FOUNDATION FOR TRAFFIC SAFETY

Does Older Adults' Self-Regulation of Driving Improve Safety? An Examination of Objective and Subjective Driving Patterns in the AAA LongROAD Study

This research brief examines the relationship between self-regulation of driving and safety outcomes using data from the AAA Longitudinal Research on Aging Drivers (LongROAD) study (Kelley-Baker et al., 2017; Molnar et al., 2024). Self-regulation is the act or process of modifying one's driving (e.g., avoiding certain driving situations) in response to an awareness of one's declining abilities (Molnar et al., 2013, 2018). Self-regulation can take many forms. Two common forms of self-regulation are strategic and tactical self-regulation. Strategic self-regulation (SR-S) largely encompasses decisions regarding the conditions one is willing to drive in (e.g., avoiding driving at night or on freeways). These decisions are made prior to one's actual driving. Tactical self-regulation (SR-T) is a behavior that occurs while driving and is in response to circumstances of the environment (e.g., avoiding changing a radio station while driving). Self-regulation of one's driving is often discussed as a factor that could influence or extend the safe mobility of older drivers (Dykstra et al., 2020; Molnar et al., 2013). However, there is a gap and lack of consensus within the literature demonstrating the safety benefits of self-regulation (Ang et al., 2019).

This study has two goals. The first goal is to extend on prior work that has examined contributing factors of rapid deceleration events (RDEs) (Eby et al., 2019) by taking into account self-regulation behavior by drivers and by using additional years of LongROAD data now available. RDEs, commonly known as hard braking events, are used as a proxy for unsafe driving (Eby et al., 2019). The second goal of this study is to better understand the effects of older drivers' self-regulation on safety, more broadly.

The present study assessed the relationship between strategic and tactical self-regulation of driving and RDEs and self-reported crashes. It was hypothesized that increasing levels of self-regulation would be associated with fewer RDEs and self-reported crashes. However, no statistically significant relationships from the LongROAD data were observed demonstrating a clear correlation between self-regulation of driving and safety over time.

METHOD

This research used data from the AAA LongROAD study (Molnar et al., 2024). This prospective cohort study was designed to better understand and meet the safe mobility needs of older drivers through the collection of health, environmental, technological, and behavioral data. Data were collected on 2,990 participants across five geographically diverse study sites in the United States: Ann Arbor, MI; Baltimore, MD; Cooperstown, NY; Denver, CO; and San Diego, CA. Each site obtained approval from its respective institutional review board.

Participants were eligible to participate in the study if the following criteria were met:

- Aged 65-79 at the time of enrollment
- Have a valid driver license
- Drove at least one day per week by self-report
- Drove a primary vehicle of model year 1996 or newer
- Drove that vehicle at least 80% of the time if they also drove other vehicles
- Remain in the study area for 10 months each year, and planned to remain in the study area for the next several years
- Scored at least 4 on the Six Item Screener for cognitive impairment (Callahan et al., 2002) to ensure they were able to consent to participation in the study

Data for this study was collected annually over five years for each participant. Baseline data was first collected in July 2015 and lasted through March 2017 until all participants were enrolled. Data collection concluded in December 2022. Study data included demographics, subjective reporting of self-regulatory behaviors, visual functioning assessments, cognitive functioning assessments, GPS/datalogger data, and self-reported crashes.

During the baseline visit and every year thereafter during the study, a participant completed a survey that collected information on demographics (e.g., age, gender, etc.) and driving behavior. Participants were asked whether they engaged in 20 various driving behaviors. All 20 items can be viewed in Tables 4 and 5 below. Example items include "Do you try to avoid backing up while driving?" and "While driving, do you try to avoid talking on a mobile phone?" If a participant said "yes" to any item, their motivations were probed. Based on these motivations, it was determined whether a participant modified their driving due to self-regulation or modified their behavior for other reasons (e.g., lifestyle changes) (Molnar et al., 2013). If driving was modified for other reasons, it was not considered self-regulation and excluded from the two sum scores of self-regulation: tactical (SR-T) and strategic (SR-S). The SR-T score was the sum of all the tactical self-regulation items (7 items total), and the SR-S score was the sum of all the strategic self-regulation items (13 items total). Scores were indicative of the number of situations in which a participant modified their driving behavior due to self-regulation.

