dance teacher tagged the dancer's behaviour if she performed the skill correctly and did not provide a tag if the dancer made an error. After an error

was made, the dance teacher did not proceed to the next tagpoint until the dancer performed the tagpoint correctly three times in a row. The dance teachers assessed each dancer's performance at the end of each TAGteach session. The researchers found TAGteach was effective at improving performance of all three dance skills for three of the four participants; however, they did not provide an pre-determined acquisition criterion. The researchers hypothesized that TAGteach alone was not effective for the fourth participant because the tag may not have served as a conditioned reinforcer for this individual. The researchers added a token system for this participant and found that this combined approach was effective at improving the performance of all three dance skills for this participant. The results of this study show that dance teachers with no previous TAGteach training can be taught to implement TAGteach in a short period (2 hours) and that TAGteach was effective to teach dancers a variety of complex dance moves.

Andrews (2014) also studied TAGteach alone using a multiple baseline across behaviours design. The researcher taught four female participants (ages 23 to 26 years old) to perform three yoga poses: tree pose, downward dog pose, and pigeon pose. During baseline, the researcher showed the participant a photo of the pose, showed the participant a live model of the pose, and asked the participant to perform the pose three times. The researcher did not provide any feedback on the participants' performance. During the experimental phase, the researcher conducted 15-min TAGteach sessions with each participant where she only taught those tagpoints that the participant performed incorrectly during baseline. During each session, the researcher introduced the lesson and the target tagpoint(s). Before asking the participant to peform the target tagpoint(s), the researcher first tested the participant's understanding of the tagpoints by instructing the participant to tag the researcher's behaviour while performing a live model of the pose. The participant then attempted the target tagpoint once and developed a

personalized tagpoint phrase, if she desired. Next, the researcher delivered the tagpoint phrase and the participant attempted the target tagpoint. If the participant performed the target tagpoint correctly, the researcher provided a tag; if the participant performed the target tagpoint incorrectly, the researcher did not provide a tag and the participant tried again. If the participant did not perform the target tagpoint correctly within three attempts, the researcher applied the three-try rule by breaking the skill down into smaller, more achievable steps. Once the participant performed the target tagpoint six times in a row, the researcher moved on to the next tagpoint. This process continued for the duration of the 15-min TAGteach session. At the end of the TAGteach session, the researcher asked the participant to perform the pose three times while receiving no feedback. The researcher found that TAGteach was effective at improving all four participants' performance of all three yoga poses within TAGteach sessions and that performance maintained at 90% to 100% once teaching had been removed. Participants' performance also generalized to a group yoga class at the end of the study. The researcher assessed the social validity of TAGteach - all participants reported finding TAGteach sessions enjoyable and reported that their performance of the three poses improved. Finally, two certified yoga instructors rated videos of each participant's performance from baseline to the end of the intervention. These yoga instructors were kept blind to the phase of the study and rated poses higher after the TAGteach intervention had been implemented. Overall, the results of this study were consistent with previous research indicating that TAGteach is an effective coaching method to teach physical skills to typically-developing adults.

Along with the application of TAGteach in sports and fitness coaching, TAGteach has been used in both clinical work and professional education. Persicke et al. (2014) used a reversal design to compare the effectiveness of response correction alone and response correction plus

TAGteach to decrease toe-walking behaviour of a 4-year-old boy with autism spectrum disorder. First, the researchers conducted reinforcer pairing sessions in which they presented an auditory stimulus followed immediately by an edible reinforcer (chip) for a minimum of 15 trials per day. These pairing sessions continued each day of the study. During baseline, the therapist walked next to the participant and did not provide any feedback on his walking. In the response correction condition, if the participant took two consecutive steps on his toes the therapist placed her hands on his shoulders until his heels were on the floor. In the response correction plus TAGteach condition, the therapist implemented the response correction procedure and delivered the auditory stimulus after every flat-footed step. Once the mastery criterion was met during the response correction plus TAGteach, the therapist faded the auditory stimulus to every two flat steps then every four flat steps. The researchers found that response correction plus TAGteach was more effective than response correction alone at increasing the percentage of flat-footed steps performed by this individual. This study contains elements not seen in others to date; namely, the inclusion of reinforcer pairing and fading of reinforcement within the TAGteach procedure. The authors highlight that behaviour analysts are in an ideal position to study and validate the use of TAGteach in clinical practice and among more diverse applications.

Finally, Levy, Pryor, and McKeon (2016) used a between-subjects research design to compare the use of demonstration plus TAGteach (experimental condition) and demonstration alone (control condition) when teaching two surgical techniques to 23 medical students. Participants consisted of a combination of orthopaedic residents, non-orthopaedic surgical residents, and first- and second-year medical students. Participants were randomly assigned to the test and control groups. The test group consisted of six orthopaedic residents and six medical students. The control group consisted of five non-orthopaedic surgical residents and six medical

students. An experienced surgeon evaluated both groups' surgical techniques. The researchers found that the demonstration plus TAGteach group achieved more precise knot-tying and more consistent hole-drilling than the control group. Interestingly, the authors also measured the amount of time it took students to learn each task and found that it took the demonstration plus TAGteach group longer to complete the knot-tying task correctly the first time, but that there was no difference between groups for the hole-drilling task. The researchers concluded that the demonstration plus TAGteach procedure was superior to demonstration alone when the desired result is a more accurate terminal behaviour and not time saved during the learning process.

Both TAG and TAGteach have been shown to improve performance across multiple skills when combined with other intervention strategies. However, there are several noteworthy limitations to these studies. First, TAGteach consists of several individual components that have not yet been empirically validated (e.g., specific tagpoint phrasing, using personalized tagpoints, employing the three-try rule). Second. only two of the six studies assessed maintenance of skills (Fogel et al., 2010; Stokes et al., 2010). Third, only one of the six studies assessed generalization of the skill to a real-world application (Stokes et al., 2010). Fourth, only three of the six studies included a measure of social validity (Fogel et al., 2010; Quinn et al., 2015; Stokes et al., 2010). Fifth, two of four studies included a single participant, which may limit the generalizability of these results to a larger population (Fogel et al., 2010; Persicke et al., 2014). Finally, two of four studies evaluated the effectiveness of TAGteach alone; therefore, additional studies are needed to support the use of TAGteach alone.

Therefore, the primary purposes of this study were to evaluate the error-correction component of the TAGteach intervention package and to compare the effectiveness and efficiency of two different error-correction procedures (standard TAGteach and TAGteach with

reduced practice) to teach beginner yoga poses to novice adult yoga practitioners. The secondary purposes of this study were to compare the relative preference for these error-correction procedures by participants and to compare ratings obtained by a second (blind) yoga teacher on participants' experience, errors, fluidity, and safety on all poses pre- and post-TAGteach training with both error-correction procedures.

Method

Participants, Setting, and Materials

Four adults were recruited for this study: Edward (34 years), Madeleine (32 years), Makayla (39 years), and Nadine (35 years). Prospective participants were eligible to be in the study if they performed less than 50% of a task analysis correctly for at least three of the five selected beginner yoga poses, reported no physical injuries, and refrained from practicing yoga outside of research sessions for the duration of the study. All prospective participants who did not meet these criteria were excluded from the study. Recruitment posters were distributed to coffee shops, libraries, grocery stores, and gyms in the Greater Hamilton Area. The principal student investigator (hereafter called, *the researcher*) also contacted yoga teachers and yoga-studio owners in the Greater Hamilton Area. See Appendix A for the certificate for ethics clearance for human participant research and Appendix B for the informed consent form.

The researcher of this study carries a certification of 200 hours of hatha (i.e., physical postures) yoga teacher training (the standard first level of yoga teacher training) from a yoga studio located in Hamilton and has three years of teaching experience. A second certified hatha yoga teacher was recruited to verify the procedures and poses that were used in this study. In addition, the second yoga teacher served as a *blind observer* and rated the participants'

performance pre- and post-intervention after the conclusion of data collection. The second yoga teacher carries a certification of 500 hours of hatha yoga teacher training from a yoga studio located in New York City and has 12 years of teaching experience. The second yoga teacher was recruited from a yoga studio in the Greater Hamilton Area, and met with the researcher to review the consent form (Appendix C).

All sessions were conducted in a room (at least 3 m wide by 5 m long) in participants' homes. Materials varied according to the experimental phase, but typically included two digital video cameras mounted on tripods, a clipboard with paper data sheets, a pencil, a standard-sized yoga mat (60 cm wide by 182 cm long), colour photographs of the selected poses, and a training clicker called a tagger.

Beginner Yoga Poses

Task Analyses. Five common beginner-level yoga poses were selected for this study. These poses include: (a) chair pose (Utkatasana), (b) extended side angle pose (Utthita Parsvakonasana), (c) half pigeon pose (Kapotasana), (d) warrior III pose (Virabhadrasana III), and (e) downward dog pose (Adho Mukha Svanasana). Prior to the study, the researcher consulted the second yoga teacher to develop and approve a task analysis (TA) for these five-beginner yoga poses (Appendix D).

Logical Analysis. The researcher conducted a logical analysis of each TA to ensure that the difficulty of each pose was equal in terms of the number of steps required to perform the pose (Wolery, Gast, & Hammond, 2010) and the mean time required to perform each pose (Wolery et al., 2010). In addition, the second yoga teacher rated the difficulty level for each pose (Wolery et al., 2010) as either beginner-, intermediate-, or advanced-level yoga poses (see Table 1 for the

results of the logical analysis). The number of TA steps required to perform each of the five yoga poses was 17 steps. When performed by an experienced yoga practitioner five times, the mean completion times were 6 s for the extended side angle, warrior III, and half pigeon poses, and 5 s for the chair and downward dog poses. The difference in mean completion time of only 1 s suggests that all yoga poses took nearly the same amount of time to perform. Finally, the second yoga teacher rated each yoga pose selected as a beginner yoga pose. Given that each pose has 17 steps, was performed in 5 s to 6 s, and is rated as a beginner pose, we concluded that all five poses are relatively equal in difficulty.

Table 1

Summary of Logical Analysis for Five Yoga Poses

Measure	Chair Pose	Extended Side Angle Pose	Half Pigeon Pose	Warrior III Pose	Downward Dog Pose
No. steps / pose	17	17	17	17	17
Completion time (s) *M (SD)*	5 (0.4)	6 (0.6)	6 (0.3)	6 (0.7)	5 (0.3)
Expert rating	Beginner	Beginner	Beginner	Beginner	Beginner

Experimental Design and Response Measurement

Experimental design. The effects of two different error-correction procedures on the acquisition of beginner yoga poses were compared using an adapted alternating treatments design (Sindelar, Rosenberg, & Wilson, 1985) in which standard TAGteach, TAGteach with reduced practice, and control conditions were alternated across sessions. This design can be used to compare the effectiveness (which procedure produces the desired result) and relative

efficiency (which procedure produces results faster, using fewer resources) of these error-correction procedures (Wolery et al., 2010). Two yoga poses were taught simultaneously. One pose was assigned to each TAGteach error-correction procedures and a third yoga pose assigned to the control condition (Table 2). Poses were quasi-randomly assigned to each condition such that no more than two poses were assigned to the same condition across participants. In addition, the order in which conditions were conducted was counterbalanced across participants. The experiment consisted of two phases: baseline and error-correction comparison, with a one-week follow up assessment.

Table 2

Beginner Yoga Poses Assigned to each Condition for Edward, Madeleine, Makayla, and Nadine

Participant	Standard TAGteach	TAGteach RP	Control
Edward	Chair	Half Pigeon	Side Angle
Madeleine	Half Pigeon	Side Angle	Downward Dog
Makayla	Side Angle	Chair	Downward Dog
Nadine	Side Angle	Half Pigeon	Warrior III

Response measurement. The researcher collected data during all sessions using paper and pencil (Appendix E). An *independent tagpoint* was defined as the participant correctly performing the skill outlined in the target TA step. An *error* was defined as the participant incorrectly performing the skill outlined in the target TA step. The researcher recorded data live while the participant was performing the target yoga pose. These data were converted into a percentage of independent tagpoints by dividing the sum of independent tagpoints by the total number of tagpoints for the target yoga pose.

