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Stop-Signal Reaction Time Correlates with a Compensatory Balance Response in Older Adults

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STOP-SIGNAL REACTION TIME CORRELATES WITH A COMPENSATORY BALANCE RESPONSE IN OLDER ADULTS

by

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ABSTRACT

Response inhibition involves stopping undesired and automatic actions allowing for behavioral flexibility. This ability is theoretically able to contribute to fall prevention, which older adults are known to have difficulty with. Although much has been learned from cognitive psychology regarding response inhibition**,** translation to the challenge of balance recovery is unclear. Recently a correlation has been found between performance on a standard test of response inhibition called the Stop Signal Task (SST) and a balance test that required inhibition of a reactive step in young adults. This highlights a neural mechanism for stopping action across different behavioral contexts in young adults. The present study was conducted to determine if this relationship was similarly evident in older adults. A group of 19 older adults (50-85 years) performed the SST and reactive balance test separately. The SST evaluates an individual's ability to suppress a visually-cued button press upon hearing a "Stop" tone, and measures the response inhibition speed called the Stop Signal Reaction Time (SSRT). Reactive balance was tested by releasing participants from a supported lean position, where the environment was changed during visual occlusion. Upon receiving vision, participants were required to step to regain balance, or suppress a step when obstacles were present. The stepping muscle responses between the "step" and "no step" trials were compared to quantify step suppression. Results indicated that SSRT was correlated with muscle activation in the stance leg. More specifically, individuals with faster SSRTs were also better at inhibiting leg muscle activation on no step trials. Present results suggest the ability to inhibit finger responses in a seated cognitive test reflects an individual's capacity for response inhibition, which is preserved in a whole-body, balance recovery task. Potentially, response inhibition via the SST could identify a risk factor leading to falls and have clinical application.

INTRODUCTION

In daily life, common actions are accomplished using well practiced skills and basic reflexes. However, there are times when our unpredictable environment requires behavioral flexibility to revise automatic and reflexive actions and make them more suitable to the environmental demands. This behavioral flexibility relies on higher brain processes (Cohen, Nutt, & Horak, 2011). A key process the brain uses that allows for behavioral flexibility is called response inhibition. Response inhibition refers to the ability to suppress no-longer required or inappropriate actions (Verbruggen & Logan, 2008). Inhibitory control is a well-established focus in cognitive psychology, however, recently there has been speculation about it playing an important role in fall prevention (Liu-Ambrose, Nagamatsu, Hsu, & Bolandzadeh, 2013). For example, a passenger on a bus that comes to a sudden stop must respond quickly and appropriately to the environment to avoid a fall. If the bus was not crowded, the individual would likely react by changing their base of support by taking a step for balance recovery. However, if the bus is crowded, such as with baggage or other individuals in front of the person, a step would not be appropriate and would need to be suppressed to initiate a more appropriate action such as grasping a support handle.

Research has provided evidence of a link between cognitive function and balance control. For example, a correlation has been shown between cognitive decline and rate of falls in older adults (Mirelman et al., 2012; Schoene, Delbaere, & Lord, 2017). While this correlation is reputable, little known about the underlying mechanisms of cognitive ability determining falls (Bolton, 2015). Some studies have tried to find the cause and have shown more specifically that executive function tasks requiring response inhibition are correlated with falls (van der Wardt, 2015; Saverino, 2016) suggesting that response inhibition has an important role in balance control.

A possible reason for why we may fail to appreciate how response inhibition could influence resistance to falls is the types of study designs normally used to test balance control (Dakin & Bolton, 2018). Normal designs usually involve an unobstructed setting or a simple step neither of which require a need for response inhibition. In an attempt to overcome this limitation a recent study used a reactive balance task that specifically forces the need for response inhibition to avoid kicking a leg block and thus leading to a fall (Rydalch, Bell, Ruddy, Bolton, in review)[2]. The results found that healthy young adults' performance on a standard test of response inhibition (Stop-Signal Task, SST) was correlated with performance on a balance test where a recovery step needs to be inhibited. This suggests a fundamental capacity for response inhibition that is preserved within a given person, and that can be expressed both through a seated cognitive test using simple finger responses and a postural recovery task.

The present study builds upon this prior study to explore the connection in older adults. Given that older adults have specific deficits in inhibitory control (Seidler, 2010), we aimed to determine if the generalizable nature of response inhibition across different tasks was similarly evident in healthy older adults. Our prediction was that older adults would reveal deficits in response inhibition relative to the young adult's data from Rydalch et al. in both the cognitive and balance tests; however, we further predicted that performance on these tasks would be correlated. This would extend from recent findings in young adults to healthy older adults

[2] Rydalch, G., Bell, H., Ruddy, K., & Bolton, D. A. E. (In Review) Stop-signal reaction time correlates with a compensatory balance response.

regarding how a measure derived from seated participants reacting with focal finger movements generalizes to performance on a whole-body, balance recovery task.

