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Human Factors Guidelines to Develop Educational Tip Cards for Aging Road Users

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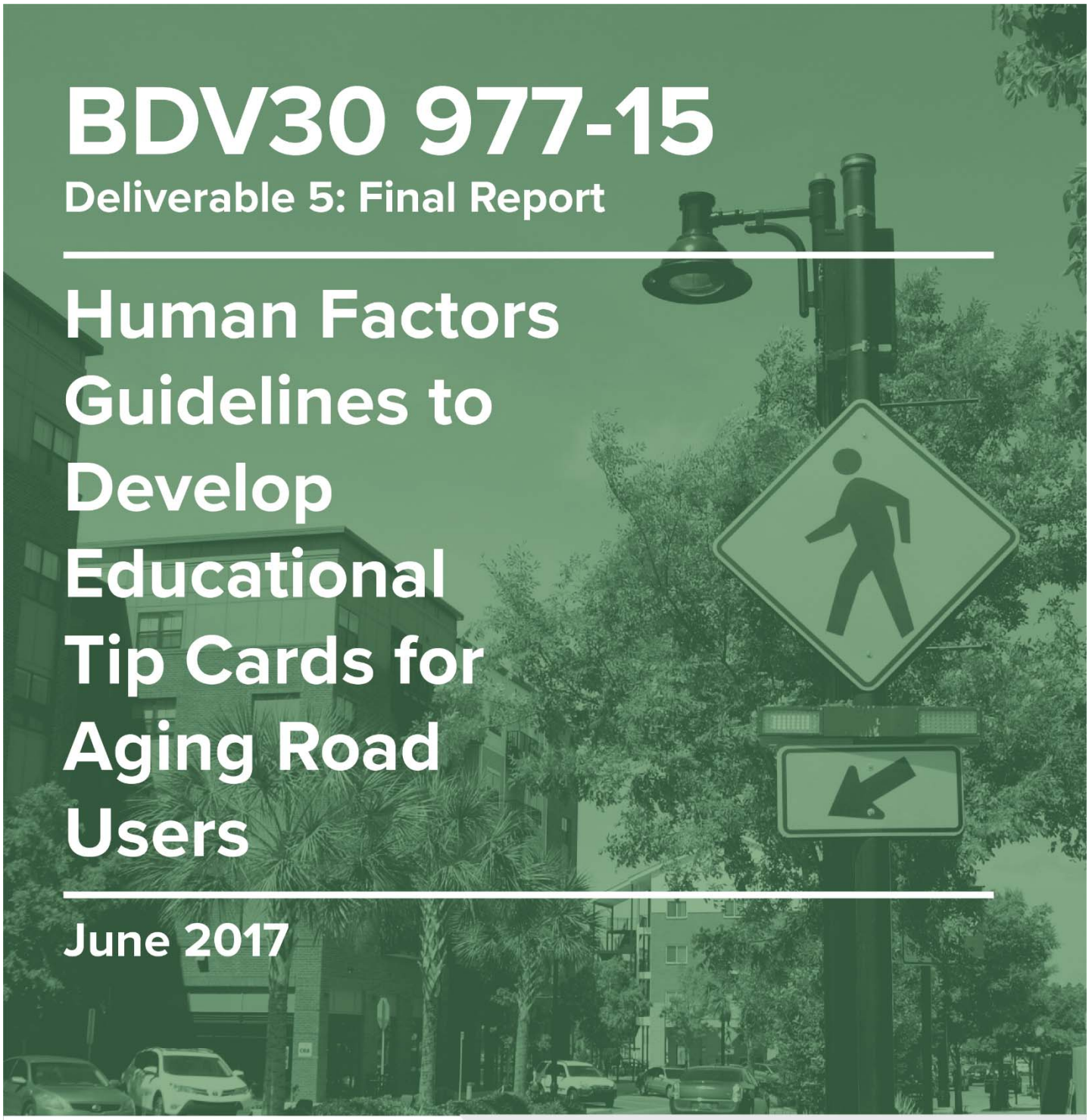

Prepared for

FDOT

Florida Department of Transportation

Prepared by

Dr. Neil Charness
Dr. Walter Boot
Dr. Michael Kaschak
Dr. Laura Arpan
Dr. Juliann Cortese
Dr. Russell Clayton
Dr. Cary Stothart
Nelson Roque
Brennan Paedae
Kimberly Barajas

Final Report:

Human Factors Guidelines to Develop Educational Tip Cards for Aging Road Users

Neil Charness, Walter Boot, Michael Kaschak, Laura Arpan, Juliann Cortese, Russell Clayton, Nelson Roque, Brennan Paedae, Kimberly Barajas.