Interobserver Agreement. Interobserver agreement (IOA) was assessed during 35% of sessions for each condition during each phase for all participants. A second independent observer, currently completing a master's degree in applied behaviour analysis, viewed video footage of sessions and collected data on the dependent variables. These data were compared to those collected by the researcher during sessions. An agreement was defined as both observers recording the same response (i.e., an independent tagpoint or an error) for each step of the task analysis. A disagreement was defined as one observer recording a response differently from the second observer (e.g., one observer scored a response as an independent tagpoint while the second observer scored the same response as an error). Trial-by-trial IOA was calculated by dividing the number of agreements by the total number of TA steps and converting the ratio to a percentage. Mean interobserver agreement scores for independent tagpoints and errors were 98.5% (94% to 100%) for Edward, 97% (94% to 100%) for Madeleine, 98% (94% to 100%) for Makayla, and 96% (88% to 100%) for Nadine.

Procedural Integrity. Procedural integrity was assessed during 33% of sessions for each condition and each phase for all participants to ensure that the procedures described in each experimental condition were implemented as designed and reported. The second observer viewed video footage of sessions and collected post-hoc data on the correct provision of the tagpoint phrase, correct feedback on independent tagpoints, correct feedback on errors, correct progression to subsequent tagpoints in the task analysis, and correct termination of the session (Appendix F). *Correct provision of the tagpoint phrase* consisted of the researcher providing a verbal response specifying the correct task analysis step to be performed by the participant (e.g., "The tagpoint is fingers wide"). The tagpoint phrase consisted of a pre-determined phrase developed by the researcher when writing the task analysis or was a personalized tagpoint

developed by the participant prior to the start of the TAGteach session. *Correct feedback on independent tagpoints* consisted of the researcher providing a tag within 3 s after the participant performs the tagpoint correctly. *Correct feedback on errors* consisted of the researcher withholding a tag and verbal feedback following an error. *Correct progression to subsequent tagpoints* in the task analysis depended on the condition. During the standard TAGteach condition, correct progression consisted of the researcher initiating the next tagpoint following three consecutive independent tagpoints. During the TAGteach with reduced practice condition, correct progression consisted of the researcher delivering the next tagpoint following one independent tagpoint before initiating teaching on the following tagpoint. *Correct termination of the session* consisted of the researcher ending the session (a) upon participant request, (b) after the correct error-correction procedures have been implemented for all target tagpoints, (c) termination criteria have been met for any target tagpoint, or (d) when 15 min had lapsed. Procedural integrity was calculated by dividing the number steps performed correctly by the total number of steps and converting the ratio to a percentage. Mean procedural integrity scores across all researcher behaviours were 97% (86% to 100%) for Edward, 97% (92% to 100%) for Madeleine, 96% (88% to 100%) for Makayla, and 100% for Nadine.

A delegate from TAGteach International collected IOA on these procedural integrity measures during 33% of sessions in which procedural integrity was calculated for each condition within the error-correction comparison phase. An agreement was defined as both observers recording the same researcher response (i.e., correct delivery of the tagpoint or an error) for each step of the TA. A disagreement was defined as one observer recording a response differently from a second observer (e.g., one observer scored a response as correct while the second observer scored the same response as an error). Trial-by-trial IOA was calculated by dividing the

number of agreements by the total number of procedural steps and converting the ratio to a percentage. Mean interobserver agreement scores across all procedural integrity measures were 100% for Edward, 96% (92% to 100%) for Madeleine, 98% (96% to 100%) for Makayla, and 100% for Nadine.

Procedures

Eligibility pre-test. Prior to the baseline phase, we conducted an eligibility pre-test to identify three target yoga poses for each participant. The researcher showed the participant a photograph of the target yoga pose, provided a live model of the pose, then asked the participant to perform the pose. All potential participants performed each pose safely during each eligibility pre-test such that the researcher was not required to ask potential participants to exit the pose. Poses in which the participant performed 50% or less of the task analysis correctly were included in this study.

General experimental visit structure. The researcher visited each participant's home one to three days per week to conduct sessions. During each visit, two video cameras, one with a forward-facing view and one with a side-facing view, recorded the participants' performance of the target yoga poses (see Table 2 for pose assignment). All participants performed poses safely during all sessions in this study such that the researcher was not required to ask any participant to exit the pose. Each visit was no more than one hour in duration. The order in which conditions were conducted was counter-balanced across participants.

Assessment sessions. We conducted assessment sessions to evaluate the participant's current level of performance of the three-target yoga poses. Each assessment session was up to 5 minutes in duration and assessed one beginner yoga pose. We conducted two to three assessment

sessions per visit. During baseline, only assessment sessions were conducted. During the error-correction comparison phase, both assessment and TAGteach sessions (described below) were conducted. No more than one assessment and TAGteach session were conducted for each pose per visit.

During all assessment sessions, regardless of phase, the researcher showed the participant a photo of the target yoga pose, performed a live model of the pose, and asked the participant to perform the pose independently. No praise or corrective feedback was provided to the participant based on his or her performance. Once the participant had performed the pose, the researcher said, “Thank you” to indicate that he or she may exit the pose. Only data collected during assessment sessions were graphed and analyzed in this study because these data depict each participant’s independent (i.e., unprompted) performance on each task analysis and allowed us to detect changes in responding as a function of the two error-correction procedures.

TAGteach sessions. We only conducted TAGteach sessions if a participant did not perform 100% of the task analysis of the yoga pose correctly during the assessment session. Only one pose was taught in each TAGteach session. Each TAGteach session was conducted until the participant performed all tagpoints in the TA correctly or until 15 minutes had lapsed. Before each TAGteach session, the researcher reviewed the tagpoints the participant performed correctly and incorrectly during the previous assessment session. The researcher asked the participant to create a personalized tagpoint for each tagpoint performed incorrectly during the assessment session. If the participant chose not to state a personalized tagpoint, the researcher provided him or her with a pre-determined tagpoint. These tagpoints were developed by the researcher and validated by a delegate of TAGteach International prior to the start of the study. During each TAGteach session, only those tagpoints that the participant performed incorrectly during the

assessment session were taught. Data collected from TAGteach sessions were not graphed; however, these data were used to assess the relative efficiency of the two error-correction procedures. Total session duration, mean session duration, and the number of teaching sessions required to meet the acquisition criterion were used to determine if one error-correction procedure was more efficient than the other.

Experimental Phases.

Baseline. During the baseline phase, assessment sessions were conducted until the participant's level of performance of the target yoga poses was stable.

Error-correction comparison. Three conditions were alternated during this phase: (a) standard TAGteach error-correction (practicing a tagpoint three times), (b) TAGteach with reduced practice (practicing a tagpoint once), and (c) a control condition that was identical to baseline. The acquisition criterion was independent performance on 100% of the TA steps of the yoga pose across three consecutive assessment sessions (Wolery, Gast, & Hammond, 2010).

If the participant failed to perform a tagpoint correctly three times during a TAGteach session (not necessarily three times in a row), the researcher used the TAGteach strategy called *point of success*. That is, the researcher returned to the last previously successful tagpoint, tagged the participant's correct performance of that tagpoint three consecutive times, then terminated the session. Before conducting the next session for that pose, the researcher divided the tagpoint in which the participant errored into its smaller, more teachable movements. For example, if the participant errored on the tagpoint "toes forward," the researcher divided that step into right toes forward, left toes forward, both toes forward.

Standard TAGteach condition. At the beginning of a TAGteach session, the researcher introduced TAGteach by showing the participant the tagger and saying, "This is a tagger. Today

I’m going to ask you to show me your [target yoga pose]. To help you learn how to do [target yoga pose] correctly, I broke it down into several small steps, which are called tagpoints. You already do several of these tagpoints well such as [the researcher listed the tagpoints that the participant performs correctly], so I’m only going to focus on the tagpoints that you can improve upon. When you are showing me [target yoga pose], I will be paying close attention to how you perform the following tagpoints [the researcher listed and model each tagpoint that the participant did not perform correctly during the assessment session]. When you perform each tagpoint correctly, you will hear this sound [the researcher pressed the tagger to make a click sound]. If you do not perform the tagpoint correctly, you will not hear this sound and you can try again. During this session, I will ask you to practice each tagpoint *three times in a row* before moving on to the next tagpoint. Do you have any questions?”

Because each yoga pose consists of many individual steps that must be completed in sequence, each pose is considered a behavioral chain. As such, in order to complete a later step in the chain, the participant was first required to complete all earlier steps in the chain. Therefore, at the start of the TAGteach session, the researcher asked the participant to begin performing the target yoga pose then specified the first target tagpoint on which the participant errored during the preceding assessment session. For example, "Show me the downward dog pose. The tagpoint is straight arms." Although *straight arms* is the sixth tagpoint (or sixth step in the behavioral chain), the participant first needed to complete the first five tagpoints (or the first five steps in the behavioral chain). If the participant performed the tagpoint correctly, the researcher delivered a tag (click sound). The participant had to perform the tagpoint correctly on three consecutive attempts before progressing to the next tagpoint. This process continued until the participant performed all tagpoints correctly or 15 min lapses, whichever occurred first. If the

participant performed the tagpoint incorrectly, the researcher did not provide a tag or verbal feedback, the participant tried again until he or she performed the tagpoint correctly three times in a row. The researcher provided a tag for each independent tagpoint during the error-correction procedure.

TAGteach with reduced practice condition (TAGteach RP). This condition was identical to the standard TAGteach condition, apart from the error-correction procedure. That is, the researcher introduced the tagger and the tagpoint the same way she did during the standard TAGteach condition. However, the researcher informed the participant that, "If you do not perform the tagpoint correctly, you will not hear this sound and you can try again. During this session, I will ask you to practice each tagpoint *once* before moving on to the next tagpoint. Do you have any questions?"

Control condition. This condition was identical to baseline. These sessions were conducted after every sixth assessment session during the error-correction comparison phase. We included this condition for experimental control, which is demonstrated when two criteria have been met: (a) responding in the control condition remains within the same range observed in the baseline phase (Figure 1) and (b) an increase in responding occurs in at least one test condition relative to responding in the control condition (Figure 2; Wolery et al., 2010). The inclusion of a control condition allowed us to demonstrate that the change in performance in the standard TAGteach and TAGteach with reduced practice conditions was a function of the independent variables and not a confounding variable.

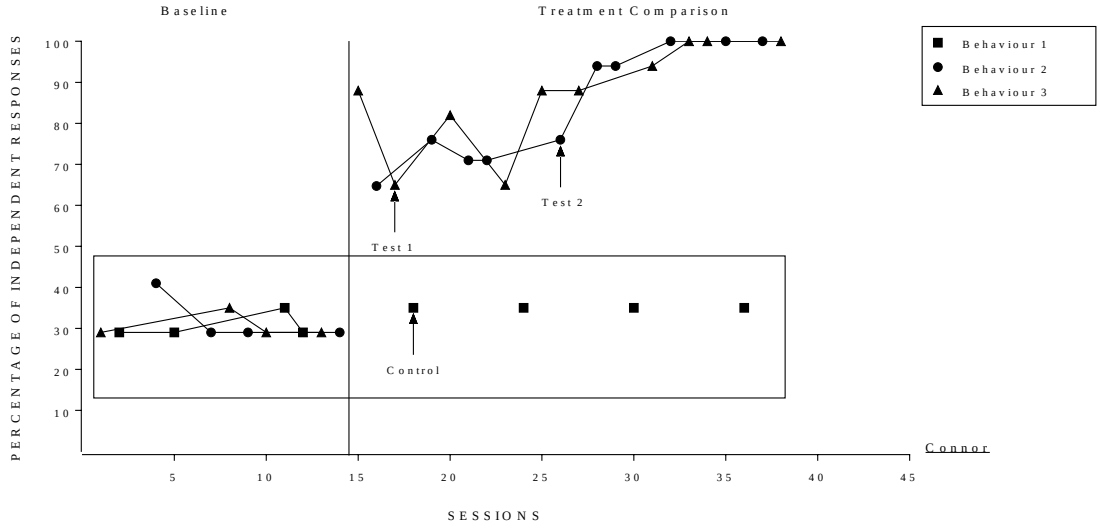

Figure 1. Hypothetical data representing the first criterion (i.e., responding in the control condition remains within the same range observed in the baseline phase) of demonstrating experimental control with an adapted alternating treatments design.

