

Reducing the Magnitude of Negative Left-Turn Lane Offset Reduces Risky Turning Behavior of Younger, Middle-Aged, and Older Drivers: A Driving Simulator Study

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Introduction

Nearly half of all traffic-related fatalities and serious injuries occur at or near intersections and crashes in which a left-turning vehicle is struck by oncoming traffic (left-turn crashes) are common and severe. These turns are particularly challenging because the opposing left-turn lane may contain vehicles blocking the view of oncoming traffic. Older adults are particularly at risk for this type of crash due to age-related declines in visual and spatial processing. Positive offset left-turn lanes are one countermeasure intended to reduce left-turn crashes by providing drivers with an unobstructed view of oncoming traffic. While positive lane offsets tend to reduce crash risk, space requirements for positive offset turn lanes make them impractical to install at some intersection locations. An alternative to positive offset lanes is to reduce the degree of negative offset, but evidence for the efficacy of less dramatic lane offsets is mixed. We examined how large (11.8 ft) and small (3.2 ft) negative lane offset influenced the turning behavior (gap acceptance) of younger, middle-age, and older drivers in a series of driving simulator studies.

Method

Participants

35 younger adults, aged 31 to 35 ($M = 23$ years)
23 middle-aged adults, aged 50 to 64 ($M = 58$ years)
25 older adults, aged 65+ ($M = 72$ years)

Tasks 1 and 2 were completed during a single 1 hour session

Task 1: Left Turn Judgments

Viewed scenes from the perspective of a driver in either a large negative offset (11.8 ft) or minimal negative offset (3.2 ft) left-turn lane

Presented with a continuous stream of traffic with varying gaps between cars

Speed of oncoming traffic varied between subjects, either 35 mph or 45 mph

Prompted every 2.5 or 5.5 seconds to indicate whether or not it was safe to turn

Made a total total of 147 turn judgments

Dependent measure was the distance between the participant's vehicle and the nearest oncoming vehicle

Task 2: Simulated Driving Task

Participants completed a simulated driving task where they executed four left turns at signal-controlled intersections

Two turns were made from negative offset left turn lanes and two were made from minimal offset left turn lanes

Speed of oncoming traffic varied between subjects, either 35 mph or 45 mph

Dependent measure was the distance between the participant's vehicle and the nearest oncoming vehicle

Eye movements were also recorded during the task



Figure 2. Driver's view from the left-turn lane for negative offset (left) and minimal negative offset (right) lanes

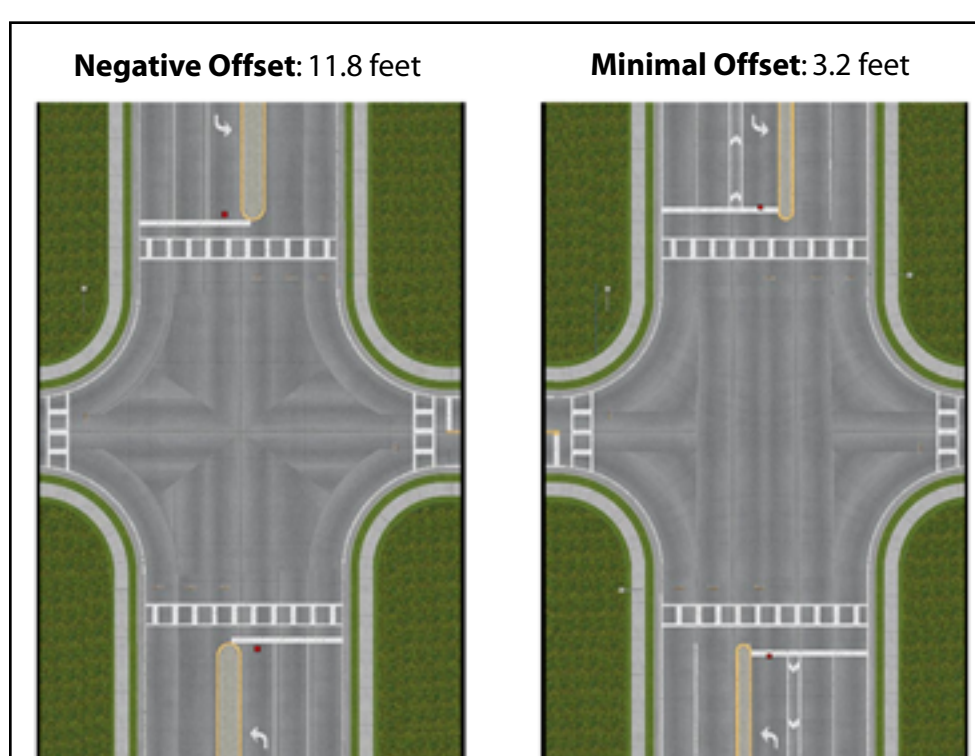


Figure 1. Negative offset and minimal negative offset left turn lanes

Task 1: Results

Participants accepted smaller gaps when oncoming traffic was moving at 35 mph than at 45 mph, $F(1,58) = 13.81, p < .001, d = .94$