METHOD

Participants

Nineteen, healthy, older adults, (50-85 years) provided written informed consent prior to participation in this study. The average age was 69 years (*SD* = 7.732) with seven of the participants being male and twelve being female. Participants were excluded if they have had a lower body injury within a one-year period, have a known neuromuscular disease, or a known cognitive disorder. Procedures were approved by the Utah State University, Institutional Review Board conducted in accordance with the Declaration of Helsinki.

Research Design

Participants visited the lab on two separate occasions with at least a 48-hour period in-between. During the first visit the participants filled out descriptive paperwork and participated in a familiarization period with the tasks they would perform during the next visit. During the second visit participants performed a SST while seated at a computer followed by a reactive balance test.

Electromyography

Electromyography (EMG) was recorded using Delsys DE-2.1 differential surface electrodes, and EMG signals were amplified (gain = 1000) using a Delsys Bagnoli-4 amplifier (Delsys Inc., Boston, MA, USA). EMG data was sampled at 5000Hz and band pass filtered (10-500Hz) using Signal Software and a Cambridge Electronic Device (Power 1404, Cambridge Electronic Design, Cambridge, UK). EMG was collected from the Tibialis Anterior (TA) on both the right (TA_R) and left (TA_L) legs to measure muscle activity in the stepping leg. Participants were free to step with either leg during testing. To identify stepping characteristics such as lift off and touch down, footswitches (B&L Engineering, Santa Ana, California) were placed in the soles of participants shoes. An experimenter also recorded which leg was used for stepping in each trial.

Procedures

Stop Signal Task (SST). The participants were trained on the SST until they were comfortable with the task. The SST used a customized MATLAB program (The MathWorks Inc., Natick, MA) adapted from the version used in Aron & Poldrack (2006). This was completed while participants were seated at a desk facing a computer. The participants were presented with verbal and visual instructions on the monitor prior to training and testing. Participants were instructed that going quickly and stopping successfully were both equally important. The SST measures an individual’s capacity for stopping a response after the stop signal is presented. Participants were asked to press specific keys on a keyboard in response to left- or right-pointing arrows that appear on the screen. Specifically, participants pressed “>” if the arrow points to the right, and “<” if the arrow points to the left. They were to do this as quickly as possible once the arrow appears. The maximum time allotted to press a key after the “Go” stimulus was presented is 500 milliseconds. If a key is not pressed within 500 milliseconds a new trial began. Randomly throughout the trials an auditory beep would happen shortly following the appearance of the arrow. This sound is the inhibition signal and the participants were to not press the key if the sound is heard. The auditory signal was not present on all trials; it occurred in about 25% of the trials. Figure 1 shows a visual representation of the SST. The delay between the go and stop signals is referred to as the stop-signal delay. The stop-signal delay was set at 250ms, and was adjusted in 50ms increments depending on the participant's performance. If the participant successfully stopped, the delay increased, if the participant failed to stop, the delay was decreased. The idea is that inhibition is more difficult when the inhibitory stimulus is presented after a longer time interval than a shorter one (i.e. closer to movement onset). This approach to the stop-signal delay was to achieve a probability of successful stopping on about 50% of trials. The data collected from this test provides a Stop Signal Reaction Time (SSRT) variable. SSRT is a measure of the speed of stopping, assessing how abruptly someone can stop relative to their own reaction time. Participants performed 256 trials divided across 4 blocks with rest as needed between blocks.

