



Driven to Distraction: Effects of a Driving Challenge on Control Beliefs, Physiological Reactivity, Attention, and Memory in Younger and Older Adults

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INTRODUCTION

- Situations experienced as uncontrollable are associated with increased stress (Dickerson & Kemeny, 2004) and poorer cognitive performance (Lachman, 2006). Seeman et al. (1999) suggested that situations which threaten one's sense of control are likely to lead to increased physiological activation, especially for those with strong control beliefs.
- Previous studies have found that older adults have a lower sense of control compared to younger adults and that lower control is related to poorer memory performance (Lachman, 2006). Strategy use, anxiety and task interference have been identified as possible mediators (Lachman et al., 2011). However, little is known about physiological processes that may contribute to differences in performance. Older adults typically show greater physiological reactivity than younger adults in challenging situations (Neupert, Miller & Lachman, 2006; Seeman & Robbins, 1994; Uchino, Birmingham, & Berg, 2010).
- Previous studies have shown that higher levels of physiological reactivity are associated with better memory performance (e.g., heart rate: Jennings et al., 1990 - especially in older adults; cortisol: Domes et al., 2002; Nater et al., 2007).

- Little is known about the relationship between control beliefs, situational control, physiological reactivity, and cognitive performance.
- Our goal was to understand the physiological processes linking control and memory, and whether the relationships vary by age.

PREDICTIONS

- Those with higher control beliefs in a low situational control condition were expected to show greater arousal, perhaps indicating a mismatch with their control expectancies or a mobilization of resources to meet the challenge.
- Older adults were expected to show greater reactivity than younger adults, as found in previous studies.
- Older adults were expected to have poorer memory performance than the younger adults. We expected age differences in memory to be moderated by situational control and level of physiological reactivity such that greater reactivity when in a low control situation would lead to better performance.

METHOD

Participants

- Drawn from a Boston area probability sample
- Inclusion criteria (e.g., Pfeiffer dementia screener, no stroke or brain injury, current drivers)
- 152 individuals aged 22 to 84 ($M = 57.24$, $SD = 15.63$)
- 46.7% Women; Education: 17.1% - less than college, 30.3% - college degree, 52.6% - some graduate school or higher

Procedure

- Participants were randomly assigned to one of two experimental driving conditions:

NORMAL SITUATIONAL CONTROL

- Normal driving conditions
- coefficient of friction on the road surface = .8
- no wind

LOW SITUATIONAL CONTROL

- Windy & slippery road
- coefficient of friction on the road surface = .4
- 18 instances of wind (10 to 25s. each)

Funke, Matthews, Warm, & Emo (2007)
STISIM Drive™ Driving Simulator - M100

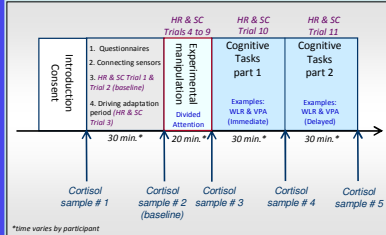


Diagram of the Lab Session: Experimental Manipulation, Physiological and Cognitive Measures

Measures

- Control Beliefs**
 - General Control Beliefs (Lachman & Weaver, 1998)
 - completed at home before the lab session
 - Control during Driving - "On a scale of 1 to 5 where 1 is no control and 5 is a lot of control, how much control did you feel you had during the driving segment?"
 - completed after the experimental manipulation
- Memory Performance**
 - During the Experimental Manipulation (Divided Attention)
 - Number of streets correctly recalled
 - "At the end of the driving period we will ask you a few questions about what you saw while you were driving, so please pay close attention".
 - "Please name as many of the streets as you can remember that you saw in the simulation".
 - Logical Memory - story heard during driving/recalled after driving (Wechsler, 1997)

After the Experimental Manipulation

- Word List Recall (WLR - Immediate & Delayed; Hertzog, Dixon, & Hultsch, 1990)
- Verbal Paired Associates (VPA - Immediate & Delayed; Wechsler, 1997)

Physiological Reactivity

- During and After the Experimental Manipulation
 - Saliva Samples (5 samples - Sarstedt Salivettes)
 - Cortisol
 - Electrophysiological Measures (11 trials - MEDAC System/3 NeuroDyne)
 - Skin Conductance (SC) Level & Heart Rate (HR)

Two measures of reactivity were computed for each measure:

	Cortisol	Skin Conductance and Heart Rate
Reactivity 1 = during the experimental manipulation	sample #4 minus baseline (sample #2)	the maximum value of trials 4 to 9 minus baseline (trial 2)
Reactivity 2 = after the experimental manipulation	the maximum value of samples #4 and #5 minus baseline (sample #2)	the maximum value of trials 10 to 11 minus baseline (trial 2)

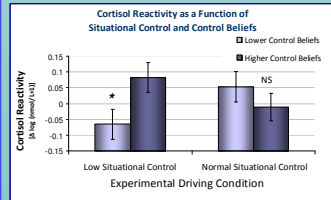
RESULTS

Question 1: Is a driving challenge an effective way to manipulate control in younger and older adults? Yes.