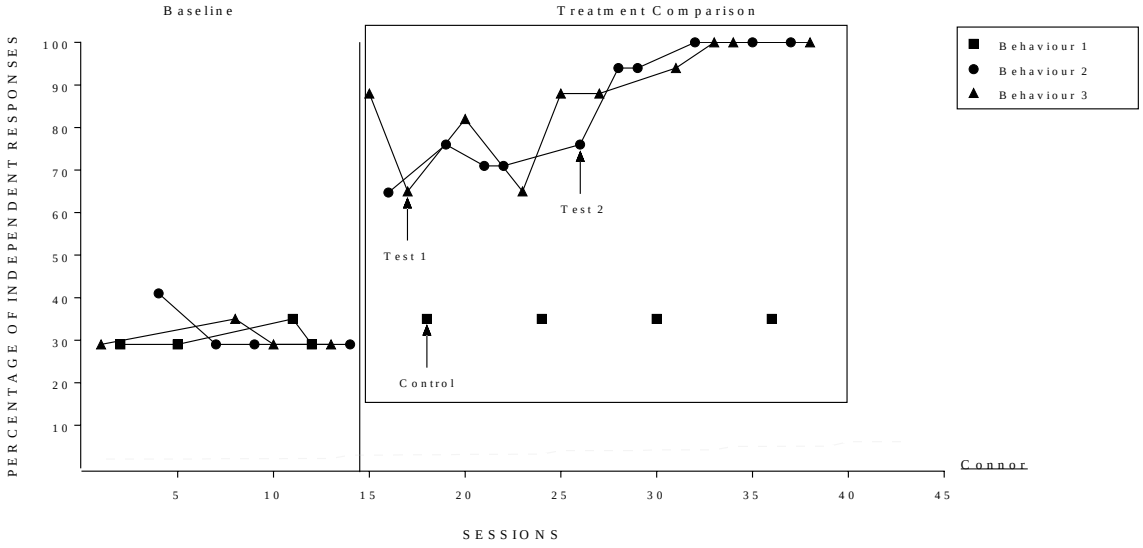

Figure 2. Hypothetical data representing the second criterion (i.e., an increase in responding occurs in at least one test condition relative to responding in the control condition) of demonstrating experimental control with an adapted alternating treatments design.

Follow up Assessment. An assessment session was conducted as a follow up probe one week after the participant met the acquisition criterion for each yoga pose assigned to the experimental conditions. Data from these probes were used to assess the maintenance of performance of each yoga pose over time. Assessment sessions conducted during this probe were identical to those conducted during the baseline and error-correction comparison phases so we could directly compare participant performance across phases (Fogel et al., 2010; Quinn et al., 2015; Persicke et al., 2014).

Social Validity. A social validity questionnaire was administered to each participant within two days of his or her completion of the one-week follow up probe. This questionnaire consisted of two sections, one section with eight open-ended questions and a second section of eight questions on a 6-point rating scale (Appendix G). The purpose of the eight open-ended questions was to determine (a) what each participant liked and disliked about each condition, (b) the participant's overall preference for each error-correction procedure, and (c) the participant's perceived helpfulness of each error-correction procedure on improving performance of the selected yoga poses. The questions rated on a 6-point scale were used to assess the participant's perception of the two error-correction procedures along the following dimensions: (a) improvement of overall yoga skills, (b) helpfulness when learning more-complex yoga poses, (c) improved confidence with the target yoga poses, and (d) preference for which TAGteach procedure if taught yoga in the future using TAGteach.

Face Validity. To measure face validity, the second yoga teacher rated video clips for each pose, one video from baseline and one video after the participant met the acquisition criterion in the error-correction comparison phase. The second yoga teacher watched all videos in a random order and was blind to the phase and condition of the study (i.e., the researcher did

not inform the second yoga teacher if the video clip was taken before or after treatment). The second yoga teacher was asked to rate each participant's experience with the pose, if any mistakes were made, fluidity when performing the pose, and safety when performing the pose (Appendix H).

Statistical Analysis. Consistent with data analysis in single-subject research, we evaluated all data via visual inspection (Parker, Cryer, & Byrns, 2006). We observed a large enough increase in participants' independent responding in the error-correction comparison phase to warrant using visual inspection. However, the differences between error-correction conditions for the efficiency, social validity, and face validity measures were often too small to detect using visual inspection; therefore, we conducted statistical analyses to determine if the differences were statistically significant. First, we tested the efficiency, social validity, and face validity data using the Shapiro-Wilk normality test to determine if data for each of these measures were normally distributed. We conducted a parametric test if the data were normally distributed and a nonparametric test if the data were not normally distributed. All efficiency data were normally distributed; therefore, we performed a unpaired t-test to compare the relative differences between standard TAGteach and TAGteach with reduced practice across our four efficiency measures. The social validity data were not normally distributed; therefore, we performed a Mann-Whitney test to compare participant ratings of the two error-correction procedures. Finally, the face validity data were not normally distributed; therefore, we performed a (a) Wilcoxon test to compare the second yoga teacher's overall ratings of poses in baseline and post-TAGteach and (b) Friedman's test to compare ratings of poses assigned to the control, standard TAGteach, and TAGteach with reduced practice conditions across four measures. We conducted a post hoc analysis of these data using a Mann-Whitney test to compare each of the error-correction

procedures to each other and to the control condition to determine the relative superiority of each error-correction procedure. Statistical significance was set at $p \leq 0.05$ for all tests.

Results

Treatment Evaluation

Edward. Figure 3 depicts the percentage of independent tagpoints Edward performed. During baseline, we observed low to moderate levels of responding across each beginner yoga pose. During the error-correction comparison phase, chair pose was assigned to the standard TAGteach condition, half pigeon pose was assigned to the TAGteach with reduced practice condition, and extended side angle pose was assigned to the control condition. Both error-correction procedures produced an immediate increase in the percentage of independent tagpoints, with a higher initial increase in the standard TAGteach condition. Edward met the acquisition criterion in 10 assessment sessions in both error-correction conditions, indicating that both procedures were effective in promoting independent performance of each target yoga pose. Throughout the error-correction comparison phase, we observed (a) stable responding during the control condition (35% during each assessment session), which was within the level observed in baseline (29% to 35%) and (b) differentiated responding between the control and both error-correction conditions. This indicates that the two error-correction procedures did not influence responding in the control condition or in the other error-correction condition. Independent responding maintained at 100% (17/17 independent tagpoints) at follow up in the standard TAGteach condition and at 94% (16/17 independent tagpoints) in the TAGteach with reduced practice condition, suggesting that both error-correction procedures were roughly equal in terms of maintenance, with standard TAGteach being slightly superior.

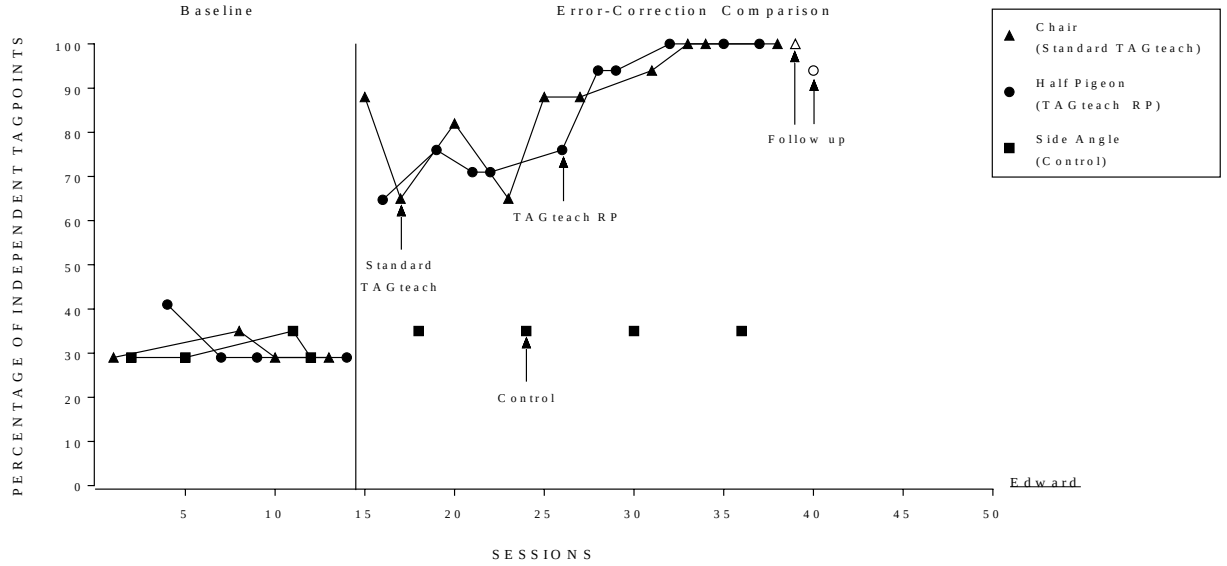

Figure 3. Percentage of independent tagpoints performed by Edward during baseline, error-correction comparison of standard TAGteach and TAGteach with reduced practice, and follow up.

Madeleine. Figure 4 depicts the percentage of independent tagpoints Madeleine performed. During baseline, we observed low to moderate levels of responding across each beginner yoga pose. During the error-correction comparison phase, half pigeon pose was assigned to the standard TAGteach condition, extended side angle pose was assigned to the TAGteach with reduced practice condition, and downward dog pose was assigned to the control condition. Both error-correction procedures produced an immediate increase in the percentage of independent tagpoints, with a slightly higher initial increase in the standard TAGteach condition. Madeleine met the acquisition criterion in nine assessment sessions in the standard TAGteach condition and 11 assessment sessions in the TAGteach with reduced practice condition, indicating that both error-correction procedures were effective in the independent performance of these yoga poses. During the error-correction comparison phase, we observed (a) stable

responding in the control condition (*M* = 43%; range, 41% to 47%), which was within the level observed in baseline, and (b) differentiated responding between the control and both error-correction conditions. This indicates that the two error-correction procedures did not influence responding in the control condition or in the other error-correction condition. Independent responding maintained at 100% (17/17 independent tagpoints) at follow up in the standard TAGteach condition and at 82% (14/17 independent tagpoints) in the TAGteach with reduced practice condition, indicating that standard TAGteach was superior at maintaining independent performance over a one-week period.

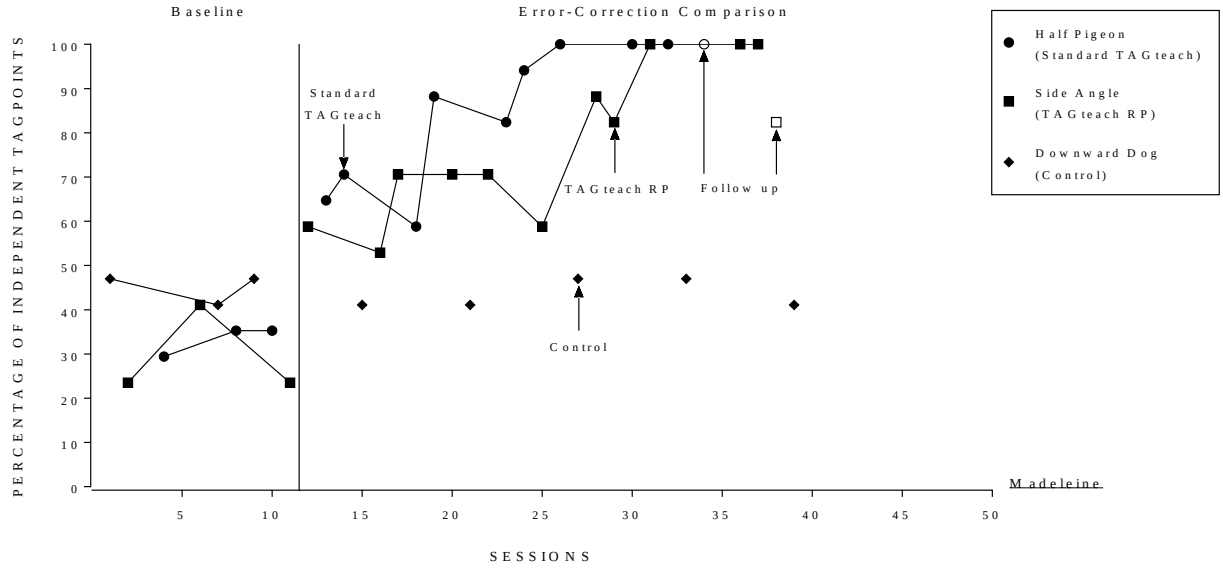

Figure 4. Percentage of independent tagpoints performed by Madeleine during baseline, error-correction comparison of standard TAGteach and TAGteach with reduced practice, and follow up.