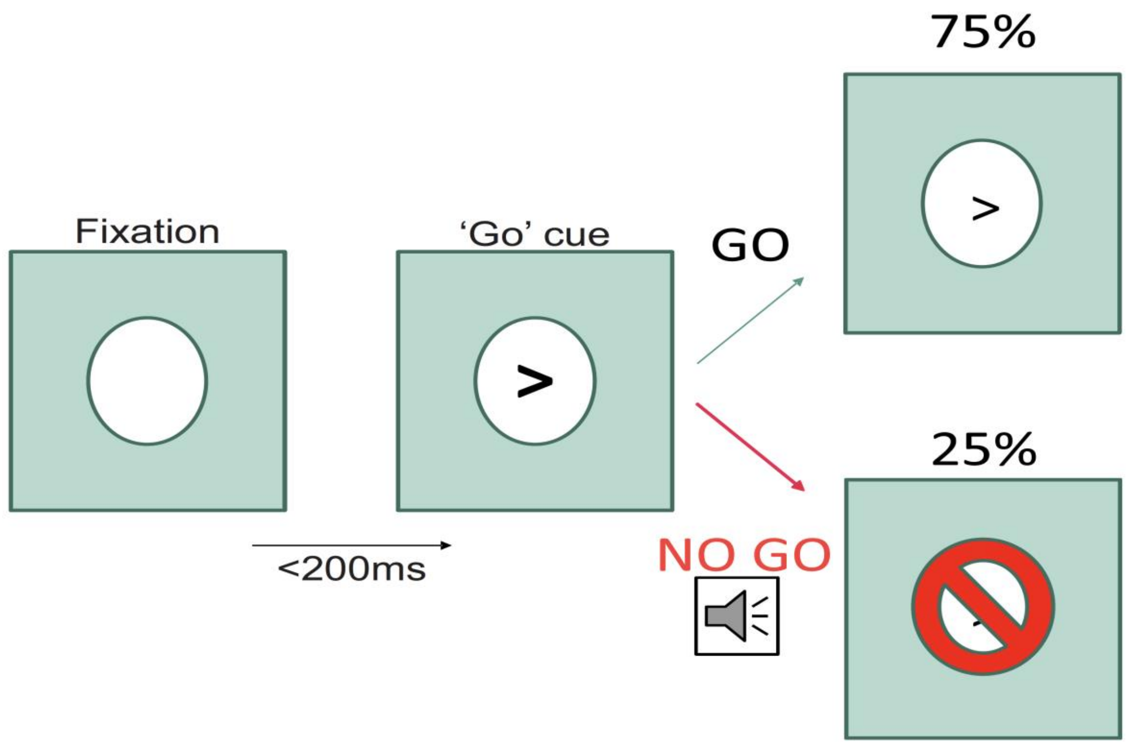

Figure 1. Stop Signal Task Visualization. A representation of what the participant will see on screen along with the possible options that will be presented. The "Go" cue will signify which key will need to be pressed. After the "Go" cue there is a possibility that there will be an auditory signal which will inform the participant to not press any key.

Reactive Balance Testing. A custom-made “lean and release” cable system (Figure 2A) was used to impose unpredictable forward perturbations. The lean and release device has been successfully used in healthy adult populations as well as in clinical populations to assess reactive balance (Lakhani, Mansfield, Inness, & McIlroy, 2011; Mansfield et al., 2011). While some aspects of the perturbation were predictable, such as the direction and amplitude of perturbation, the exact onset of the cable release was unpredictable. Participants were placed in a harness that is connected by a cable to the wall behind them. Here, they leaned forward in a standing position to start each trial. During each trial a leg block was moved, or not moved, randomly in front of the participant’s feet. If the block was placed in front of the participant’s legs when they were released from the wall, they were prevented from taking a forward step and were forced to grab a wall-mounted safety handrail that was uncovered when the block is present. When the leg block wasn’t present, the participants took a forward step to recover balance after the cable release. The participants wore special liquid crystal goggles (Translucent Technologies Inc. Toronto, ON, Canada) that occluded vision prior to the start of each trial to ensure they do not know what environment will be presented to them until the goggles open. An additional failsafe cable was attached from the ceiling to the harness that would catch the person in the event of a fall. Participants were told to remain relaxed and to look at a fixation point on the ground about a meter in front of them. The fixation point was adjusted per individual to ensure that the top of the leg block and the handrail were visible in their peripheral vision when the goggles were opened.

Participants were released shortly after the goggles opened either 200 milliseconds, 400 milliseconds, or 600 milliseconds later to avoid predictability of perturbation onset. Also, for a small portion of the trials (four trials per block) no perturbation happened to act as a “catch” trial in an effort to make sure participants were only acting in response to a perturbation. After, a familiarization period, testing involved 3 blocks of 28 trials each with a brief rest as long as needed between blocks. For 70% of the trials the handrail was covered and a step response was required. For 30% of the trials the leg block was present and the handrail was uncovered, requiring a compensatory reach-to-grasp without taking a forward step. The ratio of 70:30 was to create a bias in automated stepping responses, to force the participants to suppress a prepotent response when they could not step. Figure 2B depicts this protocol. The present study investigated the link between compensatory stepping reactions and stopping ability, thus it was important to create a bias in the stepping reaction, similar to the way that a rapid button pressing reaction is promoted in the stop signal task.