Participant vehicles were each equipped with a datalogger device that recorded GPS information when the vehicle ignition was activated. The primary outcome of this study, RDEs, is calculated from the longitudinal acceleration that is derived from the GPS data. Lower thresholds of RDEs indicate less severe braking by the driver whereas higher thresholds of RDEs indicate more severe braking and more dangerous driving. Thresholds were adapted from those used by Eby et al. (2019) with the LongROAD cohort's baseline data; the authors found that RDEs with a threshold of .35g were of limited use as a surrogate for driving safety and RDEs with a threshold of .75g were too rare to draw inferences about driving safety. Thus, we used a higher value for our lower threshold of .40g (RDE40), while retaining .75g (RDE75) as the higher threshold, because we had additional years of data and potential declines in functioning and safety. The total counts of all RDE40s or more and RDE75s or more were calculated for each participant each month. In addition, at the end of each study year, participants self-reported the number of crashes they experienced (as a driver) in the past year.

Analyses

Available and complete datalogger data for each participant was used. Descriptive information is reported on the months of datalogger data, including the number of miles driven, the average number and rate of RDE40s/RDE75s/self-reported crashes, self-regulation items, and self-regulation sum scores. RDEs were summed across all months within an interval (i.e., year) in the study. Rates are reported per 1000 miles driven.

As there were few RDE75s in this study, a binary variable was calculated to indicate whether a participant had experienced at least one RDE75 in a given year. Likewise, a binary variable was calculated to indicate whether a participant had self-reported a crash occurring in the past year. These dichotomized variables were used in the following analyses.

Unadjusted associations between the individual self-regulation items and safety outcomes were assessed. Associations between individual items and RDE40s were assessed via t-tests. Associations between individual items and RDE75s/self-reported crashes were assessed via chi-square tests.

A mixed effects negative binomial regression model was used to assess the relationship between self-regulation sum scores and RDE40s, because the average number of RDE40s was less than the variance. A mixed effects logistic regression was used to assess the relationship between self-regulation sum scores and the dichotomized RDE75. A random-intercept logistic regression was used to assess the relationship between self-regulation sum scores and the dichotomized crash variable. Each model was adjusted for the year in the study, study site, visual functioning, cognitive functioning, and several objective driving measures (# of trip chains [number of trip-sequences that start and end at the participant's home], % of trips during AM peak [weekdays 7–9 AM], % of trips during PM peak [weekdays 4–6 PM], % of trips within 15 miles of the participants home, and # of speeding events [speed >80 mph, sustained for at least 8 seconds]). All models accounted for driving exposure by including every 1000 miles driven as an offset.

RESULTS

Descriptives

The sample size was reduced (n=2,363) based on two qualifications: 1) a year of participant data was removed if there was any missing data on any of the variables used in the final analytic models; and 2) to exclude any year of participant data where there was at least one month of missing datalogger data between two in-person appointments. That is, a given year of data for a participant was retained if datalogger data was complete and available for every possible month. As a result, only 2,230 participants had complete and available datalogger data in their first year in the study. Within this subset of data, a total of 55,263 full months (~4,605 years) of datalogger data was recorded among all participants (excluding months where there was partial data). On average, participants had 23.4 full months (SD=7.9; range: 8–38 months) of datalogger data available. Across all participants, a total of 43,979,296 miles were driven. On average, participants drove 787.8 miles per month (SD=433.1; range: 61.3–3,930.8); see Table 1.

Table 1. Averages across all participants by year

	Year 1 (n=2,230)	Year 2 (n=1,843)	Year 3 (n=748)
	M (SD)	M (SD)	M (SD)
Average Number of Full Months of Datalogger Data	11.1 (1.1)	11.9 (1.4)	11.4 (1.3)
Average Miles Driven	8968.6 (5104.9)	9510.7 (5524.3)	8624.3 (5156.5)
Average Number of Miles Driven per Full Month of Datalogger Data	809.8 (451.8)	797.7 (448.9)	751.5 (434.3)

RDE Counts and Rates

Over the course of the study, for which there was complete and available datalogger data, a total of 48,982 RDE40s and 185 RDE75s were recorded. Over the course of the study and on average, participants experienced 20.7 RDE40s (SD=30.4; range: 0–498 events) and 0.08 RDE75s (SD=0.83; range: 0–33 events); 96.8% and 3.6% experienced an RDE40 and RDE75, respectively, at some point during the years they had complete and available datalogger data.