Makayla. Figure 5 depicts the percentage of independent tagpoints Makayla performed. During baseline, we observed moderate levels of responding across each beginner yoga pose. During the error-correction comparison phase, extended side angle pose was assigned to the

standard TAGteach condition, chair pose was assigned to the TAGteach with reduced practice condition, and downward dog pose was assigned to the control condition. In the comparison phase, we observed an immediate increase in the percentage of independent tagpoints in the standard TAGteach condition but responding in the TAGteach with reduced practice condition initially remained within the range observed in baseline. After the second TAGteach with reduced practice assessment session, responding steadily increased. Makayla met the acquisition criterion in nine assessment sessions in the standard TAGteach condition and 11 assessment sessions in the TAGteach with reduced practice condition, indicating that both error-correction procedures were effective. Throughout the error-correction comparison phase, we observed (a) stable responding during the control condition (41% during each assessment session), which was within the level of responding observed in baseline and (b) differentiated responding between the control and both error-correction conditions. This indicates that the two error-correction procedures did not influence responding in the control condition or in the other error-correction condition. Independent responding maintained at 100% (17/17 independent tagpoints) at follow up in both error-correction conditions, suggesting that both procedures were equally effective at maintaining performance over a one-week period.

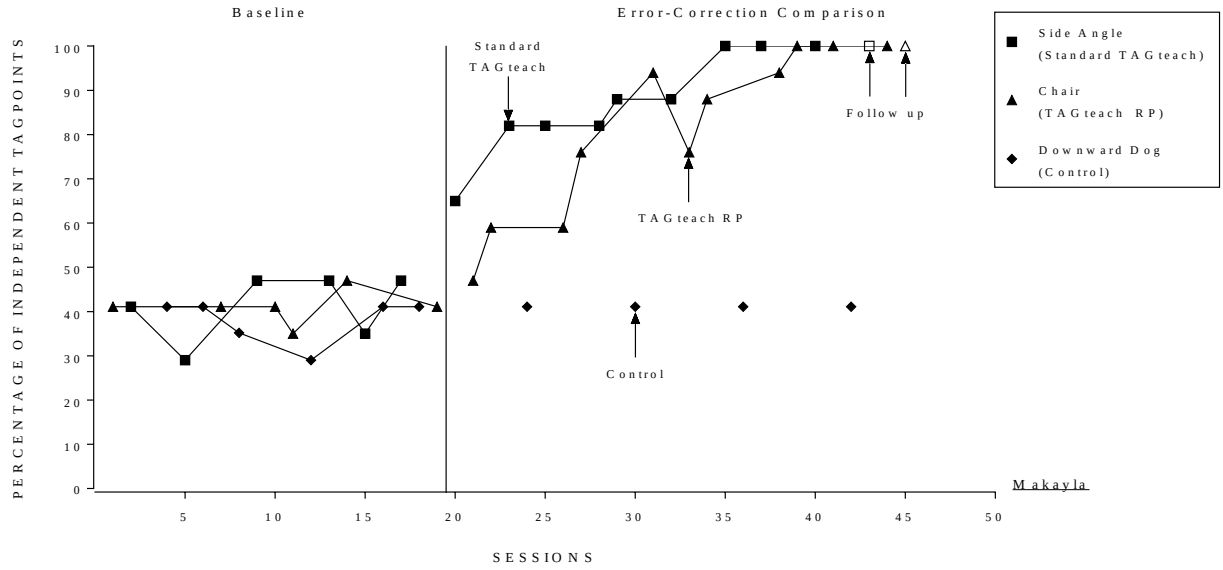

Figure 5. Percentage of independent tagpoints performed by Makayla during baseline, error-correction comparison of standard TAGteach and TAGteach with reduced practice, and follow up.

Nadine. Figure 6 depicts the percentage of independent tagpoints Nadine performed. During baseline, we observed low to moderate levels of responding across each beginner yoga pose. During the error-correction comparison phase, extended side angle pose was assigned to the standard TAGteach condition, half pigeon pose was assigned to the TAGteach with reduced practice condition, and warrior III pose was assigned to the control condition. In the comparison phase, we observed an immediate increase in the percentage of independent tagpoints in the TAGteach with reduced practice condition but responding in the standard TAGteach condition remained within the range observed in baseline. After the second standard TAGteach assessment session, responding steadily increased. Nadine reached the acquisition criterion in eight assessment sessions in the standard TAGteach condition and seven assessment sessions in the TAGteach with reduced practice condition, suggesting that both error-correction procedures

were effective. During the error-correction comparison phase, we observed (a) stable responding during the control condition (41% during each assessment session), which was within the level of responding observed in baseline and (b) differentiated responding between the control and both error-correction conditions. This indicates that the two error-correction procedures did not influence responding in the control condition or in the other error-correction condition. Independent responding maintained at 88% (15/17 independent tagpoints) at follow up in the standard TAGteach condition and at 94% (16/17 independent tagpoints) in the TAGteach with reduced practice condition, suggesting that both error-correction procedures were roughly equal in terms of maintenance, with TAGteach with reduced practice being slightly superior.

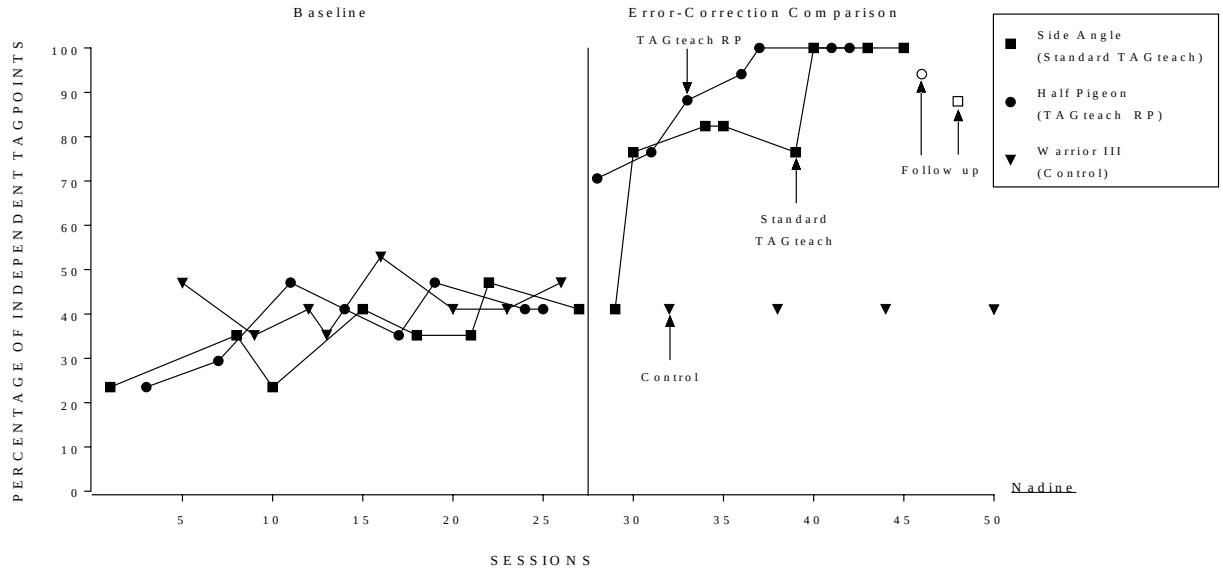

Figure 6. Percentage of independent tagpoints performed by Nadine during baseline, error-correction comparison of standard TAGteach and TAGteach with reduced practice, and follow up.

To assess the relative efficiency of each error-correction procedure, we collected data on four measures: number of TAGteach sessions, total duration of TAGteach sessions, average

duration of TAGteach sessions, and the total percentage of errors. Because we often observed very small differences on several of our efficiency measures, we created the following criterion to allow us to make conclusions regarding the relative efficiency of these procedures: we considered the error-correction procedures to be *roughly equal* when we observed a difference of (a) one or fewer sessions, (b) 1 min or shorter, and (c) 5% or smaller difference between error-correction procedures.

Edward. Efficiency data for Edward are depicted in Table 3. We found both error-correction procedures to be equally efficient for one of the four efficiency measures: the number of TAGteach sessions. Edward reached the acquisition criterion in eight TAGteach sessions in both error-correction conditions. We found that TAGteach with reduced practice was slightly more efficient than standard TAGteach with respect to the total duration of TAGteach sessions. The total duration of TAGteach sessions in the TAGteach with reduced practice condition was 1 min 23 s shorter than in the standard TAGteach condition. We found that both error-correction procedures were roughly equally efficient when considering the average duration of TAGteach session. We observed a 12-s difference in the average duration of TAGteach sessions between error-correction procedures. Finally, we found that the standard TAGteach condition was more efficient than the TAGteach with reduced practice condition with respect to the total percentage of errors obtained in each error-correction procedure. The standard TAGteach condition produced 26.7% fewer errors than the TAGteach with reduced practice condition.

Madeleine. Efficiency data for Madeleine are depicted in Table 3. We found that standard TAGteach was more efficient than TAGteach with reduced practice on three of the four efficiency measures: (a) number of TAGteach sessions, (b) total duration, and (c) percentage of errors. Madeleine reached the acquisition criterion in two fewer TAGteach sessions in the

standard TAGteach condition than in the TAGteach with reduced practice condition. The total duration of TAGteach sessions in the standard TAGteach condition was 2 min 47 s shorter than in TAGteach with reduced practice. In addition, the standard TAGteach condition produced 28.5% fewer errors than the TAGteach with reduced practice condition. Finally, we found the two error-correction procedures to be roughly equally efficient with respect to the average duration of TAGteach sessions. There was only a 1-s difference in the average duration of TAGteach sessions between error-correction procedures.

Makayla. Efficiency data for Makayla are depicted in Table 3. We found that standard TAGteach was more efficient than TAGteach with reduced practice on two of the four efficiency measures: number of TAGteach sessions and percentage of errors. Makayla met the acquisition criterion in two fewer TAGteach sessions in the standard TAGteach condition than the TAGteach with reduced practice condition. In addition, the standard TAGteach condition produced 14.2% fewer errors than the TAGteach with reduced practice condition. We found that TAGteach with reduced practice was more efficient than standard TAGteach with respect to the total duration of TAGteach sessions. The total duration of TAGteach sessions in the TAGteach with reduced practice condition was 2 min 18 s shorter than in the standard TAGteach condition. Finally, we found the two error-correction procedures to be roughly equally efficient with respect to the average duration of TAGteach sessions. There was only a 35-s difference in the average duration of TAGteach sessions between error-correction procedures.

Nadine. Efficiency data for Nadine are depicted in Table 3. We found both error-correction procedures to be roughly equally efficient for two of the four efficiency measures: number of TAGteach sessions and average duration of TAGteach sessions. Nadine met the acquisition criterion within one fewer TAGteach sessions in the TAGteach with reduced practice

condition than in the standard TAGteach condition. In addition, there was only a 9-s difference in the average duration of TAGteach sessions between error-correction procedures. We found that TAGteach with reduced practice was more efficient with respect to the total duration of TAGteach sessions. The total duration of TAGteach sessions in the TAGteach with reduced practice condition was 1 min 23 s shorter than in the standard TAGteach condition. Finally, we found that the standard TAGteach condition was more efficient than the TAGteach with reduced practice condition with respect to the total percentage of errors obtained in each error-correction procedure. The standard TAGteach condition produced 7.8% fewer errors than the TAGteach with reduced practice condition.