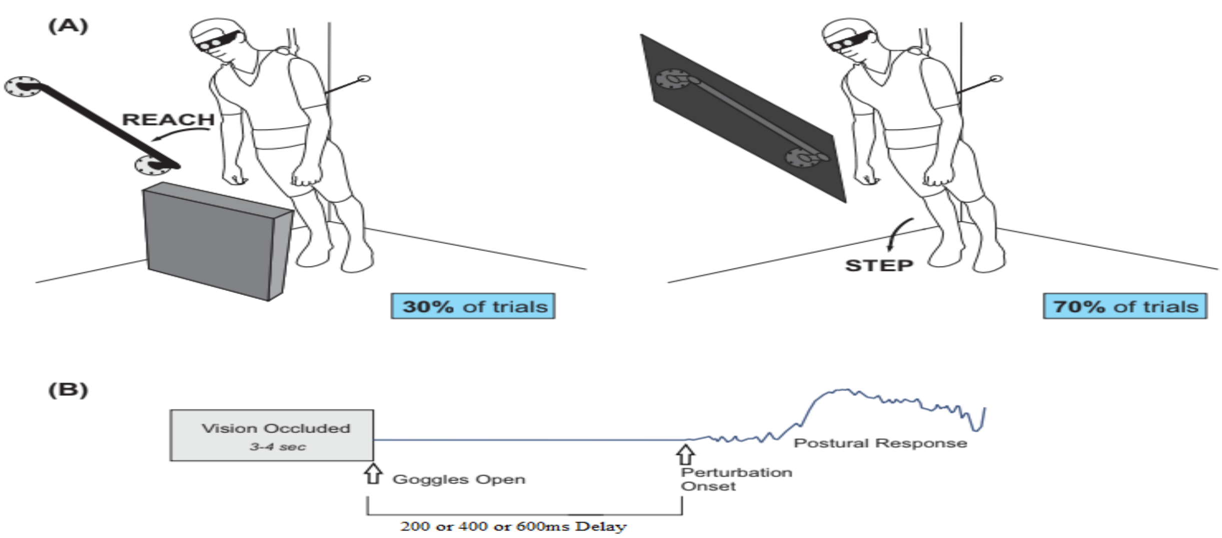

Figure 2. *Custom-made "lean and release" system*. A) Participants were suspended in a leaning position next to a wall mounted safety handle within reach of the right arm. Visual access was controlled through liquid crystal goggles and the environment was randomly altered while the goggles were closed. When the goggles opened, participants see either the leg block present and the handrail available to grab or the handrail is covered and no leg block allowing for a step reaction. 70% of trials were steps with 30% of trials being a reach creating a biased response. B) A visual timeline of visual access relative to perturbation onset and muscle response.

Analysis

EMG signals from the TA_R and TA_L muscles were band-pass filtered (10-500Hz) and full-wave rectified. The magnitude of the EMG response was assessed as the integrated EMG (iEMG) for the period following perturbation onset to action (Lift off of foot or handle grasped). This time frame was selected to capture the early muscle response of the stepping leg. This specific window was based upon the average onset activity in all participants and the average liftoff onset activity in all participants. Visual inspection of the group average TA waveforms in the step leg revealed that the bulk of the TA activity was captured within this timeframe. The rationale for focusing on the earliest stepping EMG activity in the stepping leg was to capture the early motor activity that would be most susceptible to errors in response inhibition under time pressure. The goal was to imitate the type of rapid response errors captured by the SST using a button press on a keyboard.

Trials where an anticipatory muscle response occurred prior to postural perturbation were identified and eliminated from further analysis. Two discrete time windows of EMG activity were measured, one immediately before the goggles opened and another after the goggles opened, but immediately before perturbation. Both windows took the average rectified EMG for a period of 100ms. If EMG activity in the second time window exceeded the mean of EMG activity in the first time window by more than three standard deviations, the trial was removed from the analysis. This allowed exclusion of trials where participants may have prematurely responded before the actual magnet release.

For the reactive balance test, the iEMG was assessed for each trial, and grouped according to condition (step or reach). The purpose was to use whichever action was afforded (step forward or reach for the handle) to group the EMG activity of the stepping leg, not necessarily the response that actually transpired. Trials where a participant accidently failed to suppress a step were still classified as "reach" trials. By doing so, the muscle response from the step leg could be compared between trials where the participant should reach versus trials where they should step. A ratio was calculated by dividing iEMG of the reach condition by the iEMG of the step condition to accomplish this. The assumption is that the closer the ratio value is to one, the more difficult suppressing the normal step response is. As the ratio becomes smaller this would indicate a greater ability to refrain from stepping, while the participant grasps the handrail instead. The magnitude of muscle activation created a sensitive measure of the tendency to respond with the leg either appropriately or inappropriately given the context.

Primary outcome measures were (a) muscle response ratio (iEMG Reach/Step trials), and (b) the SSRT. To address our main research question, a 1-tailed bivariate Pearson Correlation determined if SSRT was correlated with muscle response ratio during conditions where a compensatory forward step should be inhibited. This was done for the stepping leg and stance leg using separate tests. A standard 5% significance level was used throughout.