Rates of RDEs were calculated per 1000 miles driven. The overall average rates of RDE40s and RDE75s per 1000 miles driven were 1.2 (SD=1.8; Range: 0–30.6) and 0.005 (SD=0.085; Range: 0–5.07), respectively; see Table 2 for a breakout by year.

Table 2. Average RDEs across all participants by year

	Year 1 (n=2,230)	Year 2 (n=1,843)	Year 3 (n=748)
	M (SD)	M (SD)	M (SD)
Average Number of RDE40s	9.9 (13.8)	10.6 (15.8)	9.9 (15.6)
Average Rate of RDE40s per 1000 Miles Driven	1.2 (1.7)	1.2 (1.7)	1.3 (2.1)
Average Number of RDE75s	0.03 (0.38)	0.03 (0.22)	0.08 (1.24)
Average Rate of RDE75s per 1000 Miles Driven	0.004 (0.041)	0.004 (0.036)	0.012 (0.196)

Self-Reported Crash Counts and Rates

A total of 507 crashes were self-reported. Over the course of the study and on average, participants self-reported experiencing 0.21 crashes (SD=0.56; Range: 0–5 crashes). About 1 in 6 participants (16.2%) reported experiencing a crash at some point during the years for which they had complete and available datalogger data.

Rates of self-reported crashes were calculated per 1000 miles driven. The overall average rate of crashes per 1000 miles driven was 0.02 (SD=0.07; Range: 0–2.25); see Table 3 for a breakout by year.

Table 3. Average crashes across all participants by year

	Year 1 (n=2,230)	Year 2 (n=1,843)	Year 3 (n=748)
	M (SD)	M (SD)	M (SD)
Average Number of Self-Reported Crashes	0.10 (0.34)	0.12 (0.38)	0.08 (0.29)
Average Rate of Self-Reported Crashes per 1000 Miles Driven	0.02 (0.07)	0.02 (0.06)	0.01 (0.05)

Self-Regulation Scores

Approximately 96% of the participants reported engaging in some form of tactical self-regulation during the period for which they had available datalogger data. Regarding specific tactical self-regulatory behaviors that participants engaged in, the most common were: avoiding reading a paper road map while driving (71.4% of participants), avoiding personal grooming while driving (59.7%), and avoiding talking on a mobile phone while driving (52.5%). A composite score of all the SR-T behaviors was calculated. The average SR-T score across timepoints and participants was 2.8 (SD=1.7; range: 0–7), meaning, on average, a participant engaged in approximately 3 tactical self-regulatory behaviors in any given year they were in the study; see Table 4.

Table 4. Tactical Self-Regulation Scores and Prevalence by Year

	Year 1 (n=2,230)	Year 2 (n=1,843)	Year 3 (n=748)
	M (SD)	M (SD)	M (SD)
Total SR-T Score *	2.8 (1.6)	2.9 (1.7)	2.7 (1.7)
	%	%	%
Left greater distance ahead	36.6	34.7	35.6
Avoided talking conversationally while driving	12.0	12.4	14.8
Avoided eating	34.1	43.0	38.2
Avoided reading paper road map	71.9	72.5	67.4
Avoided changing radio stations	13.8	14.1	11.2
Avoided talking on mobile phone	52.4	52.4	49.6
Avoided personal grooming	57.3	63.2	55.8

* This score was calculated based on survey data collected at the beginning of each interval.

Approximately 81% of the participants engaged in some form of strategic self-regulation during the period for which they had available datalogger data. Regarding specific behaviors, the most common were: avoiding driving at night in bad weather (53.3%), avoiding driving in bad weather (41.7%), and avoiding night driving (33.2%). The average SR-S score across timepoints and participants was 2.3 (Range: 0–12); see Table 5.

Table 5. Average Strategic Self-Regulation Scores and Prevalence by Year

	Year 1 (n=2,230)	Year 2 (n=1,843)	Year 3 (n=748)
	M (SD)	M (SD)	M (SD)
Total SR-S Score*	2.2 (2.2)	2.4 (2.2)	2.3 (2.3)
	%	%	%
Avoided night driving	31.8	34.0	35.0
Avoided driving in unfamiliar areas	13.5	13.9	13.5
Avoided driving in rush hour traffic	20.0	21.4	19.8
Avoided freeway driving	7.4	7.7	8.2
Avoided left turns	10.0	10.0	9.8
Avoided driving in bad weather	39.0	45.7	39.6
Avoid driving on busy roads	13.5	14.5	13.4
Avoided driving alone	0.7	0.7	1.5
Avoided driving at night in bad weather	51.0	55.8	53.9
Avoided backing up	10.5	11.8	12.4
Usually make practice runs	9.6	9.4	8.7
Usually combine trips	9.6	14.3	10.7
Bring along someone to help navigate	2.3	3.0	2.5

* This score was calculated based on survey data collected at the beginning of each interval.