Table 3

Summary of Efficiency Data for Edward, Madeleine, Makayla, and Nadine

		TAGteach sessions			
Participant	Condition	No. sessions	Total duration (min:s)	Avg. duration (min:s)	% errors
Edward	Standard TAGteach	8	6:44	0:58 (range, 0:17-1:36)	8.3%
	TAGteach RP	8	5:24	0:46 (range, 0:05-1:30)	35%
Madeleine	Standard TAGteach	7	8:06	1:21 (range, 0:08-4:48)	7.9%
	TAGteach RP	9	10:53	1:22 (range, 0:19-2:19)	36.4%
Makayla	Standard TAGteach	7	7:13	1:12 (range, 0:22-2:59)	4.2%
	TAGteach RP	9	4:55	0:37 (range, 0:06-1:28)	18.4%
Nadine	Standard TAGteach	6	3:56	0:47 (range, 0:27-1:36)	12.2%
	TAGteach RP	5	2:33	0:38 (range, 0:30-0:57)	20%

Due to the inconsistent efficiency data within and across participants, we were unable to conclude which, if either, error-correction procedure was more efficient using visual inspection alone. Therefore, we collapsed all efficiency data for all participants to determine if, on average, one error-correction procedure was more efficient than the other. We defined the two error-correction procedures as roughly equal using the same criteria specified above; namely, a difference of (a) one or fewer sessions, (b) 1 min or shorter, and (c) 5% or smaller difference between error-correction procedures. We found both error-correction procedures to be roughly equally efficient for three of the four efficiency measures: (a) number of TAGteach sessions, (b) total duration, and (c) average duration of TAGteach sessions. On average, we observed a difference of 0.75 TAGteach sessions to meet the acquisition criterion. Also, there was only a

33.5-s difference in the total duration and only a 13.7-s difference in the average duration of TAGteach sessions across participants. Finally, we found that standard TAGteach was more efficient than TAGteach with reduced practice with respect to the total percentage of errors obtained in each error-correction procedure. On average, the standard TAGteach condition produced 19.3% fewer errors than the TAGteach with reduced practice condition.

Because of these small differences, we collapsed data across participants for each efficiency measure and conducted a statistical analysis to determine if the mean differences were significant between the two error-correction procedures. Table 4 summarizes the results of the statistical analysis. The statistical analysis showed that the differences between the means of (a) the number of TAGteach sessions, (b) total duration of TAGteach sessions, and (c) average duration of TAGteach sessions were not statistically significant, suggesting that both error-correction procedures were roughly equally efficient. The statistical analysis also showed that the difference between the means of the percentage of errors was statistically significant, indicating that standard TAGteach was more efficient with respect to this efficiency measure.

Table 4

Summary of Statistical Analysis of Efficiency Data

Efficiency Measure	Standard TAGteach *M (SD)*	TAGteach RP *M (SD)*	Paired t-test	Superior Condition
# TAGteach sessions	7.0 (0.81)	7.75 (1.9)	t (3) = 1, p = 0.391	No statistical difference
Total duration (s)	389.8 (108)	356.3 (211.5)	t (3) = 0.492, p = 0.657	No statistical difference
Average duration (s)	64.5 (15)	50.8 (21.2)	t (3) = 1.81, p = 0.169	No statistical difference

Total errors (%)	8.15 (3.3)	27.5 (9.57)	t (3) = 3.88, p = 0.030	Standard TAGteach

Social Validity Questionnaire

Results from the social validity questionnaire are depicted in Table 5. The social validity questionnaire was divided into two categories. In the first category, all four participants reported liking both standard TAGteach and TAGteach with reduced practice. Edward and Madeleine preferred standard TAGteach and Makayla and Nadine preferred TAGteach with reduced practice. Edward reported that standard TAGteach helped him improve more than TAGteach with reduced practice while Madeleine, Makayla, and Nadine reported that both error-correction procedures helped them improve their performance equally. The second category of the questionnaire consisted of a 6-point rating scale from strongly disagree (1) to strongly agree (6). We found that, on average, participants rated standard TAGteach 0.5 points higher when asked which error-correction procedure helped them improve, 0.25 points higher when asked which error-correction procedure would help them learn more complex yoga poses, and 0.75 points higher when asked which error-correction procedure helped them gain more confidence when performing the yoga poses. Finally, we found that, on average, participants rated standard TAGteach equal to TAGteach with reduced practice when asked which error-correction procedure they were like to be taught with again in the future. Because we observed very small mean differences between the error-correction procedures, we collapsed data across participants for each question on the rating scale and conducted a statistical analysis to determine if the mean differences were significant between the two error-correction procedures (Table 6). The results of this statistical analysis indicate that these differences were not statistically significant,

suggesting that the all participants rated both error-correction procedures roughly equally across these four questions.

Table 5

Summary of Social Validity Questionnaires for Edward, Madeleine, Makayla, and Nadine

Category	Questions	Participant			
		Edward	Madeleine	Makayla	Nadine
Open-ended Questions	Did you like participating in practices where standard TAGteach was used?	Yes	Yes	Yes	Yes
	Did you like participating in practices where TAGteach RP was used?	Yes	Yes	Yes	Yes
	Did you prefer practices with standard TAGteach or TAGteach RP?	Standard TAGteach	Standard TAGteach	TAGteach RP	TAGteach RP
	Do you think standard TAGteach or TAGteach RP, both, or neither helped you improve the skills that you chose to work on?	Standard TAGteach	Both	Both	Both
Rating Scale	My yoga skills are better following (error-correction procedure).				
	Standard TAGteach	5	6	6	4
	TAGteach RP	5	4	5	5
	Learning the skills with (error-correction procedure) will help me move onto more complex yoga poses.				
	Standard TAGteach	6	4	4	4
	TAGteach RP	5	4	4	4
	I am more confident in the yoga poses I learned through (error-correction procedure) than I was at the beginning of the intervention.				
	Standard TAGteach	6	6	6	4
	TAGteach RP	5	4	5	5
	I would like my teacher (or a future teacher) to train me using (error-correction procedure).				
	Standard TAGteach	4	6	5	4
	TAGteach RP	4	4	6	5

Table 6

Summary of Statistical Analysis of Social Validity Data

Rating Scale Item	Standard TAGteach *M (SD)*	TAGteach RP *M (SD)*	Mann-Whitney (*p* value)	Superior Condition
My yoga skills are better following (error-correction procedure).	5.25 (0.96)	4.75 (0.5)	0.6286	No statistical difference
Learning the skills with (error-correction procedure) will help me move onto more complex yoga poses.	4.5 (1)	4.25 (0.5)	> 0.999	No statistical difference
I am more confident in the yoga poses I learned through (error-correction procedure) than I was at the beginning of the intervention.	5.5 (1)	4.75 (0.5)	0.1429	No statistical difference
I would like my teacher (or a future teacher) to train me using (error-correction procedure).	4.75 (0.96)	4.75 (0.96)	> 0.999	No statistical difference

Face Validity Rating Scale

Figure 7 depicts the results of the face validity assessment. For each participant, the second yoga teacher rated two videos for each pose - one video from baseline and one video after the participant met the acquisition criterion in the error-correction comparison phase. The 5-point rating scale ranged from strongly disagree (1) to strongly agree (5) and we averaged these ratings for across measures across all participants. On average, the second yoga teacher rated poses performed in baseline 0.72 points lower than poses performed after receiving TAGteach training, suggesting that both error-correction procedures produced enough change in participant performance to be detected by an outside expert. These findings were corroborated by the results

of the statistical analysis (Table 7), which indicated that the difference in ratings of baseline and post-TAGteach were statistically significant ($p < 0.0001$).

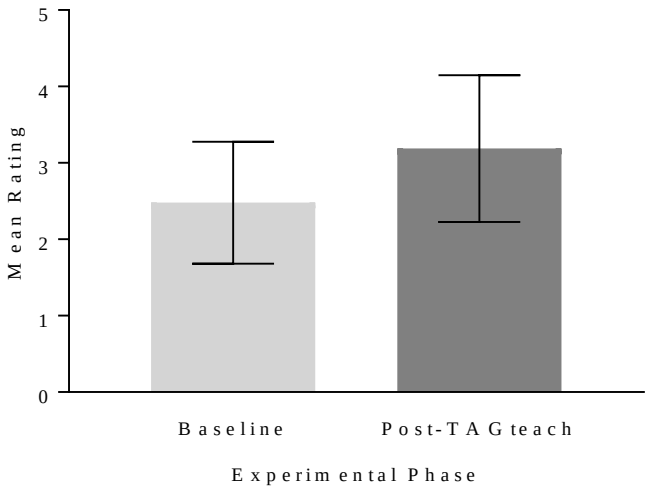

Figure 7. The second yoga teacher's mean rating of participants' baseline and post-TAGteach performance collapsed across experience, mistakes, fluidity, and safety. Light grey bars depict mean ratings of baseline performance and dark grey bars depict mean ratings of post-TAGteach performance. Error bars indicate standard deviation.

Table 7

Summary of Statistical Analysis of Face Validity Pre- and Post-TAGteach Data

Measure	Pre-TAGteach *M (SD)*	Post-TAGteach *M (SD)*	Wilcoxon (*p* value)	Superior Condition
Mean Rating Across Measures	2.47 (0.80)	3.19 (0.96)	< 0.0001	Standard TAGteach

Figure 8 depicts mean post-TAGteach ratings across face validity measures. We found very small differences in the second yoga teacher's ratings of both error-correction procedures. On average, the second yoga teacher rated poses assigned to the standard TAGteach condition

0.8 points higher than poses assigned to the TAGteach with reduced practice condition. We found a larger difference in the second yoga teacher's ratings of these two error-correction procedures when each was compared to the poses assigned to the control condition in which no teaching was provided. That is, relative to the poses assigned to the control condition, the second yoga teacher rated the poses assigned to the standard TAGteach condition 1.5 points higher than those assigned to the control condition, whereas she only rated the poses assigned to the TAGteach with reduced practice condition 0.7 points higher than the poses assigned to the control condition. Although these differences in ratings are small, they may suggest that standard TAGteach may produce a small qualitatively superior performance to TAGteach with reduced practice across these four measures. To further analyze these data, we conducted a Friedman's test to determine if the mean differences between the three conditions were significant for each of the following: (a) participants' experience with the pose, (b) if any mistakes were made, (c) fluidity when performing the pose, and (d) safety when performing the pose. Table 8 depicts the results of the statistical analysis, which indicates that the differences between standard TAGteach, TAGteach with reduced practice, and control were significant for the second yoga teacher's rating of experience, but the difference was not significant for the other three measures. We then conducted a post hoc analysis of the experience ratings using a Mann-Whitney test. The results of this test indicated that standard TAGteach was significantly higher than control, suggesting that participants were rated as having more experience with poses assigned to the standard TAGteach condition relative to control. Taken together, standard TAGteach was rated higher with respect to the participants' experience when performing the poses, but the two error-correction procedures were rated roughly equally for (a) if any mistakes were made when

performing the pose, (b) fluidity when performing the poses, and (c) safety when performing the poses.

