To brake or accelerate when the light turns yellow?

Stress reduces older adults’ risk taking in a driving game

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September, 2008: in press, Psychological Science
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Many rewards in life require taking risks and the decision to take such risks often must be made under stressful circumstances—whether one is a stockbroker, a surgeon or just a commuter in rush hour traffic. Stress hormones affect prefrontal brain regions and dopaminergic pathways involved in decision making (Moghaddam & Jackson, 2004; Wang et al., 2005). As people age, prefrontal brain regions decline in volume and in dopamine transmission effectiveness (Raz, 2004; Volkow et al., 2000), potentially altering the impact of stress on decision making.

To examine age differences in the effects of stress on risky decisions, we asked younger and older participants to play a computer-based driving game either after a stress challenge or in a control condition.

Methods

Younger adults (aged 18-33 years; N=45; 22 males) and older adults (aged 65-89 years; N=40; 21 males) played 15 driving game trials. Participants randomly assigned to the stress condition submerged their non-dominant hand in ice water (2.0 to 4.2 C) for three minutes. In the control condition, participants held their hand in warm water (37.3 C to 38.8 C) for three minutes. They started the driving game 18 min after the stress challenge, during the period of peak cortisol response to acute stress (Dickerson & Kemeny, 2004). Salivary cortisol was measured using an enzyme immunoassay kit (Salimetrics, State College, PA) from saliva samples at three time points.
Each game trial started with a green light that changed to yellow with the first press of the accelerator key. The yellow light lasted for a randomly determined time (2-7 s) before turning red. While participants pressed the accelerator key, the car moved at a constant speed across the screen and the participant’s score increased. Whenever they released the key the car and the score counter stopped. Participants could start and stop the car as often as they liked until the red light appeared; their behavior did not influence the length of the yellow light. If the car was stopped when the red light appeared, the points from that trial were added to their cumulative total and they heard, "yippie!" But if the light turned red while they were driving they lost all their points from that trial and heard a police siren. Time spent driving during yellow lights was our measure of risk taking.

Results

Compared with the control group, the stress group’s salivary cortisol levels increased by the time of the game (Fig. 1A), for both younger, $F(1,43)=10.64, p<.01$, and older adults, $F(1,38)=8.10, p<.01$, with no significant age difference in the increase. The stress condition also resulted in higher post-experiment self-ratings of stress during the water task for both younger, $t(43)=8.11, p<.001$, and older adults, $t(37)=7.24, p<.001$, with no significant age difference in the effect of the cold pressor task.

Being stressed reduced older adults' final scores by nearly half, $t(38)=-3.50, p<.01$, but did not significantly affect younger adults' scores, $t(43)=1.03, p=.31$ (Fig. 1B), leading to a significant interaction of age group and stress condition, $F(1,81)=12.10, p<.001$. Stressed older adults risked driving for a smaller proportion of the yellow light
intervals than control older adults, \( t(38) = -3.64, p < .01 \), whereas younger adults showed little effect of stress on risk taking, \( t(43) = -0.38, p = .71 \) (Fig. 1C), \( F(1,81) = 9.09, p < .01 \). In general, stopping and restarting more often was negatively correlated with points scored \((r = -0.61, p < .001)\). Stress increased older adults’ stopping rate, \( t(38) = 3.21, p < .01 \), but did not significantly affect younger adults’ stopping rate, \( t(43) = 1.41, p = .17 \), leading to a significant interaction, \( F(1,81) = 11.12, p < .01 \) (Fig. 1D). Overall, older adults had fewer losing trials \((M = 27\%)\) than younger adults \((M = 41\%)\), \( F(1,81) = 17.74, p < .001 \), but there were no effects of stress on losing rates.

Partitioning results into three phases of five trials each and including phase as a factor revealed consistent effects of stress on driving time, stopping rate and points throughout the game (all \( p > .3 \) for the stress condition by phase and stress condition by age by phase interactions). Furthermore, the age by stress condition interactions were significant for each phase analyzed separately (all nine \( p < .05 \)).

All the age by stress condition interactions remained significant \((p <= .01)\) when years of education, intelligence (as assessed by a reading test\(^2\)), mood,\(^3\) depression\(^4\) or health self-ratings were entered separately as covariates into the ANOVAs examining each driving game dependent measure. In addition, all the age by stress condition interactions remained significant \((p < .05)\) when male and female data were analyzed separately.

Discussion

This study reveals that stress can change older adults’ decision strategies. In the control condition, older adults risked driving during yellow lights for only a little less
time than younger adults and performed better than younger adults in terms of final scores. This is consistent with previous lab studies showing little or no decline in decision-making abilities with age (for a review see Mather, 2006). In contrast, after a stress challenge, older adults not only risked significantly less driving time but also stopped and restarted more frequently than those in the control condition. The age differences in the effects of stress were robust, occurring even when each sub-phase of the game was analyzed separately and when male and female data were analyzed separately. These findings highlight the need for more research on age differences in the impact of stress. In particular, further research is needed using different measures of risky decision making to see if these age differences are specific to risky decisions made under time pressure (as in the current task) or also extend to other decision tasks.
References


Author Note

We acknowledge Corey Wasson for data collection assistance and NIA grant R21AG030758 for support.
Footnotes

1  Stops per second driven yielded a skewed distribution, thus we analyzed rank transformed data.

2  Wechsler Test of Adult Reading (Wechsler, 2001).

3  Positive and Negative Mood Scale (Watson et al., 1988).

4  Geriatric Depression Scale (Yesavage, 1988).
Figure Caption

*Figure 1.* A) In the control condition, cortisol levels did not change from 9 min prior to immersing hand in warm water to 6 or 16 min post immersion; in the stress condition, cortisol levels increased significantly for both younger and older adults by the time of the decision task, which started 18 min after hand immersion. B) Stressed older adults earned fewer points in the game than the control older adults but stress did not significantly affect younger adults’ scores. C) Stressed older adults spent less of the time during each yellow light driving than other participants. D) Stressed older adults had a higher ratio of stops/restarts to driving time than control older adults (medians are shown for this ratio instead of means due to skewed data).