Unadjusted Associations Between Individual Self-Regulation Items and Safety Outcomes

No single tactical self-regulation item was associated with all three safety outcomes (i.e., RDE40s, RDE75s, and self-reported crashes); see Table 6.

Four tactical self-regulation items were associated with the occurrence of RDE40s. Older drivers experienced fewer RDE40s when they reported the following:

- Avoiding reading a paper road map due to self-regulation (M=9.6, SD=13.1) compared to those that did not avoid this behavior through self-regulation (M=11.5, SD=18.5), $t(4819)=3.8$, p<0.001
- Avoiding changing a radio station (M=8.9, SD=12.8) compared to those that did not avoid due to self-regulation (M=10.4, SD=15.1), $t(4819)=2.34$, p=0.01
- Avoiding talking on a mobile phone (M=9.3, SD=12.9) compared to those that did not avoid due to self-regulation (M=11.1, SD=16.7), $t(4819)=4.06$, p<0.001
- Avoiding personal grooming (M=9.4, SD=12.7) compared to those that did not avoid due to self-regulation (M=11.2, SD=17.5), $t(4819)=4.19$, $p<0.001$

Three tactical self-regulation items were associated with the occurrence of RDE75s. Older drivers were less likely to experience an RDE75 when they reported the following:

- Avoiding talking conversationally while driving (0.7%) compared to those that did not avoid due to self-regulation (2.0%), $\chi^2(1)=5.53$, p=0.019
- Avoiding changing radio stations (0.6%) compared to those that did not avoid due to self-regulation (2.1%), $\chi^2(1)=6.47$, p=0.011
- Avoiding talking on a mobile phone (1.4%) compared to those that did not avoid due to self-regulation (2.4%), $\chi^2(1)=6.26$, p=0.012

Only one tactical self-regulation item was associated with the occurrence of self-reported crashes. Surprisingly, older drivers were more likely to report being in a crash in the past year when they reported leaving a greater distance ahead while driving due to self-regulation (10.7%) compared to those that did not engage in this behavior due to self-regulation (8.9%), $\chi^2(1)=4.14$, p=0.042. It is unclear why this self-regulatory behavior is associated with a slight increase in crash involvement.

Table 6. Means and Prevalence of Safety Outcomes by Individual Tactical Self-Regulation Items

	RDE40s (n=4,821) Engaged in behavior		RDE75s (n=4,821) Engaged in behavior		Self-Reported Crashes (n=4,780) Engaged in behavior	
	Yes	No	Yes	No	Yes	No
	Mean (SD)		Prevalence (%) of ≥1			
Left greater distance ahead	10.4 (15.9)	9.7 (12.8)	1.7	2.2	**8.9**	**10.7**
Avoided talking conversationally while driving	10.2 (15.0)	10.1 (13.6)	**2.0**	**0.7**	9.4	10.3
Avoided eating	**10.3 (15.4)**	**10.0 (13.9)**	2.0	1.7	9.6	9.4
Avoided reading paper road map	**11.5 (18.5)**	**9.6 (13.1)**	2.3	1.7	8.2	10.0
Avoided changing radio stations	**10.4 (15.1)**	**8.9 (12.8)**	**2.1**	**0.6**	9.4	10.2
Avoided talking on mobile phone	**11.1 (16.7)**	**9.3 (12.9)**	**2.4**	**1.4**	9.7	9.3
Avoided personal grooming	**11.2 (17.5)**	**9.4 (12.7)**	2.1	1.7	10.1	9.1

Note. Bolded numbers indicate statistical significance.

As with the tactical self-regulation items above, no single strategic self-regulation item was associated with all three of the safety outcomes; see Table 7.