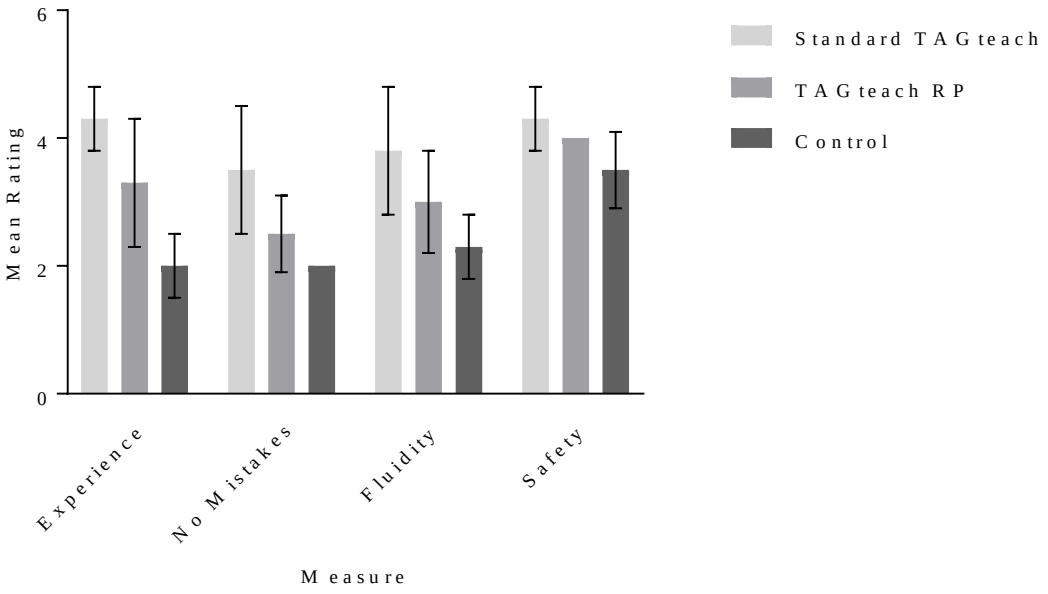

Figure 8. The second yoga teacher's mean ratings collapsed across participants' performance in all conditions after TAGteach training. Light grey bars depict mean ratings of the standard TAGteach condition, medium grey bars depict mean ratings of the TAGteach with reduced practice condition, and dark grey bars depict mean ratings of the control condition. Error bars indicate standard deviation.

Table 8

Summary of Statistical Analysis of Face Validity Rating Scale Data

Measure	Standard TAGteach *M (SD)*	TAGteach RP *M (SD)*	Control *M (SD)*	Friedman (*p* value)	Superior Condition
Experience	3.38 (0.75)*	2. 75 (1.0)	2 (0.5)	0.005	Standard TAGteach
No Mistakes	2.63 (0.63)	2.25 (0.29)	2 (0)	0.111	No statistical difference

Fluidity	2.88 (0.48)	2.75 (0.65)	2.25 (0.5)	0.556	No statistical difference
Safety	3.63 (0.63)	3.88 (0.25)	3.63 (0.48)	0.444	No statistical difference

*Significantly different from control with p value < 0.05

Discussion

We evaluated and established preliminary empirical evidence for one component of TAGteach; namely, the standard error-correction procedure, in which a student practices each error three times, and a modified error-correction, in which a student practices each error once. In addition, we demonstrated that both error-correction procedures were effective for all four participants. However, we could not definitively conclude which error-correction procedure was more efficient because of the inconsistent results across three of the four efficiency measures we assessed. On the first section of our social validity questionnaire, all four participants reported satisfaction with both error-correction procedures, with two participants preferring standard TAGteach and two preferring TAGteach with reduced practice. On the second section of our social validity questionnaire, on average, participants rated the two error-correction procedures roughly equally. A second yoga teacher provided face validity ratings on each participant's pre- and post-TAGteach performance and on average, rated baseline performance lower than post-TAGteach performance for those poses assigned to both error-correction conditions across all measures. Further, the second yoga teacher rated poses significantly higher in the standard TAGteach condition with respect to the participants' experience with the poses, but rated poses roughly equally with respect to the number of mistakes made and the fluidity and safety with which the participants performed the poses.

The inclusion of a control condition during the error-correction comparison phase allowed us to detect multiple threats to internal validity, including practice effects, history

effects, maturation effects, and multi-treatment interference (Wolery et al., 2010). We measured responding in the control condition during baseline and intermittently throughout the error-correction comparison phase. We observed differentiated responding between the control and both error-correction conditions with all four participants, indicating that responding in each condition was not influenced by multi-treatment interference from the two error-correction procedures. We also observed similar levels of responding in the control condition in both phases for all participants. This suggests that the participants' performance was not influenced by (a) the repetitive practice of the poses during the intervention, (b) changes outside of the error-correction conditions, or (c) changes within the participant themselves over the course of this study. It should be noted that for one participant, Edward, there was a slight increase in the level of responding in the control condition in the error-correction phase relative to baseline. However, Edward's performance in the control condition only increased by one tagpoint (i.e., right foot parallel to long side of mat) in the error-correction comparison phase. It is possible that this slight increase in responding is due to response generalization given that Edward received direct training on a different, yet very similar, tagpoint in the standard TAGteach condition (i.e., both feet parallel to long side of the mat). Despite this slight increase in responding in the control condition from baseline to the error-correction comparison phase, Edward's responding during the control condition within the error-correction comparison phase remained stable, demonstrating that the improvement we observed with all four participants was function of the error-correction procedures and not a confounding variable.

This study adds to the existing research evaluating the effectiveness and efficiency of the TAGteach intervention package to teach physical skills. First, we confirmed previous findings (Levy et al., 2016; Quinn et al., 2015) that TAGteach alone is an effective intervention package

to teach physical skills to typically developing adults and children. This is an important contribution to the existing literature because only two studies to date have evaluated the effectiveness of TAGteach alone. Numerous studies evaluating the effectiveness of TAGteach included one or more additional intervention components (Fogel et al., 2010; Persicke et al., 2014). It should be noted that Quinn et al. (2015) found that TAGteach alone was effective for three of four participants; however, an additional component was added for the fourth participant for whom TAGteach alone was not sufficient to improve performance.

Second, our study is the first of its kind to establish preliminary empirical support for an individual component of TAGteach. That is, we validated one component of the TAGteach intervention package – the [standard] error-correction procedure. We found that practicing a tagpoint three times was effective for all participants. We also found that practicing a tagpoint one time was effective for all participants, indicating that students can practice a tagpoint fewer times than is traditionally suggested by TAGteach International. While previous researchers have established effectiveness of TAGteach alone (Levy et al., 2016; Quinn et al., 2015) or in combination with other intervention components (Fogel et al., 2010; Persicke et al., 2016; Quinn et al., 2015), several individual TAGteach components (e.g., specific tagpoint phrasing, using personalized tagpoints, employing the three-try rule) have yet to be validated; therefore, researchers should establish empirical support for each of these individual TAGteach components. In addition, because TAGteach consists of many components, the necessary and sufficient components that contributed to the increase in performance for all participants remain unclear. Although this was outside the scope of our study, researchers may consider conducting a component analysis to identify the necessary and sufficient components involved in TAGteach.

Third, we found several interesting outcomes on the face validity rating scale. The second yoga teacher rated participants' mean performance significantly higher post-TAGteach than in baseline across all four measures: experience, errors, fluidity, and safety. These findings suggest that the improvements obtained in this study were sufficiently robust for an outside expert (the second yoga teacher) to detect. However, even though each participant's performance increased, on average, from 37% in baseline to 100% post-TAGteach, the face validity ratings only increased, on average, from 2.47 to 3.19 on a 5-point scale. This finding may be explained by the fact that we trained participants to perform the targeted yoga poses to 100% accuracy within TAGteach sessions but did not include a measure of fluency in the acquisition criterion. The fluidity with which a participant entered a pose or moved through the task analysis may have impacted the second yoga teacher's rating of their performance. Researchers may consider training future participants to fluency when teaching a physical skill via TAGteach and including a measure of fluency within the acquisition criterion. Perhaps the most interesting finding is that the second yoga teacher rated the participants' performance post-TAGteach higher in the standard TAGteach condition than the TAGteach with reduced practice condition when assessing the participant's experience with the pose and that this difference was statistically significant. One possible explanation for these findings may be that participants received a greater number of tags in the standard TAGteach condition (M = 86.25; range, 66 to 144) than in the TAGteach with reduced practice condition (M = 35.25; range, 12 to 62). Another possible explanation for these findings may be that participants received more practice on tagpoints in the standard TAGteach condition (M = 53.25; range, 15 to 72) than in the TAGteach with reduced practice condition (M = 28.75; range, 12 to 42). It is presently unclear if the greater number of tags, the greater number of times tagpoints were practiced, or a combination of the two produced the

qualitatively superior performance ratings for experience with poses assigned to the standard TAGteach condition. Therefore, researchers should investigate the underlying operant mechanisms of the TAGteach error-correction procedure.

There are four potential noteworthy limitations. First, due to the small sample size included in this study ($N = 4$), we may not have had sufficient statistical power to detect differences between means for our statistical analyses. Researchers may consider replicating this study with a larger number of participants. Second, it was impossible to definitively conclude which error-correction procedure was more efficient because of the inconsistency across three of the four efficiency measures within and across participants. That is, for one (Madeleine) of four participants, we found that standard TAGteach was more efficient across all four measures. However, for the remaining three participants, we found that neither error-correction procedure was consistently more efficient across three of four measures; namely, number of TAGteach sessions, total duration of TAGteach sessions, and average duration of TAGteach sessions. Further, the differences in efficiency between the two error-correction procedures across these three measures were small and not statistically significant, making it difficult to conclude if one error-correction procedure was more efficient than the other.

When considering the relative efficiency of these two error-correction procedures in terms of total percentage of errors, all participants made significantly fewer errors ($p = 0.030$) in the standard TAGteach condition compared to the TAGteach with reduced practice condition. In fact, one possible rationale for the small difference in total and average TAGteach session duration may be due to the smaller number of errors all participants made during the standard TAGteach condition. That is, it may have taken participants roughly the same amount of time to perform a smaller number of incorrect tagpoints three times during the standard TAGteach

condition as it did for participants to perform a greater number of incorrect tagpoints one time. Therefore, when selecting an error-correction procedure to use with students, TAGteachers may consider using standard TAGteach for those physical skills where errors increase the risk of harm to the student. For example, if a student is learning a skill where an error would greatly increase the risk of harm (e.g., a flip on a balance beam), using the standard TAGteach error-correction procedure may reduce the overall risk to the student. Because we found the efficiency results to be unclear, researchers may consider (a) assessing additional efficiency measures (e.g., frequency of repeated errors per tagpoint, total and average duration of time spent practicing each incorrect tagpoint) and (b) developing a pre-assessment to determine which tagpoints increase the risk to the student.

A third potential limitation is that we were unable to determine which, if any, TAGteach error-correction procedure results in fewer injuries because all participants performed poses safely during all sessions. Researchers should assess additional measures of risk and safety (e.g., pain rating scales before and after each session) to evaluate these relative differences among error-correction procedures. It may also be possible that the systematic way we asked participants to enter a pose may have increased the likelihood that they performed the pose safely. Anecdotally, we observed that participants entered poses slowly and systematically by talking themselves through each tagpoint. One possible way that researchers can capture information on the influence of TAGteach on the safe execution of poses, albeit somewhat indirectly, is to collect data during generalization probes in an actual yoga class prior to and following TAGteach.

Fourth, we did not assess generalization of these skills to (a) real-world settings, (b) a large number of diverse participants, or (c) both sides of the body. To assess for generalization of

performance to a real-world setting, researchers can conduct generalization probes in an actual yoga class at the beginning of baseline and intermittently throughout the comparison phase. We only included four typically developing adults in this study, limiting the generalizability of these results to a larger population. Therefore, researchers should evaluate the effectiveness and efficiency of TAGteach (a) with a greater number of participants; (b) in more naturalistic settings; (c) with a more diverse population, including children, older adults, or individuals with intellectual and developmental disabilities; (d) across a wider range of sport-related skills (e.g., tennis, baseball, soccer, hockey, gymnastics); and (e) across a wider range of fluid behaviours that require precision, such as writing, shoe-tying, and playing a musical instrument. Finally, not all poses selected for this study could be performed on both sides of the body (i.e., half pigeon pose, extended side angle pose, and warrior III pose). Researchers evaluating TAGteach may also consider including sport skills that can be performed on both sides of the body (e.g., martial arts, gymnastics, soccer) to assess generalization to the other side of the body.

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Appendix A

Brock University
Research Ethics Office
Tel: 905-688-5550 ext. 3035
Email: reb@brocku.ca

Bioscience Research Ethics Board

Certificate of Ethics Clearance for Human Participant Research

DATE: 8/10/2017

PRINCIPAL INVESTIGATOR: ZONNEVELD, Kimberley - Centre for Applied Disability Studies

FILE: 15-326 - ZONNEVELD

TYPE: Faculty Research STUDENT: Talia Ennett
SUPERVISOR: Kimberley Zonneveld

TITLE: Assessment of the Effectiveness of Teaching with Acoustical Guidance (TAG) for Teaching Yoga Poses to Beginner and Intermediate Yoga Practitioners

ETHICS CLEARANCE GRANTED

Initial Clearance Date: 8/2/2016

Type of Clearance: RENEWAL

Expiry Date: 8/1/2018

The Brock University Bioscience Research Ethics Board has reviewed the above named research proposal and considers the procedures, as described by the applicant, to conform to the University's ethical standards and the Tri-Council Policy Statement.