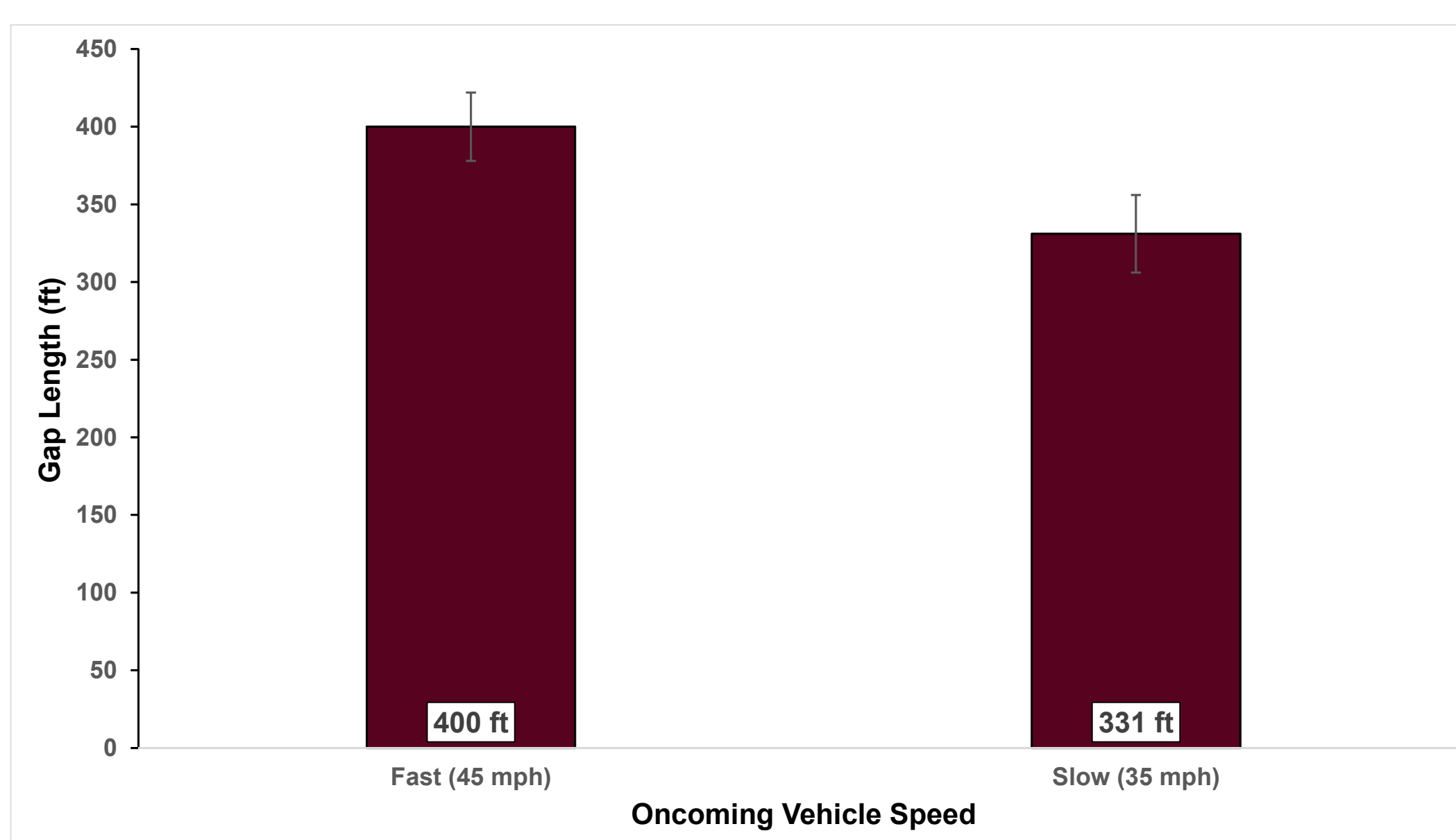


Figure 3. Average gap length by oncoming vehicle speed for Task 1.