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Department of Psychology
Florida State University
Tallahassee, FL 32306-4301

Project Manager: Gail Holley,
FDOT Traffic Engineering and Operations Office

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Disclaimer

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the State of Florida Department of Transportation or the U.S. Department of Transportation.

Prepared in cooperation with the State of Florida Department of Transportation and the U.S. Department of Transportation.

SI* (Modern Metric) Conversion Factors

Approximate Conversions to SI Units

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")

TEMPERATURE (exact degrees)				
ºF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	ºC
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2

FORCE and PRESSURE or STRESS				
lbf	pound force	4.45	newtons	N
lbf/in^2	pound force per square inch	6.89	kilopascals	kPa
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3

MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
TEMPERATURE (exact degrees)				
^{o}C	Celsius	1.8C+32	Fahrenheit	^{o}F
ILLUMINATION				
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-Lamberts	fl
FORCE and PRESSURE or STRESS				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

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16. Abstract

Our objective was to provide empirically supported guidelines and templates for the design of tip cards and other public service transportation materials to educate aging road users on traffic control devices. Task 1 identified relevant theories and data concerning the design of public service materials. We used this literature review to provide guidelines in the form of a human factors checklist. We then validated these guidelines. Task 2 aimed to produce tip cards to educate aging road users about correct actions to take for flashing yellow arrow (FYA), rectangular rapid flashing beacon (RRFB), and Right Turn on Red (ROR). We tested samples of younger (21-35 years), middle-aged (50-64 years), and older (65 years and older) drivers and compared standard and enhanced designs, conducting attitude and memory surveys, lab-based studies of speeded decision making, and a driving simulator study. We assessed human factors usability criteria of *learnability*, *efficiency*, *memorability*, *errors*, and *satisfaction*. Enhanced cards that conformed to the guidelines showed a large advantage in reading time over standard ones (*efficiency*) and an advantage in shorter wait times for making permissible right turns in a ROR simulator scenario (*efficiency*). They were not consistently superior for measures of learnability, memorability, errors, or satisfaction, but are considered effective. Task 3, based on the outcomes of usability testing, aimed to produce updated guidelines and example templates for tip card generation that attended to ordering and layout of components such as text and graphics and legibility of such materials, to yield designs that support comprehensibility and memorability. We generated specific templates for tip card production in a variety of Adobe formats.

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We also thank Craig Carnegie and Mercedes Spencer for their assistance with scheduling, and we thank the many Florida State University psychology undergraduates who worked on this project. We are also extremely grateful to all the Florida and other state residents who participated in this research.

Executive Summary

When new traffic control devices are introduced on a roadway system, it is important that aging road users have enough information to be able to respond to them safely and efficiently. Tip cards are a potentially effective method for communicating this information. Initially, we reviewed the literature on designing media materials for older adults, focusing on age-related changes in attention, encoding, comprehension, attitudes, and motivation as well as ways to mitigate those changes. We then generated a human factors checklist consisting of best practices for design. We then attempted to validate the design guidelines through a series of experiments that compared usability of standard and guideline-enhanced tip cards with younger (21-35), middle-aged (50-64), and older (65+) drivers. The usability facets we examined included learnability, memorability, efficiency, errors, and user satisfaction.

An initial usability study (Study 2a) examined learnability based on participants' understanding of card information immediately following reading about flashing yellow arrow (FYA) and rectangular rapid flashing beacon (RRFB) traffic control devices via standard or enhanced tip cards. Results showed that enhanced tip cards that followed our guidelines were able to convey the same information in less reading time than existing tip cards with equivalent user satisfaction measured by attitude questions. We next evaluated tip card long-term memorability for standard vs. enhanced tip cards either immediately or after a one-week delay (Study 2b) using lab-based experiments requiring rapid decision-making in traffic scenarios containing those traffic control devices. No difference in memorability was observed and overall performance was quite high even in the absence of tip card exposure. We found slightly better performance using realistic photographs compared to stimuli created using 3-D modelling software for rapid decision-making about traffic control devices.