Renewed certificate valid from **8/10/2017 to 8/1/2018**.

The Tri-Council Policy Statement requires that ongoing research be monitored by, at a minimum, an annual report. Should your project extend beyond the expiry date, you are required to submit a Renewal form before **8/1/2018**. Continued clearance is contingent on timely submission of reports.

To comply with the Tri-Council Policy Statement, you must also submit a final report upon completion of your project. All report forms can be found on the Research Ethics web page at http://www.brocku.ca/research/policies-and-forms/research-forms.

In addition, throughout your research, you must report promptly to the REB:

a) Changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) All adverse and/or unanticipated experiences or events that may have real or potential unfavourable implications for participants;
c) New information that may adversely affect the safety of the participants or the conduct of the study;
d) Any changes in your source of funding or new funding to a previously unfunded project.

We wish you success with your research.

Approved: Sandra Peters

Sandra Peters, Chair
Bioscience Research Ethics Board

Note: Brock University is accountable for the research carried out in its own jurisdiction or under its auspices and may refuse certain research even though the REB has found it ethically acceptable.

If research participants are in the care of a health facility, at a school, or other institution or community organization, it is the responsibility of the Principal Investigator to ensure that the ethical guidelines and clearance of those facilities or institutions are obtained and filed with the REB prior to the initiation of research at that site.

Appendix B

Research Consent for Participants

Project Title: Assessment of the Effectiveness of Teaching with Acoustical Guidance (TAG) for Teaching Yoga Poses to Beginner and Intermediate Yoga Practitioners

Co-Principal Investigators (PI):
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INVITATION
You are invited to participate in a research project that is evaluating the effect of Teaching with Acoustical Guidance (TAG) as a training method to help beginner and intermediate yogis improve their form for various yoga poses.

Teaching with Acoustical Guidance (TAG), which provides an immediate sound (i.e., click) following correct performance of a skill, for helping improve yoga poses. This technique has been shown to be effective for improving physical performance in other sports such as golf[1] and football[2]. The current study will assess whether TAG is helpful in improving your form for various yoga poses. This involves spending some time, up to 1 hour with a researcher, Talia Ennett, who is trained to implement TAG and has her 200-hr Yoga Teacher Training. Three other research assistants, Mahfuz Hassan, Adam Carter, and Anne Wormald, may also be present during your session to help set up the video camera and take data. Before any sessions begin, there will be a discussion as to which poses you would like to improve. During sessions, you will be asked to show these poses to the researcher. You will hear a "click" sound after specific points in the pose that correspond with correct form (e.g., feet perpendicular to floor, back parallel to floor, etc.). When you don't hear a click, sometimes it will mean that you will practice performing the skill correctly three times and sometimes it will mean that you will practice performing the skill correctly once.

In addition, we would like to video record you practicing the target yoga poses. We will ask a second yoga teacher (who did not teach you to perform the target poses) to view these video clips. He/she will then be asked to rate how well you performed the skill. This will help us identify whether yoga teachers who did not participant in delivering the TAG procedure agree that you are performing the skill safely and correctly. This second yoga teacher will be required to sign a confidentiality agreement so that your participation in the study remains anonymous. At the end of the study, we will ask you to answer some questions about what you liked and didn't like about using this teaching strategy, which will take you about 5-10 minutes to complete. The total amount of time spent practicing with the clicker would be 1-5 days/ week for 1-2 months. With your permission, teaching sessions may be run in your home instead of a designated community studio space.

POTENTIAL BENEFITS AND RISKS

As a participant, you may feel some level of physical stress in trying to perform new poses that you have not done before. You may feel some level of negative emotion such as embarrassment, worry, or stress if you do not learn the skill as quickly as you hoped. These potential physical and psychological stressors would be no different than if you attend a regular yoga class in a studio. However, in order to mitigate these potential risks, the researchers will work with you to break complex skills down into smaller steps in an individualized way, using your own wording when deciding on TAGpoints (phrases used to help you remember what to do), and focus on what you are doing correctly instead of what you are doing wrong. Further, you may feel obligated to participate in this research if your yoga studio is advertising the study or your yoga teacher is interested in participating. Participation in this study is voluntary and we would be happy to discuss with you any potential feelings of obligation.

It is expected that TAG may improve your form in the selected yoga poses, which may decrease the likelihood of injuries in the future. Improved performance may also build your confidence in continuing to practice yoga, which may lead to increased health benefits.

CONFIDENTIALITY

Due to the fact that the study sessions may be conducted at your yoga studio, the researchers cannot guarantee that your participation in the study will be completely confidential. The researchers will not discuss your participation with anyone other than the principal investigators and research assistants and will ensure that any windows or doors to the yoga room will be covered during sessions. The additional yoga teachers who will be viewing the video footage of sessions will be asked to sign a confidentiality agreement as well. Data collected during this study will be kept confidential and will be kept in a secure location (i.e., a locked filing cabinet at Brock University and a password-protected computer drive. Your name will be removed from any data collected and instead, a numerical code will be assigned to all of your data. Access to these data will be restricted to the co-investigators and their research assistants (who will have signed confidentiality agreements). You will never be identified in any way if/when the results of this study are published in a peer reviewed journal or presented at a professional conference. If you choose to withdraw from the study, your data will be destroyed immediately unless you choose to still receive the results of the study once it is complete. If you do still wish to receive the study results after withdrawing, the researchers will keep your contact information (e.g. name, phone number, email address) for up to 4 months after the completion of the study, after which time it will be destroyed.

VOLUNTARY PARTICIPATION

Participation in this study is voluntary. You may decline to participate in any component of the study. Further, you may decide to withdraw from this study at any time up to and including your last study session and may do so without any reprisal from Brock University or your yoga studio. If you withdraw from the study, the data collected from the videos of your performance viewed by the blind observer yoga teachers will be omitted from the analysis and deleted immediately.

PUBLICATION OF RESULTS

Results of this study may be published in professional journals and presented at conferences. Feedback about this study will be available from the co-investigators via email (kthomson@brocku.ca; kzonneveld@brocku.ca) within 4 months of the completion of the study.

CONTACT INFORMATION AND ETHICS CLEARANCE

If you have any questions about this study or require further information, please contact Drs. Kendra Thomson or Kimberley Zonneveld using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University #15-326. If you have any comments or -concerns about your rights as a research participant, please contact the Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca.

PARTICIPANT CONSENT

I, _____, agree to participate in the study described above. I have made this decision based on the information I have read in this form and the Invitation Letter. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time.

☐ I have read the consent form and agree to participate in this study.

☐ I would like study sessions to occur in my home.

☐ I would like to receive a summary of the results of the study.

Name: _____ Ph./Email: _____

Signature : _____ Date: _____
(dd/mm/yy)

Appendix C

Research Consent Form- Blind Observers

Project Title: "Assessment of the Effectiveness of Teaching with Acoustical Guidance (TAG) for Teaching Yoga Poses to Beginner and Intermediate Yoga Practitioners."

Co-Principal Investigators (PI):

Dr. Kendra Thomson, BCBA-D, Assistant Professor, Centre for Applied Disability Studies; Ph: (905) 688-5550 x6710; Email: kthomson@brocku.ca

Dr. Kimberley Zonneveld, BCBA-D, Assistant Professor, Centre for Applied Disability Studies; Ph: (905) 688-5550 x6708; Email: kzonneveld@brocku.ca

INVITATION

A local yoga practitioner has indicated an interest in participating in a research project that is evaluating the effect of a validated training strategy, Teaching with Acoustical Guidance (TAG), which provides an immediate sound (i.e., click) following correct performance of a skill, for helping improve yoga poses. This technique has been shown to be effective for improving physical performance in other sports such as golf[1] and football[2]. As a yoga teacher, we are inviting you to participate in the study by rating videos of the participants performing specific yoga poses and scoring them using your professional opinion of the yogis' experience with the pose, fluidity, and safety when performing the pose, and if any mistakes were made. You will not be required to learn the TAG procedure or teach any of the study participants.

WHAT'S INVOLVED

You will be asked to meet with a member of our research team on two separate occasions (once before the study begins and once after the study ends). The entire duration of the study should take approximately 2 months. You are not required to be present when the study participants engage in the TAG practice sessions.

As a participant, you will:

- Meet with a member of the research team to discuss three specific yoga poses. Each of these yoga poses will be broken down into smaller, teachable units in collaboration with the researchers and approved by you as a yoga teacher. This meeting should take about 30 minutes.
- After completion of the study, the researchers will review the blind observer rating scale with you. You will be asked to view a practice video showing one of the researchers performing a yoga pose and you will use the rating scale to score his or her performance. You may view the practice video as many times as you would like until you are comfortable filling out the blind observer rating scale. You will then be asked to view videos of the 2-6 study participants performing the target yoga poses and complete the rating scale for the participant's experience with the pose, fluidity and safety when

performing the pose, and if any mistakes were made. It should take approximately 1 hour to complete.

You may decide at any time whether you wish to withdraw your participation in any part of the study.

POTENTIAL BENEFITS AND RISKS

By participating in this study you may wish to learn more and apply the TAG procedure with your yoga students in the future.

Potential risks of participating may include feeling stressed or worried when viewing and rating the participant videos. The researchers will review the rating scale before you view the videos and answer any questions you may have, which may alleviate any negative feelings you may have. Further, you may feel obligated to participate in this research if your yoga student is interested in participating. We would be happy to discuss with you and your student any potential feelings of obligation.

CONFIDENTIALITY

The researchers will not discuss your participation with anyone other than the co-principal investigators and research assistants. Data collected during this study will be kept confidential and will be kept in a secure location (i.e., a locked filing cabinet at Brock University and a password-protected computer drive). Your name will be removed from any data collected and instead, a numerical code will be assigned to all of your data. Access to these data will be restricted to the co-investigators and their research assistants (who will have signed confidentiality agreements). You will never be identified in any way if/when the results of this study are published in a peer reviewed journal or presented at a professional conference. If you choose to withdraw from the study, your data will be destroyed immediately unless you choose to still receive the results of the study once it is complete. If you do still with to receive the study results after withdrawing, the researchers will keep your contact information (e.g. name, phone number, email address) for up to 4 months after the completion of the study, after which time it will be destroyed.

VOLUNTARY PARTICIPATION

Participation in this study is voluntary. You may decline to participate in any component of the study. Further, you may decide to withdraw from this study at any time up to and including your last study session and may do so without any reprisal from Brock University or your yoga studio in any capacity. If a participant withdraws from the study, the data collected from you watching and rating his/her video will be omitted from the analysis for that participant and deleted. If you withdraw from the study, all data collected from your ratings of participants will be deleted.

PUBLICATION OF RESULTS

Results of this study may be published in professional journals and presented at conferences. Feedback about this study will be available from the co-investigators via email (kthomson@brocku.ca; kzonneveld@brocku.ca) within 4 months of the completion of the study.

CONTACT INFORMATION AND ETHICS CLEARANCE

If you have any questions about this study or require further information, please contact Drs. Kendra Thomson, or Kimberley Zonneveld using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University #15-326. If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca.

Thank you for your assistance in this project. Please keep a copy of this form for your records.

CONSENT

☐ I have read the consent form and agree to participate in this study.

☐ I would like to receive a summary of the results of the study.

Yoga Teacher Name: _____ Ph./Email:_____

Yoga Teacher Signature: _____ Date:_____

(dd/mm/yy)

Witness Name: _____

Witness Signature: _____ Date:_____

(dd/mm/yy)

For research purposes only:

☐ I have reviewed this form in detail with the yoga teacher.

☐ I have provided a copy of this form to the yoga teacher.

Researcher initials: _____

Appendix D

Task Analyses for Five Beginner Yoga Poses.