Six strategic self-regulation items were associated with the occurrence of RDE40s. Older drivers experienced fewer RDE40s when they reported the following:

- Avoiding night driving (M=8.8, SD=11.1) compared to those that did not avoid due to self-regulation (M=10.8, SD=16.4), $t(4819)=4.40$, $p<0.001$
- Avoiding freeway driving (M=7.7, SD=10.3) compared to those that did not avoid due to self-regulation (M=10.4, SD=15.2), $t(4819)=3.36$, $p<0.001$
- Avoiding left turns (M=9.0, SD=13.6) compared to those that did not avoid due to self-regulation (M=10.3, SD=15.0), $t(4819)=1.88$, $p=0.030$
- Avoiding driving in bad weather (M=9.5, SD=12.7) compared to those that did not avoid due to self-regulation (M=10.7, SD=16.2), $t(4819)=2.78$, $p=0.003$
- Avoiding driving on busy roads (M=9.3, SD=13.8) compared to those that did not avoid due to self-regulation (M=10.3, SD=15.0), $t(4819)=1.65$, $p=0.049$
- Avoiding driving at night in bad weather (M=9.2, SD=12.0) compared to those that did not avoid due to self-regulation (M=11.2, SD=17.5), $t(4819)=4.71$, $p<0.001$

Three strategic self-regulation items were associated with the occurrence of RDE75s. Older drivers were less likely to experience an RDE75 when they reported the following:

- Avoiding night driving (1.1%) compared to those that did not avoid due to self-regulation (2.2%), $\chi^2(1)=7.15$, p=0.007
- Avoiding driving in bad weather (1.3%) compared to those that did not avoid due to self-regulation (2.3%), $\chi^2(1)=6.17$, p=0.013
- Avoiding driving at night in bad weather (1.4%) compared to those that did not avoid due to self-regulation (2.4%), $\chi^2(1)=7.66$, p=0.006

Only one strategic self-regulation item was associated with the occurrence of self-reported crashes. Older drivers were less likely to self-report being in a crash in the past year when they reported usually making practice runs due to self-regulation (6.7%) compared to those that did not engage in this behavior due to self-regulation (9.8%), $\chi^2(1)=4.63$, p=0.031. Practice runs refer to the act of driving a particular route ahead of time to familiarize oneself with the driving environment to increase driving safety.

Table 7. Means and Prevalence of Safety Outcomes by Individual Strategic Self-Regulation Items

	RDE40s (n=4,821) Engaged in behavior		RDE75s (n=4,821) Engaged in behavior		Self-Reported Crashes (n=4,780) Engaged in behavior	
	Yes	No	Yes	No	Yes	No
	Mean (SD)		Prevalence (%) of ≥1			
Avoided night driving	**10.8 (16.4)**	**8.8 (11.1)**	**2.2**	**1.1**	9.8	8.9
Avoided driving in unfamiliar areas	10.3 (15.0)	9.3 (14.2)	2.0	1.1	9.6	9.2
Avoided driving in rush hour traffic	10.3 (15.0)	9.7 (14.5)	1.7	2.5	9.4	10.0
Avoided freeway driving	**10.4 (15.2)**	**7.7 (10.3)**	1.8	2.2	9.4	11.0
Avoided left turns	**10.3 (15.0)**	**9.0 (13.6)**	1.9	1.7	9.4	10.5
Avoided driving in bad weather	**10.7 (16.2)**	**9.5 (12.7)**	**2.3**	**1.3**	9.0	10.2
Avoid driving on busy roads	**10.3 (15.0)**	**9.3 (13.8)**	1.8	2.4	9.5	9.3
Avoided driving alone	10.2 (14.9)	7.7 (8.8)	1.8	0.0	9.5	5.3
Avoided driving at night in bad weather	**11.2 (17.5)**	**9.2 (12.0)**	**2.4**	**1.4**	8.8	10.1
Avoided backing up	10.1 (14.8)	10.3 (15.2)	1.8	2.2	9.2	11.8
Usually make practice runs	10.0 (14.7)	11.4 (16.1)	1.9	1.8	**9.8**	**6.7**
Usually combine trips	10.1 (14.8)	10.5 (15.6)	2.0	1.3	9.3	10.9
Bring along someone to help navigate	10.2 (14.9)	10.1 (12.5)	1.9	2.4	9.5	10.5

Note. Bolded numbers indicate statistical significance.

Comparative Analysis of Self-Regulation and RDE40s

When adjusting for various factors (i.e., driving behavior, cognitive and visual health), analyses indicated that neither SR-T nor SR-S sum scores predicted the occurrence of RDE40s; see Table 8.