Table 1. Summary statistics for gap length by age group, turn lane type, and vehicle speed

	Mean			Standard Deviation			Participant Count		
	Neg.	Min.	Overall	Neg.	Min.	Overall	Neg.	Min.	Overall
Age Group									
Younger	371	397	384	63	87	76	17	18	35
Middle	360	346	353	69	77	72	12	11	23
Older	361	315	341	89	114	100	14	11	25
Veh. Speeds									
Fast	400	400	400	31	49	71	22	17	39
Slow	329	333	331	25	55	80	21	23	44
Overall	365	362	364	71	95	83	43	40	83

Task 2: Results

Participants made safer turning decisions when making turns from minimal negative offset left turn lanes than from lanes with a large negative offset, $F(1,67) = 10.45, p < .01, d = .44$

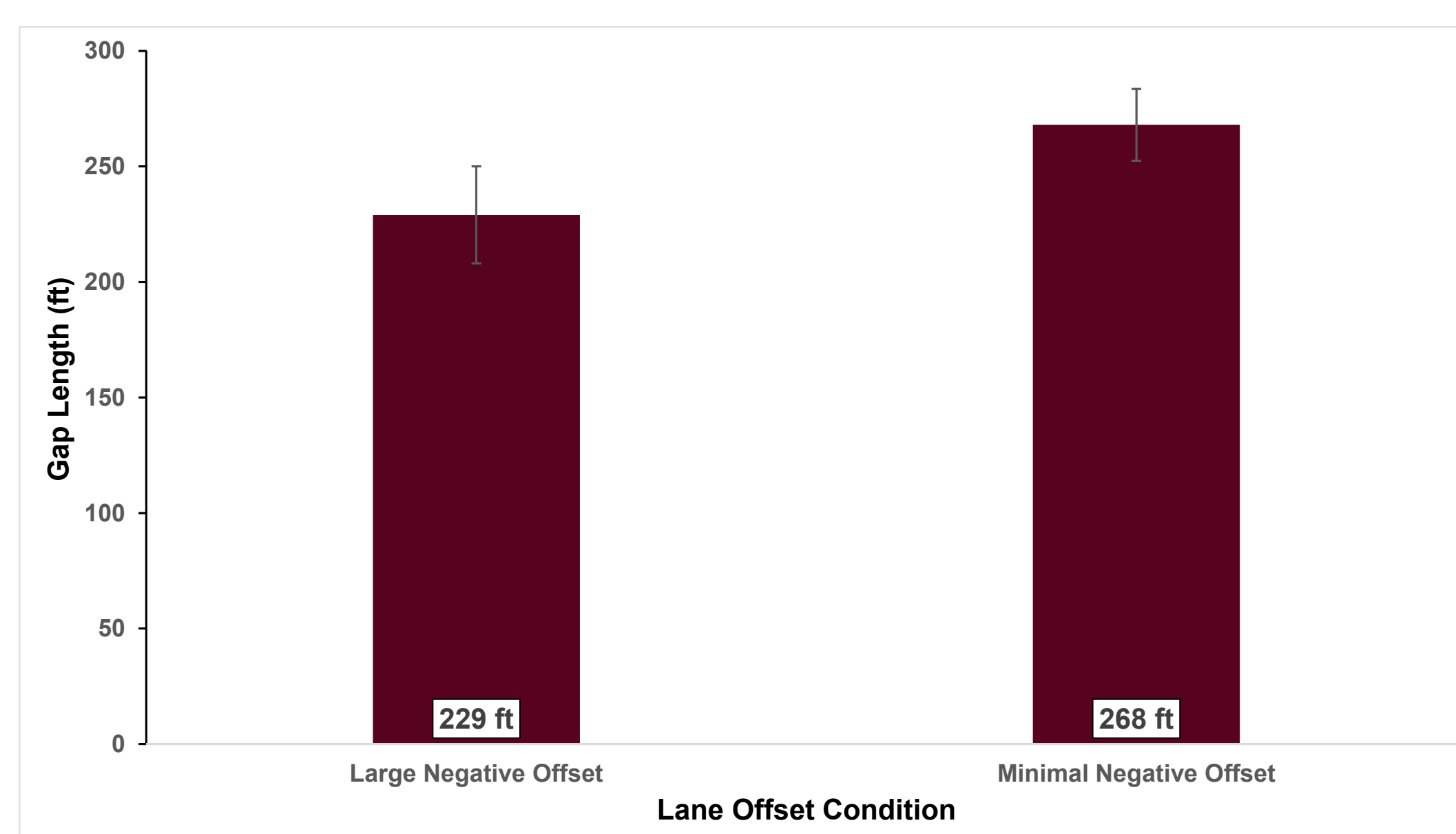


Figure 4. Average gap length by lane offset condition

Task 2: Results

Younger adults made riskier turn decisions than did middle-aged, $d = .73$, or older adults, $d = .79$, $F(2,67) = 5.06, p = .01$