Step	Chair	Side Angle	Half Pigeon	Warrior III	Downward Dog
1.	Feet hip-distance apart	Right toes forward	Right shin parallel to mat	Right foot flat	Hands 3-4’ from feet
2.	Feet parallel to each other	Right thigh parallel to floor	Right ankle flexed 90	Right toes forward	Hands shoulder-width
3.	Feet flat	Right knee bent over right heel	Hips in line	Right leg straight	Wrists parallel with top of mat
4.	Bend knees	Right knee over mid toes	Left leg straight	All weight on right leg	Fingers spread wide
5.	Knees point over toes	Back foot parallel to mat	Left toes in line with left hip	Leg lifts as torso lowers	Index finger forward
6.	Knees over middle toes	Heel to arch alignment	Top of left foot on floor	Torso parallel to floor	Straight arms
7.	Reach hips down and back	Keep torso open to the left	Hands shoulder-width	Left leg straight	Inner elbows facing
8.	Keep lower back long	Sides of body parallel	Wrists parallel with top of mat	Left ankle flexed	Shoulders down and back
9.	Shoulders down and back	Right forearm on right thigh	Up on fingertips	Left toes pointed down	Broaden across collarbone
10.	Broaden collarbone	Right palm flat and upwards	Fingers spread wide	Hips in line	Draw chest toward thighs
11.	Arms parallel to floor	Eyes and chin upwards	Index finger forward	Shoulders in line	Align ears with upper arms
12.	Reach through fingertips	Neck and head in line w/ spine	Arms straight	Line from heel to fingertips	Line from wrists to tail
13.	Palms facing floor	Left arm straight	Broaden across collarbone	Ribs tucked in	Ribs tucked in
14.	Arms straight	Left bicep above left ear	Shoulders back and down	Arms straight	Reach pelvis up
15.	Hands shoulder-width	Left fingers forward	Gaze straight ahead	Hands shoulder-width	Straight legs
16.	Gaze forward	Left palm flat facing down	Chin level with floor	Palms facing each other	Heels pressed towards floor
17.	Chin tucked	Line from left foot to fingers	Ears over shoulders	Gaze forward on floor	Feet hip-distance apart

Appendix E

Sample assessment and TAGteach session data sheet.

Participant ID:_____ Phase: BSL/ Treatment Session Type: Probe/Teaching Session #:_____
Primary / Reli:_____ Condition: CONTROL / TAG / TAG + RP Date:_____

Pose: Chair Pose

Description	Participant Tag points	#1		#2		#3		#4		#5		#6		#7		#8		#9	
		P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T
1. Stand w/ feet together/hip-distance																			
2. Feet parallel to each other																			
3. All three corners of feed on ground																			
4. Bend knees/squat down																			
5. Make sure the knees point forward over toes, not past																			
6. Knees over middle toes																			
7. Reach hips down and back																			
8. Keep lower back long																			
9. Draw shoulder blades into upper back ribs																			
10. Broaden through the collarbone																			
11. Raise arms above your head/arms lifted parallel to floor																			
12. Reach out through the fingertips/extend arms forward at shoulder height																			
13. Palms facing each other (if arms above head)/palms facing floor (if arms ahead)																			
14. Arms straight																			
15. Hands shoulder-width apart																			
16. Gaze forward/gaze at point between hands																			
17. Chin tucked																			

Participant ID:_____ Phase: BSL/ Treatment Session Type: Probe/Teaching Session #:_____
Primary / Reli:_____ Condition: CONTROL / TAG / TAG + RP Date:_____

Pose: Downward Dog

Description	Participant Tag points	#1		#2		#3		#4		#5		#6		#7		#8		#9	
		P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T
1. Hands 3-4' away from feet on mat																			
2. Hands shoulder-width apart																			
3. Fold of wrists parallel w/ top of mat																			
4. Fingers spread wide																			
5. Index finger pointing forward																			
6. Straight arms																			
7. Crease of elbow facing each other																			
8. Draw your shoulder blades into upper back ribs (neutral)																			
9. Broaden across collarbone																			
10. Draw chest toward thighs as press may away																			
11. Align ears with upper arms																			
12. Line from wrists to tailbone																			
13. Knit ribs together																			
14. Reach pelvis up towards ceiling																			
15. Straight legs/knees slightly bent																			
16. Heels pressed towards floor																			
17. Feet hip-distance apart																			

Participant ID:_____ Phase: BSL/ Treatment Session Type: Probe/Teaching Session #:_____
Primary / Reli:_____ Condition: CONTROL / TAG / TAG + RP Date:_____

Pose: Half Pigeon

Description *bolster or block is fine	Participant Tag points	#1		#2		#3		#4		#5		#6		#7		#8		#9	
		P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T
1. Right leg parallel to top of mat																			
2. Right ankle flexed 90 degrees																			
3. Hips in line with each other on floor																			
4. Left leg straight behind on mat																			
5. Left foot/toes in line with left hip																			
6. Top of left foot on floor																			
7. Hands shoulder-width apart																			
8. Folds of wrists parallel with top of mat																			
9. Palms flat/on tips of fingers																			
10. Fingers spread wide																			
11. Index finger pointing forward																			
12. Arms straight																			
13. Broaden across collarbone																			
14. Draw shoulder blades into back ribs																			
15. Gaze straight ahead																			
16. Chin level with floor																			
17. Ears over shoulder knobs																			

Participant ID:_____ Phase: BSL/ Treatment Session Type: Probe/Teaching Session #:_____
Primary / Reli:_____ Condition: CONTROL / TAG / TAG + RP Date:_____

Pose: Warrior III

Description	Tag point	Participant Tag points	#1		#2		#3		#4		#5		#6		#7		#8		#9	
			P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T
1. Three corners of right foot flat on mat	"feet flat on floor"																			
2. Right toes pointed forward	"right toes forward"																			
3. Right leg straight	"right leg straight"																			
4. Shift weight into right foot	"weight on right foot"																			
5. Lift left leg as you lower torso	"leg lifts as torso lowers"																			
6. Torso parallel to floor	"torso parallel to floor"																			
7. Left leg straight	"left let straight"																			
8. Left ankle flexed 90 degrees	"left ankle 90 degrees"																			
9. Left toes pointed downwards	"point left toes to floor"																			
10. Hips in line with each other	"hips level"																			
11. Shoulders in line with each other	"shoulders level"																			
12. Line from left heel to hips to shoulders to hands	"line from hands to heel"																			
13. Ribs tucked	"ribs tucked"																			
14. Arms straight	"arms straight"																			
15. Arms shoulder-width apart	"arms shoulder-width apart"																			
16. Palms facing each other	"palms face each other"																			
17. Gaze slightly forward on floor	"gaze forward on floor"																			

Participant ID:_____ Phase: BSL/ Treatment Session Type: Probe/Teaching Session #:_____
Primary / Reli:_____ Condition: CONTROL / TAG / TAG + RP Date:_____

Pose: Side Angle

Description	Tag point	Participant Tag points	#1		#2		#3		#4		#5		#6		#7		#8		#9	
			P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T
1. Right foot turned out 90 degrees/toes pointing towards front of the mat	"Right foot 90 degrees"																			
2. Bend right knee until right thigh parallel to floor (side view)	"Right thigh parallel"																			
3. Legs far enough apart that right knee bent over right heel (side view)	"Right knee over heel"																			
4. Right knee over middle toes (front view)	"Knee over middle toes"																			
5. Back foot rotated slightly inward or parallel to back of mat	"Back foot parallel"																			
6. Align heel of right foot w/ arch of left/making a T with right and left feet	"Heel to arch"																			
7. Keep torso open to the left	"Body open to left"																			
8. Keep chest, hips, and legs in line	"Shoulders and hips in line"																			
9. Right forearm/elbow placed on right thigh/knee	"Right forearm on thigh"																			
10. Right palm flat and facing upwards/whole hand facing the ceiling	"Right palm up"																			
11. Gaze up towards the ceiling including eyes, nose, chin pointing upwards	"Gaze to ceiling"																			
12. Neck and head in line w/ spine/draw a line where the spine would be out through the crown (top) of the head	"Neck in line"																			
13. Left arm extended straight but not hyperextended	"Arm straight"																			
14. Left bicep above left ear	"Arm over ear"																			
15. Left fingers pointing in same direction as front toes (check front view)	"Fingers to front"																			
16. Left palm flat (can have slight curve) and facing downwards	"Left palm down"																			
17. One diagonal line from outside of left foot to left fingers	"Diagonal line"																			

Appendix F

Participant ID:_____ Phase: Treatment Session Type: Teaching Session #:_____
Primary / Reli:_____ Condition: CONTROL / standard TAGteach / TAGteach RP Date:_____

Pose: _____

Target Tagpoint	Participant Behaviour	Researcher Behaviours																
	Independent Tagpoint?	Correct provision of tagpoint phrase?			Correct feedback on independent tagpoints?			Correct feedback on errors?			Correct progression to subsequent tagpoints?			Correct termination of session?			
1	Y N	Y	N	N/A							Y	N	N/A				
2	Y N	Y	N	N/A							Y	N	N/A				
3	Y N	Y	N	N/A							Y	N	N/A				
4	Y N	Y	N	N/A							Y	N	N/A				
5	Y N	Y	N	N/A							Y	N	N/A				
6	Y N	Y	N	N/A							Y	N	N/A				
7	Y N	Y	N	N/A							Y	N	N/A				
8	Y N	Y	N	N/A							Y	N	N/A				
9	Y N	Y	N	N/A							Y	N	N/A				
10	Y N	Y	N	N/A							Y	N	N/A				
11	Y N	Y	N	N/A							Y	N	N/A				
12	Y N	Y	N	N/A							Y	N	N/A				
13	Y N	Y	N	N/A							Y	N	N/A				
14	Y N	Y	N	N/A							Y	N	N/A				
15	Y N	Y	N	N/A							Y	N	N/A				
16	Y N	Y	N	N/A							Y	N	N/A				
17	Y N	Y	N	N/A							Y	N	N/A	Y	N		

steps performed correctly =

Total # steps =

Appendix G

Post-Intervention Social Validity Questionnaire

(Yoga Practitioners)

Did you like participating in practices where standard TAGteach (3x) was used?

Did you like participating in practices where TAGteach with reduced practice (1x) was used?

Did you prefer practices with standard TAGteach (3x) or TAGteach with reduced practice (1x)? Why?

What, if anything, did you like about standard TAGteach (3x)?

What, if anything, did you dislike about standard TAGteach (3x)?

What, if anything, did you like about TAGteach with reduced practice (1x)?

What, if anything, did you dislike about TAGteach with reduced practice (1x)?

Do you think standard TAGteach (3x) or TAGteach with reduced practice (1x), both, or neither helped you improve the skills that you chose to work on? Why or why not?

Please complete the following to the best of your ability. Check the box that applies most for you.

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
My yoga skills are better following standard TAGteach (3x)						
My yoga skills are better following the TAGteach with reduced practice (1x)						
Learning the skills with standard TAGteach (3x) will help me move onto more complex yoga poses						
Learning the skills with TAGteach with reduced practice (1x) will help me move onto more complex yoga poses						
I am more confident in the yoga poses I learned through standard TAGteach (3x) than I was at the beginning						
I am more confident in the yoga poses I learned through TAGteach with reduced practice (1x) than I was at the beginning						
I would like my teacher (or a future teacher) to train me using standard TAGteach (3x)						
I would like my teacher (or my future teacher) to train me using TAGteach with reduced practice (1x)						

Appendix H

Blind Observer Rating Scale

Observer name: _____ Participant number: _____

Video number: _____

RATING	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The participant performs (target yoga pose) as an experienced practitioner would.	1	2	3	4	5
The participant performs (target yoga pose) without making any mistakes.	1	2	3	4	5
The participant moves fluidly when performing (target yoga pose).	1	2	3	4	5
The participant performed the (target yoga pose) safely.	1	2	3	4	5

Note: From "Evaluating the effectiveness of TAGteach for teaching yoga postures to novice yoga practitioners," by J. S. Andrews, 2014, *Graduate Theses and Dissertations,* Retrieved from http://scholarcommons.usf/etd/5171. Copyright 2014 by Jessica S. Andrews. Adapted with permission.