Memorial Sloan Kettering Cancer Center

Age-Related Variations of Inhibition Response Times Demonstrated Through the Stop Signal Task: Implications to Cancer Patients' Executive Functioning

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The Literature

- Inhibition of response, the ability to hold back an action that is already "in motion," is a crucial component of executive functioning. It plays a role in maintaining attention and the integration of stimuli.
- The development of inhibition is relatively consistent throughout the majority of neural development, as seen in adolescents and young adults between the ages of 7 to 21. Meaning, there is no significant difference in younger children, compared to older adolescents' response rates (Huizinga, M., Dolan, C. V., & van der Molen, M. W. 2006).
- However, inhibition of response is specifically seen to decline with those who display symptoms of impairment such as ADHD and other comorbid diagnoses (Lipszyc, J. & Schachar, R. 2010).
- Medications may also play a role, drugs commonly used to treat prostate cancer (androgen deprivation therapy) were seen to impact cognitive control (Chao, H. H. *et al. 2012)*.
- Executive functioning generally is understood to decrease with age. But specific components of executive functioning should be analyzed to determine if some aspects of executive functioning are more susceptible to decline than others, and what health factors may contribute.
- Understanding age related decline of inhibition, in comparison to executive functioning and age overall, may help us better understand whether older populations may be more susceptible to inhibition impairment resulting from "chemo brain."

Hypothesis

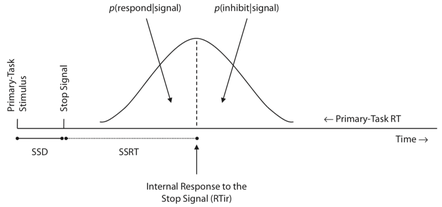
In studying a group of healthy control participants, older participants will be delayed in inhibiting their responses to the stop signal task, when compared with younger participants, due to age-related cognitive decline in executive functioning.

Study Design

23 healthy control participants between the ages of 40 to 75 years were randomly selected from protocol 18-240 to complete the stop signal task. The participants were grouped by age: 40-60 younger group, 61-75 older group. Both groups were asked to identify one of two possible letters (P or Q) using a manual response, but to refrain from responding whenever an auditory "stop signal" appeared.

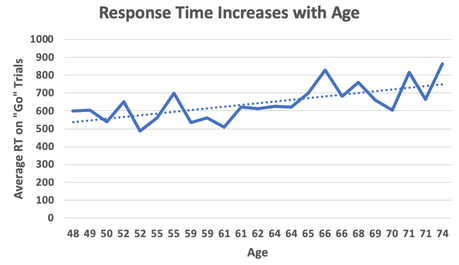
144 "Go" Trials and 48 "Stop" Trials per participant

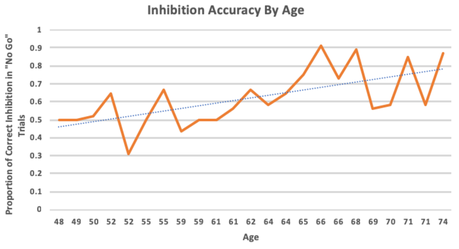
Stop signals given using a "staircasing model" in response to the participants reaction time. Upon correct inhibition, the next stop signal is delayed by 50ms. When failure to inhibit, the signal is presented 50ms sooner.

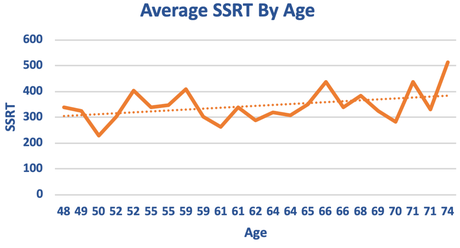


(Verbruggen, F., Logan, G. D., & Stevens, M. A. 2008)

Data







Analysis/Discussion

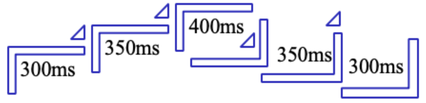
The older control participants' average reaction time on go trials is significantly greater than the younger participants. However, average inhibition accuracy proportion is significantly greater in older participants.

Group Averages	Young Group (40-60 years old)	Old Group (61-75 years old)
Avg. RT Go Trials	582.0323259	683.4116317
Avg. Inhibition Accuracy Prop.	0.509259259	0.693452381
Avg. SSRT	332.416878	350.435764

The Stop Signal Reaction Time (SSRT) is the mean stop signal time at which the participants can inhibit correctly 50%.
SSRT= average "Go" RT – average SSD
There is no significant difference between groups.

Two Tailed Independent Samples T- Test	
Avg. RT Go Trials	t= -101.379 p= 0.013
Avg. Inhibition Prop.	t= -0.184 p= 0.003
Avg. SSRT	t= -18.019 p= 0.520

After analyzing the average "Go" response times of both groups, the significant difference in "Go" RT and inhibition proportion is due to an artificial ceiling effect created by the paradigm. The staircase model is structured so that 400ms is the maximum possible SSD. However, older participants are responding significantly slower so that the max SSD is not great enough to capture their true average SSRT.



Conclusion

While it seems like older participants are better at inhibiting, their increased response times indicate that their average response time is so slow, they can not respond before the greatest administered stop signal response. This has therefore created an artificial ceiling effect.

Future Directions

Increasing the artificial ceiling created by the stop signal stair casing model could account for slower inhibition response times associated with age. This would allow participants to staircase and eventually average out around a more accurate depiction of their true SSRT, in subjects that require longer than 400ms. We would then be able to predict a more accurate average SSRT in our older population.

Investigating behavioral and psychological explanations as to why older participants may be more prone to intentionally slowing down their response may also give rise to the present result. Future directions may be to investigate disproportional activation and/or arousal associated with cognitive conflict and failure to inhibit.

In seeing that slower response times significantly correlates with aging, next steps would be to investigate whether cancer and cancer treatments may have similar effects. Further, whether older patients receiving treatment may have more significant impacts of response time due to "chemo brain", as compared to younger patients.

Lipszyc, J. & Schachar, R. (2010). Inhibitory control and psychopathology: a meta-analysis of studies using the stop signal task. J Int Neuropsychol Soc 16, 1064-1076, doi:10.1017/S1355617710000895.
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Huizinga, M., Dolan, C. V., & van der Molen, M. W. (2006). Age-related change in executive function: Developmental trends and a latent variable analysis. Neuropsychologia, 44(11), 2017-2036.