Regarding covariates, analyses indicated that site was a statistically significant predictor of RDE40s. Compared to California, the rate of RDE40s was 20.7% lower for drivers in Michigan, 25.7% lower for drivers in Maryland, and 54.1% lower for drivers in New York. No differences between California and Colorado drivers were observed in terms of the rate of RDE40s. The rate of RDE40s increased by 9.5% if the drivers were female, relative to male drivers.

The rate of RDE40s decreased by 1.3% for every unit increase in percent of trips during AM peak. In contrast, the rate of RDE40s increased by 0.8%, 0.7%, and 0.2% per unit increase in percent of trips during PM peak, percent of trips less than 15 miles, and number of speeding events, respectively.

Of the twelve cognitive/visual health outcomes, only one was significantly associated with RDE40s. For every unit increase in one's digit symbol substitution test score (DSST; a metric of general cognitive dysfunction, for which higher scores are indicative of better cognitive performance), their rate of RDE40s decreased by 0.4%.

Table 8. Results of the adjusted mixed effects negative binomial model for the association of self-regulation items and RDE40s over three years (n=4,821)

Predictor Measure	Incidence Rate Ratio	
	Unadjusted (95% CI)	Adjusted (95% CI)
Year (Interval in Study)	**1.03 (1.00, 1.05)**	1.02 (0.99, 1.04)
SR-T Score	0.99 (0.98, 1.01)	0.99 (0.98, 1.01)
SR-S Score	1.01 (1.00, 1.03)	1.01 (1.00, 1.02)

Note. Bolded numbers indicate statistical significance.
Adjusted for site, sex, number of trip chains, percent of trips during AM peak, percent of trips during PM peak, percent of trips less than 15 miles, visual health (visual acuity, color contrast sensitivity, motor visual performance), cognitive health (verbal fluency, trails A & B scores, clock drawing score, immediate & delayed word recall scores, digit symbol substitution score, & simple & choice reaction scores).

Comparative Analysis of Self-Regulation and RDE75s

When adjusting for various factors (i.e., driving behavior, cognitive and visual health), analyses indicated that neither SR-T nor SR-S sum scores predicted the occurrence of RDE75s; see Table 9.

In comparison to the model predicting RDE40s above, few predictors were significantly associated with RDE75s. For every unit increase in percent of trips during AM peak, the likelihood of an RDE75 decreased, OR=0.91, 95% CI [0.86, 0.97]. For every unit increase in the percent of trips taken within 15 miles of one's home, the likelihood of an RDE75 increased, OR=1.02, 95% CI [1.01, 1.03]. No other covariates were associated with RDE75s.

Table 9. Results of the adjusted mixed effects logistic model for the association of self-regulation items and RDE75s over three years (n=4,821)

Predictor Measure	Incidence Rate Ratio	
	Unadjusted (95% CI)	Adjusted (95% CI)
Year (Interval in Study)	1.24 (0.26, 5.96)	1.22 (0.31, 4.82)
SR-T Score	0.87 (0.74, 1.03)	0.88 (0.75, 1.04)
SR-S Score	0.99 (0.87, 1.13)	0.99 (0.87, 1.13)

Adjusted for site, sex, number of trip chains, percent of trips during AM peak, percent of trips during PM peak, percent of trips less than 15 miles, visual health (visual acuity, color contrast sensitivity, motor visual performance), cognitive health (verbal fluency, trails A & B scores, clock drawing score, immediate & delayed word recall, digit symbol substitution score, & simple & choice reaction scores).

Comparative Analysis of Self-Regulation and Self-Reported Crashes

When adjusting for various factors (i.e., driving behavior, cognitive and visual health), analyses indicated that neither tactical nor strategic self-regulation sum scores predicted the occurrence of crashes.

Only one covariate was significantly associated with self-reported crashes. For every unit increase in the percent of trips taken within 15 miles of one's home, the likelihood of a self-reported crash in the last year increased, OR=1.02, 95% CI [1.01, 1.02].

Table 10. Results of the adjusted mixed effects logistic model for the association of self-regulation items and self-reported crashes over three years (n=4,780)

Predictor Measure	Incidence Rate Ratio	
	Unadjusted (95% CI)	Adjusted (95% CI)
Year (Interval in Study)	1.02 (0.86, 1.20)	1.01 (0.85, 1.19)
SR-T Score	1.05 (0.96, 1.16)	1.06 (0.97, 1.16)
SR-S Score	1.05 (0.97, 1.12)	1.01 (0.95, 1.09)

Adjusted for site, sex, number of trip chains, percent of trips during AM peak, percent of trips during PM peak, percent of trips less than 15 miles, visual health (visual acuity, color contrast sensitivity, motor visual performance), cognitive health (verbal fluency, trails A & B scores, clock drawing score, immediate & delayed word recall scores, digit symbol substitution score, & simple & choice reaction scores).