RESULTS

Lean and Release

From the original nineteen participants, only fifteen of the nineteen participants were able to provide usable data for the lean and release (i.e. reactive balance) test. Of the four participants that were excluded, two of them were unable to complete the actual test due to (a) lower body pain, or (b) an inability to understand task instructions. Excessive noise in the EMG signal from the other two participants resulted in removal of their data from further group analysis. From the remaining fifteen participants, average onset EMG of the stepping and stance leg was 195ms

(SEM (Standard error of the Mean): 16) and 196ms (SEM: 21) respectively. The average timing for foot lift off (measured via footswitches) and onset for the handle being grasped (measured via force sensitive resistors placed on the handle) was 454ms (SEM: 23) and 516ms (SEM: 19) respectively. These values were used to calculate the iEMG for all participants. Specifically, the iEMG in all participants (across all trials) was captured over the time window starting at 200ms (which approximates group average TA onset in both stance and step legs), and ending at 450ms (which approximates group average lift off in the stepping leg). Therefore, the primary outcome measure of the TA muscle response ratio was a 250ms window of integrated EMG in both legs starting 200ms after the onset of postural perturbation (i.e. cable release).

Stop signal task

Given that fifteen of the original nineteen participants were able to provide data for the reactive balance test, only the SST data for those participants was further analyzed (note: the main purpose of this study was to investigate the relationship between performance on the SST and performance on the balance test). Median “Go” reaction time was 514ms (SEM: 16) with participants stopping on 50.7% of cued stop trials. All participants successfully stopped between 46% and 56% of trials, which indicates that the stop-signal delay staircase algorithm was effective. The average stop-signal delay was 319ms (SEM: 18). The average SSRT was 196ms (SEM: 8) within a range of 154ms to 254ms. Participants responded to almost all “Go” cues (98.8%) and made discrimination errors on less than 1.2% of the “Go” trials.

Reactive balance performance compared with stop signal reaction time

Table 1 depicts key variables for all individual subjects, including SST performance measures (Median Go reaction time, SSRT, SSD) and muscle response ratios for right and left TA muscles. Figure 3 shows averaged postural response waveforms of the stepping leg muscles from two participants, with both waveforms of step trials and reach-to-grasp trials overlapped and aligned with perturbation onset. The first panel depicts an individual with a fast SSRT and the second panel shows a participant with a slower SSRT. Results of the Pearson correlation analysis between the muscle response ratio and SSRT, shown in Figure 4 indicated that there was no significant association between SSRT and the stepping leg ($r = 0.18$; $p = 0.267$), however, there was a significant positive correlation between SSRT and the stance leg ($r = 0.59$; $p = 0.011$).

Subject Data							Ratio iEMG (RTG/Step)	
Step Leg	Subject #	Gender	Age	Median "Go" Reaction Time	Average Stop-Signal Delay	SSRT(ms)	STEP Leg	STANCE Leg
L	0129a	F	51	476.85	305.45	171.4	1.082649229	0.69546188
R	0130a	F	64	495.15	295.3	199.85	0.312153904	1.20479991
R	0131b	M	58	487.925	270.325	217.625	1.150074551	0.77198041
R	0133b	M	68	538.475	332.05	206.425	1.051846095	0.60987526
R	0134b	M	75	516.9	362.475	154.375	0.801584536	0.3896767
R	0136a	F	67	590.35	414.05	176.275	0.963743944	0.9915342
R	0137a	F	56	471.2	244.925	226.275	0.726116471	0.93849874
L	0139a	F	71	566.3	380.475	185.825	0.665859919	0.61484552
R	0140b	M	72	593.55	421.875	171.675	0.740951535	0.58754288
R	0141a	F	69	449.8	210.95	238.85	0.986159864	1.06152415
L	0142a	F	66	514.7	332.025	182.675	0.655801	0.69208653
R	0143a	F	71	474.8	299.225	175.575	1.155298816	1.00274437
R	0144b	M	75	509.9	347.675	170	0.680754836	0.36307894
R	0145a	F	71	394.75	185.925	208.8	1.108202346	1.09488976
R	0146b	M	72	636.175	382.45	253.775	0.945950176	1.00375516
Averages			67 years (*SD*: 6.826)	514ms (SEM: 16)	319ms (SEM: 18)	196ms (SEM: 8)		

Table 1. Subject Data. List of all values pertaining to subjects from which data was analyzed. The leg each participant predominately stepped with and subject data are listed. Gender, age, median "Go" reaction time, average stop-signal delay, average SSRT, and average iEMG ratios of reach trials over step trials for each leg (Step and Stance) are also listed.