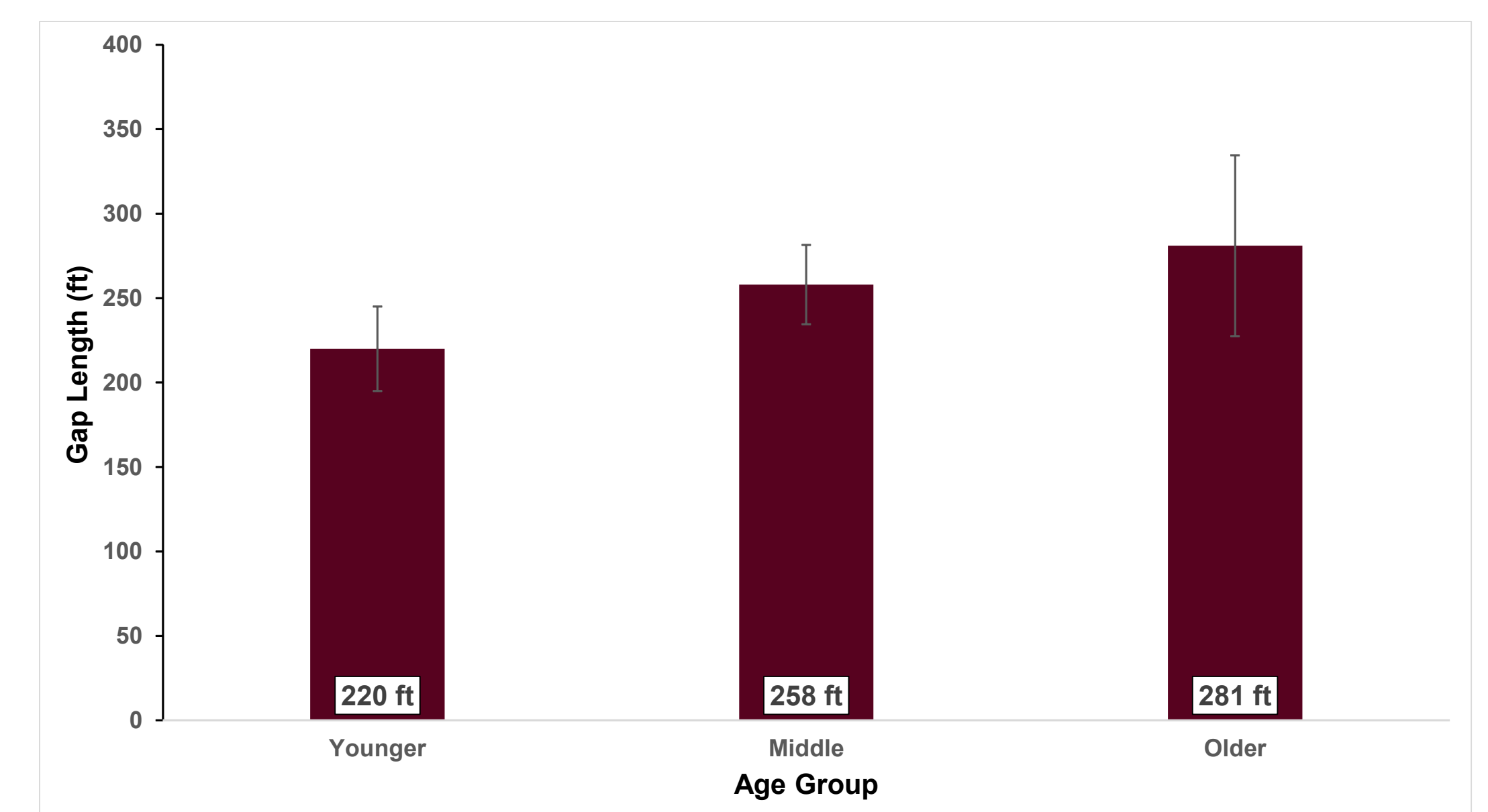


Figure 5. Average gap length by participant age group.

Table 2. Summary statistics for gap length by age group, turn lane type, and vehicle speed

	Mean			Standard Deviation			Participant Count
	Neg.	Min.	Overall	Neg.	Min.	Overall	
Age Group							
Younger	206	234	220	86	51	72	31
Middle	238	279	258	55	46	54	20
Older	254	308	281	154	95	129	22
Veh. Speeds							
Fast	238	271	255	122	59	97	41
Slow	217	266	241	81	89	88	32
Overall	229	269	249	106	73	93	73

Summary

A safety advantage was observed for all age groups for the small negative lane offset condition

Participants executing turns from left turn lanes with a smaller negative offset made safer turns, leaving a larger gap between their vehicles and oncoming traffic in a simulated driving task

Results suggest even less dramatic increases in the visibility of oncoming traffic can aid in the decision making process of the turning drivers of all ages, leading to safer left turn decisions

An implication of current findings is that when possible, and when relevant (e.g., offset probably has a minimal impact on protected turns), minimal negative offset or positive offset lanes should be implemented

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