DISCUSSION

The goal of this study was to investigate potential safety benefits of driving self-regulation among older drivers. Previously, consistency was found between driver's self-reported behaviors (e.g., their self-regulation of driving) and what can be seen in their real-world driving using data from the AAA LongROAD study (Molnar et al., 2018). While some individual self-regulation items suggested potential safety benefits, no single self-regulation item held consistent safety benefits across all outcomes. For example, avoiding changing the radio station or talking on a mobile phone while driving due to self-regulation was associated with fewer RDE40s and with the lack of an RDE75, but not self-reported crashes. Markedly, making practice runs was associated with fewer crashes reported, but was not associated with RDE40s or the occurrence of an RDE75.

Further, no statistically significant effects of composite self-regulation scores on the rate of RDEs or self-reported crashes were found in the present dataset. This was the case whether the models adjusted for driving behavior and cognitive and visual health. This does not mean, however, that self-regulation overall is not beneficial. The self-regulation sum scores represent a broad engagement in self-regulation behaviors. The formulation of these sum scores may not adequately capture some of the unique effects found between the individual item and safety outcomes. Though the sum scores did not suggest safety benefits, no negative safety effects were observed either. It may be that, broadly, self-regulation allows older drivers to drive comparably to the general population. Those who practice both tactical and strategic self-regulatory behaviors may have the opportunity to extend their driving life, and equally as important, do so safely. The prioritization of safe driving behaviors, either before or during the act of driving, aligns with older drivers' intentions to monitor their own driving behavior to increase the safety of other road users and themselves.

As noted previously, Eby et al. (2019) examined RDEs using LongROAD data, specifically baseline and Year 1 naturalistic driving data. The authors suggested that RDEs defined at the threshold of 0.35g or greater may have been too sensitive to adequately identify unsafe driving. This conclusion was drawn from the fact that gender and driving environment (factors independent of unsafe driving behavior) were related to the presence of RDEs captured at the 0.35g threshold. This may have similarly been the case with our threshold of 0.40g or greater, as we also found sex and the driving environment to be significant predictors of RDE40s. Further, there may be other factors not accounted for in this study that would better explain the relationship between sex and driving environment and our outcomes. As in Eby et al. (2019), a lack in variation across several ability-related covariates due to the LongROAD sample being healthy and high-functioning may have reduced our ability to draw conclusions about the relationship between self-regulation and RDEs (and self-reported crashes). Despite the addition of more years of available data, relationships were not found between nearly all visual and cognitive functions and RDEs. This was the case for self-reported crashes as well.

It is also possible there may have been too little variance in the composite self-regulation scores. Most participants engaged in some form of tactical and strategic self-regulation and the rates of reported self-regulation were stable across the study years. It should also be noted that the measures of self-regulation are rather coarse and do not distinguish between rare and habitual engagement in a given self-regulation behavior. Thus, analyses were unable to account for frequency of driving self-regulation. The lack of statistical significance found in the current study may be attributed to a lack of change in self-regulation, both strategic and tactical, over the study period. With an overall healthy sample, participants may not have needed to adapt their self-regulatory behaviors to promote safer driving.

Older drivers should continue to participate in both tactical and strategic self-regulation of their driving behaviors despite the lack of statistically significant findings in this current study. More research is needed to understand the complex relationship between self-regulation and driving outcomes. Again, while no additional protective effects were observed broadly, no negative effects of self-regulating one's driving were observed broadly either. Investigation into why some individual self-regulation items mapped onto a given safety outcome but not others is warranted to further determine the complex safety benefits of self-regulation.

It is important to note that all 20 strategic and tactical self-regulatory behaviors presented here are positive ideas for older drivers to practice and implement into their daily driving habits to increase their safe mobility, especially their ability to safely operate a vehicle. Despite the lack of statistically significant findings in the current study, the methods of strategic and tactical self-regulation presented may serve as a useful tool for individuals having conversations with older drivers about the aging process and driving like relatives, friends, caregivers, and physicians.