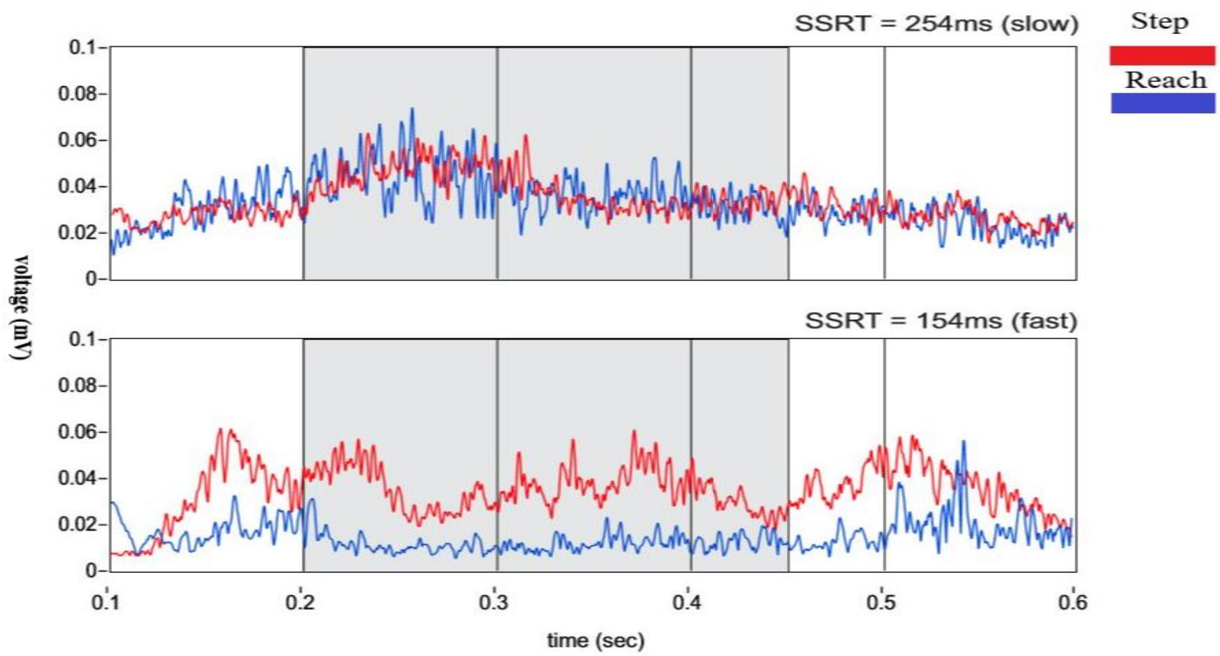

Figure 3. *Average step response*. Average waveforms for the Tibialis Anterior in the stance leg (step trials are shown in red, reach trials are shown in blue). Muscle response data examples from two participants with a slow SSRT (top) or fast SSRT (bottom). The integrated EMG was measured from 200ms – 450ms (shaded region).