- ANCOVA --- 2(Experimental condition) X 2(Age: Y = 22-59; O = 60-84)
- DV = Control during driving
- Covariates = General control beliefs, Sex
- In comparison to the normal situational control condition, those in the low situational control condition reported less control over driving, supporting the effectiveness of the manipulation. [low control: $M = 3.29$, $SD = .89$; high control: $M = 3.86$, $SD = .84$, $F(1, 136) = 16.87$, $p < .001$].
- The experimental manipulation was effective for both younger and older participants.

Question 2: Is physiological reactivity related to age, situational control and/or prior control beliefs? Yes for all.

- ANCOVA --- 2(Experimental condition) X 2(General control beliefs: lower and higher levels- median split) X 2(Age: Y = 22-59; O = 60-84)
- DV = Reactivity during the experimental manipulation (cortisol, SC, HR)
- Covariate = Sex
- Notes: Cortisol scores were log transformed before computing the reactivity measures; the models with cortisol reactivity as outcome also controlled for time since waking
- As predicted, compared to younger adults, older adults showed greater stress reactivity during the driving challenge, as measured by cortisol [Older: $M = .07$, $SD = .28$, Younger: $M = -.04$, $SD = .25$, $F(1, 121) = 6.83$, $p = .010$].



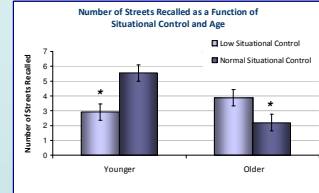
- In the low situational control condition, those with higher prior control beliefs reacted more than those with lower control beliefs for both cortisol and SC.
- $F(1, 121) = 5.21$, $p = .024$

Question 3: Do age differences in memory vary by situational control and level of physiological reactivity? Yes.

- MANCOVA --- 2(Experimental condition) X 2(Age: Y = 22-59; O = 60-84) X 2 (Physiological reactivity: lower and higher levels - median split)
- DVs = Cognitive performance
- Covariate = Sex
- Notes: Separate models were tested for cognitive performance during and after experimental manipulation, using the corresponding physiological reactivity measures

Memory Performance During Experimental Manipulation (Divided Attention)

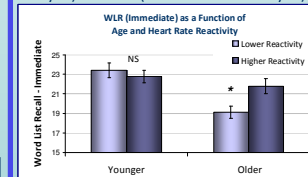
- Older participants remembered less than younger participants for number of streets correctly recalled and logical memory.
- Age differences in number of streets correctly recalled varied by experimental condition. Age differences were not observed in the low control situation. Younger are negatively affected by the low control condition; older perform better in the low control than in the high control condition.



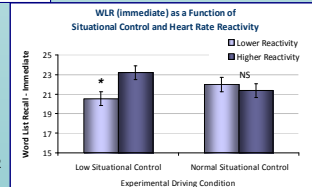
$F(1, 130) = 15.06$, $p < .001$

Memory Performance After Experimental Manipulation

- Older adults had poorer memory than younger adults for WLR (immediate and delayed) and VPA (immediate and delayed).
- Older participants with higher levels of reactivity have better memory performance than older participants with lower levels of reactivity. This pattern was obtained with HR reactivity for WLR (immediate) and with SC reactivity for VPA (immediate and delayed).



$F(1, 135) = 5.39$, $p = .022$



- Higher HR reactivity in the low control condition is associated with better memory performance. This pattern was obtained for WLR (immediate and delayed) and VPA (delayed).
- $F(1, 135) = 5.34$, $p = .022$

CONCLUSIONS & FUTURE DIRECTIONS

- The driving simulation is an effective paradigm for manipulating levels of control
- The low control situation has physiological consequences especially for those who typically expect to experience high control. Those with higher control beliefs were more likely to react physiologically in a challenging low control situation than those lower in control beliefs.
- Consistent with other research (e.g., Jennings, Nebes, & Yovetich, 1990) older adults' memory seems to benefit from greater SC and HR reactivity.
- For younger participants, memory performance during driving suffered in the low control condition, perhaps as a sign of greater distraction.
- Higher reactivity during a challenging situation seems to be beneficial in terms of memory performance.
- Future research will aim to understand the processes linking control, reactivity, and memory. Higher physiological reactivity may function as an adaptive response. Reactivity in the HPA or ANS may be indicative of efforts to mobilize and engage resources for the task at hand in the face of a challenge. Those with higher control beliefs, especially older adults, may have demonstrated better recall because they rose to the challenge and were more invested in succeeding at the task.