REFERENCES

Ang, B. H., Oxley, J. A., Chen, W. S., Yap, K. K., Song, K. P., & Lee, S. W. H. (2019). To reduce or to cease: A systematic review and meta-analysis of quantitative studies on self-regulation of driving. *Journal of Safety Research*, 70, 243–251. https://doi.org/10.1016/j.jsr.2019.07.004

Callahan, C. M., Unverzagt, F. W., Hui, S. L., Perkins, A. J., & Hendrie, H. C. (2002). Six-Item Screener to Identify Cognitive Impairment Among Potential Subjects for Clinical Research. *Medical Care*, 40(9), 771–781. https://doi.org/10.1097/01.MLR.0000024610.33213.C8

Dykstra, C., Davis, Jessica. J., & Conlon, E. G. (2020). Tactical and strategic driving behaviour in older drivers: The importance of readiness to change. *Accident Analysis & Prevention*, 141, 105519. https://doi.org/10.1016/j.aap.2020.105519

Eby, D. W., Molnar, L. J., Zakrajsek, J. S., Ryan, L. H., Zanier, N., St. Louis, R. M., Stanciu, S. C., LeBlanc, D., Bogard, S., Kostyniuk, L. P., Smith, J., Yung, R., Nyquist, L., Betz, M. E., DiGuiseppi, C., Jones, V., Li, G., Mielenz, T. J., & Strogatz, D. (2019). Factors related to rapid deceleration events among a large cohort of older drivers. *Transportation Research Part F: Traffic Psychology and Behaviour*, 66, 76–86. https://doi.org/10.1016/j.trf.2019.08.021

Kelley-Baker, Tara, Woon Kim, & Leon Villavicencio. *The Longitudinal Research on Aging Drivers (LongROAD) Study: Understanding the Design and Methods* (Research Brief). Washington, DC: AAA Foundation for Traffic Safety, November 2017.

Molnar, L. J., Eby, D. W., Charlton, J. L., Langford, J., Koppel, S., Marshall, S., & Man-Son-Hing, M. (2013). Reprint of "Driving avoidance by older adults: Is it always self-regulation?" *Emerging Research Methods and Their Application to Road Safety*, 61, 272–280. https://doi.org/10.1016/j.aap.2013.07.004

Molnar, L. J., Eby, D. W., Vivoda, J. M., Bogard, S. E., Zakraksek, J. S., St. Louis, R. M., Zanier, N., Ryan, L. H., LeBlanc, D., Smith, J., Yung, R., Nyquist, L., DiGuiseppi, C., Li, G., Mielenz, T. J., & Strogatz, D. (2018). The effects of demographics, functioning, and perceptions on the relationship between self-reported and objective measures of driving exposure and patterns among older adults. *Transportation Research Part F: Traffic Psychology and Behaviour*, 54, 367–377. https://doi.org/10.1016/j.trf.2018.02.026

Molnar, L. J., Eby, D. W., Zakrajsek, J. S., St. Louis, R. M., Zanier, N. & Lang, B. H. (2024). *AAA Longitudinal Research on Aging Drivers (LongROAD) Data User Guide* (Technical Report). Washington, D.C.: AAA Foundation for Traffic Safety.

ACKNOWLEDGEMENTS

The research team would like to acknowledge the expert opinion of Dr. Katie Wheeler in the conception of this project and the expert guidance of Drs. David Eby and Lisa Molnar in the successful execution of this project.

ABOUT THE AAA FOUNDATION FOR TRAFFIC SAFETY

The AAA Foundation for Traffic Safety is a 501(c)(3) nonprofit, publicly supported charitable research and education organization. It was founded in 1947 by the American Automobile Association to conduct research to address growing highway safety issues. The organization's mission is to identify traffic safety problems, foster research that seeks solutions, and disseminate information and educational materials. AAA Foundation funding comes from voluntary, tax-deductible contributions from motor clubs associated with the American Automobile Association and the Canadian Automobile Association, individual AAA club members, insurance companies and other individuals or groups.

SUGGESTED CITATION

Svancara, A. M., Kasha, A., Arnold, L. S., & Yang, C. Y. D. (2024). *Does Self-Regulation of Older Adults' Driving Improve Safety? An Examination of Objective Driving Patterns in the AAA LongROAD Study* (Research Brief). Washington, D.C.: AAA Foundation for Traffic Safety.