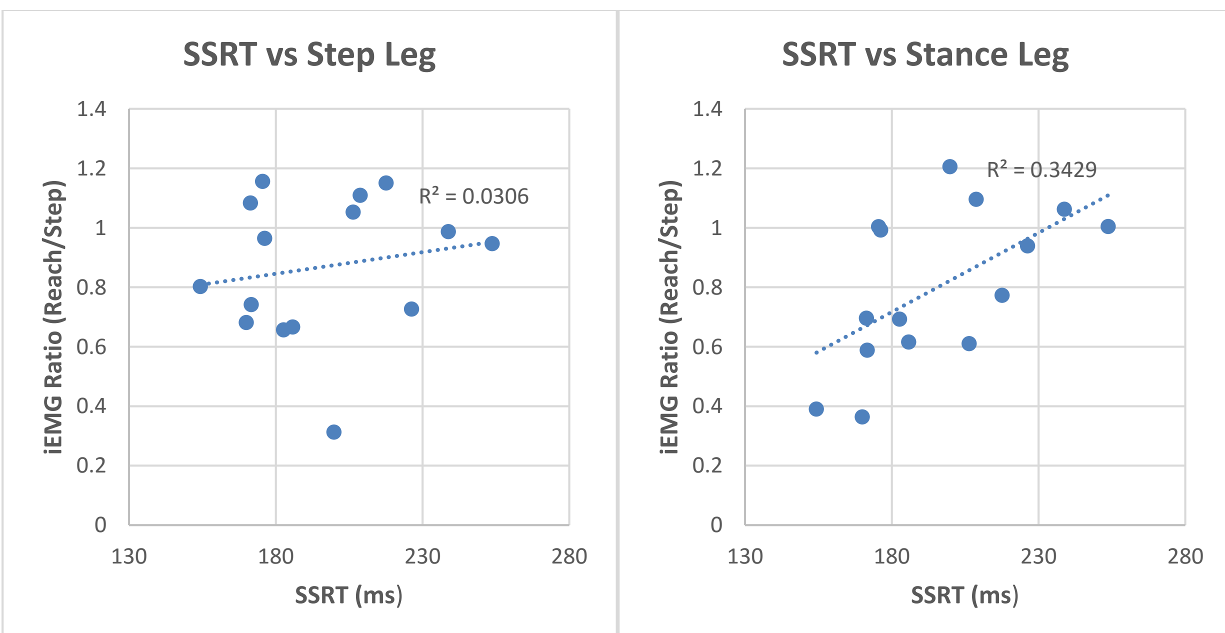

Figure 4. Scatterplots showing the correlation between SSRT and the muscle response ratio in each leg (left scatterplot is step leg, right scatterplot is stance leg).

DISCUSSION

Individuals with a faster SSRT demonstrated reduced muscle activation in their stance leg when a leg block prevented a forward balance recovery step compared to when a recovery step was allowed. This suggests that SSRT is related to an individual's response inhibition ability during a reactive balance task that requires a compensatory change of support reaction. What is remarkable about this finding is how a traditional measure of response inhibition (SSRT) obtained in a seated task using only finger responses is correlated with performance on a balance recovery task using the whole-body. The results of the present study are consistent with recent findings in our lab (Rydalch et al., in review) where a similar relationship was found in young adults, (Note: in that study it was the step leg where this relationship was found versus the stance leg in the present study – a point discussed later). The results of the previous study revealed that younger adults' median "Go" reaction time was about 100ms faster and their average SSRT was about 20ms faster, which indicates an overall slowing in terms of absolute timing with older adults. This supports the notion that overall response speed is diminished with age (Schoene, Delbaere, & Lord, 2017). Despite older adults reacting and stopping slower than young adults, the key point is that the relationship was preserved between SSRT and muscle inhibition in a postural response with the leg.

It is known that older adults perform slower on reaction time tasks, particularly those which involve a selection among options (i.e. choice reaction time) (Cohen, et al., 2011). A commonly held belief is that processing speed is the main culprit leading to these delays. Salthouse (2000) theorized that processing speed was slower in older adults for a variety of reasons such a health degradation, practice with the task, and what the task involves such as tasks with spatial information compared to verbal information. Another possibility is that muscle activation timing could be responsible for the slower movement of the older adults. This would possibly result from the signal transmission through the nervous system being slowed. Manini, Hong, & Clark (2013) proposed that as individuals age there is a decrease in the ability for the nervous system to transmit signals and communicate because of neural noise and the inability to harness neural resources creating poor precision and inaccuracy. Along with the central nervous system there is also degradation of motor units and the peripheral nervous system. As aging occurs the amount of motor units decrease and the conduction velocities of efferent axons is reduced (Manini et al., 2013). Consistent with this notion of general slowing, Thelen and colleagues in 2000 found that older adults were slower at deactivating three stance leg muscles (tibialis anterior, rectus femoris, & vastus lateralis) and activating hip flexors and knee extensors of the stepping leg. This would imply that there is a deficit in turning off these stance muscles to allow for a step to begin.

Beyond diminished transmission speed, deficits in cognitive processes such as response inhibition may also lead to response delays. Cohen and colleagues in 2011, found a link between rapid motor responses and the control of response inhibition with the changes that happen with aging. Their results found that older adults had more errors in stepping with the appropriate leg in a choice reaction stepping task. Errors in postural preparation led to increased choice reaction times for step initiation in older adults and these response errors in postural preparation were three times more common in older adults than younger adults (Cohen, et al., 2011). These results imply in a standing postural context in regards to the legs, that response inhibition deficits lead to slower reaction times in older adults because of more time taken to correct motor errors. A failure in response inhibition may be the key factor of slower performance in older adults.

In addition to the overall slowing in response speed, another important difference in the results from this study compared to Rydalch and colleagues is how the older participants reacted in response to the cable released compared to younger adults. Specifically, the relationship between the SSRT and the postural response was limited to the *stance* leg in older adults, and not the *step* leg as found in the younger adults. Therefore, in addition to the delayed absolute response timing, these responses also differ qualitatively in how they manifested. To understand why such a distinction emerged in how these groups responded, it is important to recognize the specific role played by the stance and step limb when executing a balance recovery step.

During compensatory stepping individuals incorporate strategies such as the fixed support "ankle" and "hip" strategies closely followed by or during a stepping reaction (Maki & McIlroy, 1997). Maki and McIlroy describe the "ankle strategy" as creating torque about the ankle to stabilize the whole body, while the hip "strategy" involves using hip flexors or extensor muscles to produce shear forces decelerating the center of mass. During the "ankle strategy" the body can be viewed as an inverted pendulum with dorsal muscles preventing a forward perturbation (Winter, 1995). Although these strategies involve supporting the body by being fixed in place they appear to occur and persist simultaneously with change-in-support reactions such as compensatory stepping (Maki & McIlroy, 1997). While the participants were in a leaning position at the beginning of the balance task, the TA of the stepping leg had the important role of quickly accelerating the leg to raise it off the ground to a new position to increase the base of support (Tisserand et al., 2015). In regards to the stance leg, it likely takes on the role of stabilization in both the anteroposterior and mediolateral directions while the other leg engages in a step response. In the anteroposterior axis the center of pressure is shifted backwards to promote forward propulsive forces by inhibiting ankle plantar-flexors and activating ankle dorsi-flexors; while in the mediolateral axis the center of pressure is shifted towards the step leg causing a shift in the center of mass to the stance leg creating a mediolateral fall of the center of mass towards the step leg (Yiou, Caderby, Delafontaine, Fourcade, Honeine, 2017).

The muscle response ratio and anecdotal features observed during the lean and release task provide a possible reason for the differences between the age groups. It appeared that when the older adults were released they would try to resist and delay the movement for as long as they could. The participants would lean for as long as possible by using a fixed-support strategy, then engaged in a stance pattern that leads to single leg support. The participants then tried to postpone further action until a decision was made to transition to a compensatory step or reach to establish a new support base. The aim appeared to be to use a stalling tactic to avoid commitment to a rapid compensatory response until greater certainty by inhibiting overall movement until no longer possible to “buy time”. Those who failed to suppress an upcoming step could have more TA activation in the stance leg while those who were better at suppressing the step pattern showed less activity in the TA as there was a shift from a lower limb response to the hand for a grabbing action. The participants possibly primed an anticipatory postural adjustment prior to the movement by shifting activity from the stance leg to the stepping leg. If true, this could mean that the brunt of the early postural response falls onto the stance leg in an effort to slow the decision to step. This of course is speculation, but it could offer a direction for future study to determine if the observed postural response was purely strategic.

Methodological considerations

The primary objective of the study was to determine if response inhibition from a seated cognitive task correlated with the performance in a whole body reactive balance task that on occasion would require the suppression of a highly automatic recovery step response for a reach response. A relationship between these tasks would support the idea that there was a shared cognitive mechanism. To accomplish this there were notable differences between the way response inhibition was measured in the two tasks based upon the context and difficulty of the different tasks. The SST used a “Go” cue presented by an arrow on the screen followed by an auditory stop tone, while in the reactive balance task the “Stop” cue was the leg block which was presented before the “Go” cue which was the release of the cable. The difference in the order of the approaches comes from the reactive balance task being a much faster task than a voluntary reaction like the SST (Gage, Zabjek, Hill, & McIlroy, 2007). The SST used a reaction time variable to be able to quantify the speed of stopping by making participants quickly create “Go” responses created by stimulus within a set response window while the difficulty of stopping was adjusted based on the individual’s performance. In contrast, the Lean & Release reactive balance test was not able to adjust inhibitory performance in a similar manner. Instead participants were released at three specific time points that could in theory provide a challenge to expose response inhibition errors in the suppression of a step response. Because of the context of the task, a magnitude variable quantifying muscle responses was used to measure response inhibition.

The reactive balance test design of this study was a choice-reaction task in which there is a suppression of an action and the selection of a more appropriate action compared to a pure stopping task. This approach was to create an intense postural threat to create a rapid change-of-support reaction. The lean angle was set uniquely for each participant to ensure that each trial required a step to promote step automaticity. When a step was blocked, the fall was prevented by the participants reaching for a handrail. What this means is that the present reactive balance test represents somewhat of a departure from traditional stopping tasks where actions are either suppressed or not. Despite this difference there is evidence that the selection of appropriate motor behavior engages similar neural processes (Mostofsky & Simmonds, 2008).

CONCLUSION

There is a relationship between a standard cognitive test for response inhibition, the SSRT, and individual performance on a reactive balance test in older adults; specifically, a balance test that requires response inhibition. Even though the response is slower in older adults compared with younger adults, the individual's ability to inhibit an incipient finger response is linked to the ability to control balance recovery responses with the leg in a rapid and choice-demanding environment. Because of this correlation there is a possibility of using the stop signal task to assess response inhibition that could identify the risk of higher fall chance in older adults. This cognitive test requiring a simple finger response is both safe and clinically feasible, and could determine if response inhibition ability is deficient in those individuals at risk of falling.

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