Next, we drew on these findings in a simulator study (Study 2c) to see if the enhanced tip cards would result in benefits to middle-aged and older driver behavior. We measured wait time to turn and number of permissible turns executed when drivers encountered FYA and right-on-red (ROR) traffic control devices in a driving simulation task after drivers read both a relevant and an irrelevant tip card. Drivers encountered a total of four left and right turns with opposing or no traffic. Drivers rated the tip cards for effectiveness after completing the driving task. Reading times for relevant and irrelevant tip cards did not differ nor was there an effect of age group. Based on the rating data, the waiting time data for the ROR tip card, the number of executed permissible turn results, and results from prior studies, we concluded that the enhanced tip cards were effective. Reflecting these findings, we generated templates for future tip cards (Study 3) and updated the human factors checklist.

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Chapter 1: Introduction

When designing educational materials for public dissemination, many factors are important to ensure that the intended message reaches the target audience, especially when the message concerns public safety on our roadways. In support of various programs over the past few years, the Florida Department of Transportation (FDOT) has developed and distributed several empirically validated tip cards to assist Florida road users with commonly reported confusions as well as for newly implemented traffic control devices (for a recent validation of the flashing yellow arrow tip card for use by aging road users, see a previous research project BDV30-977-04). However, the efficacy of these educational materials in quickly conveying safety-relevant educational content largely depends on the appropriateness of the design for all intended audiences. Through the implementation of FDOT's aging road user program, older adults (age 65 and older) – projected to reach 84 million by 2050 – are a priority when designing effective communications, as several age-related changes (i.e., declines in working memory and other cognitive and perceptual abilities) may present additional challenges to this population when navigating our roadways. Middle-aged adults, those aged 50 years and older, are also considered an important group of aging road users to educate. Outreach through improved communication is a vital component to reducing the crash, serious injury and fatality rates for this growing and vulnerable population and a focus area in Florida's 2017 Aging Road User Strategic Safety Plan complementing the Florida Transportation Plan.

In this project we first outline a general framework for effective communication that can guide design of communication materials. We review and evaluate the literature on aging and design pertaining to the factors identified in the framework. We explore guidelines currently in place for designing education materials and identify the particular design elements that serve to increase attention, comprehension, and memory, potentially leading to long-term behavior change, with a focus wherever possible on studies involving aging road users. In the process, we discuss several promising theories regarding factors that influence a population's motivations to engage in a recommended behavior (Atkin & Rice, 2013). We incorporate those theories and data into a set of tip card design guidelines.

In a series of tasks, including surveys, experimental, and driving simulator tasks, we tested standard and guideline-enhanced tip cards comparing the performance of younger, middle-aged, and older drivers to assess usability of the enhanced cards. Finally, based on the findings of those empirical studies, we refine our guidelines and provide templates for the design of future tip cards.

Objectives and Supporting Tasks

In this project, our objective was to provide empirically-supported guidelines and templates for the design of tip cards and other public service transportation materials aimed at educating aging road users on traffic control devices. We addressed that objective with a series of tasks.

Task 1 had the objective to identify relevant theories and existing data concerning the design of public service transportation materials for aging road users. Candidate theories include embodied cognition, the integrated model of behavioral prediction, and the Communication-Human Information Processing theory about the design of warning signs. We used that literature review to provide guidelines in the form of a human factors checklist for designing tip cards.

Task 2 had the objective to produce tip cards to educate aging road users about correct actions to take when encountering flashing yellow arrow (FYA) and rectangular rapid flashing beacon (RRFB) on the roadway system. These materials were evaluated by conducting human factors usability testing stressing assessment of the dimensions of learnability, efficiency, memorability, errors, and satisfaction. We compared standard and enhanced designs by conducting lab-based experimental studies of speeded decision making and by a driving simulator study testing samples of younger (21-35), middle (50-64) and older (65+) drivers.

Task 3 had the objective, based on the outcomes of usability testing and validation, to produce updated guidelines and example templates for tip card generation, aimed particularly for aging road users (65 years and older), that attended to ordering and layout of components such as text and graphics, legibility of such materials (e.g., fonts, color, and contrast), yielding designs that support comprehensibility and memorability. We generated specific templates for tip card production in a variety of formats including Adobe standard formats as well as in Microsoft Powerpoint and Publisher.

Chapter 2: Theories and Data about Communicating Safety Information to Aging Road Users

A Framework for Effective Communication

Figure 1 outlines a general framework for understanding the processes underlying effective communication of safety information, derived in part from the Conzola and Wogalter (2001) Communication-Human Information Processing (C-HIP) model for warning effectiveness.

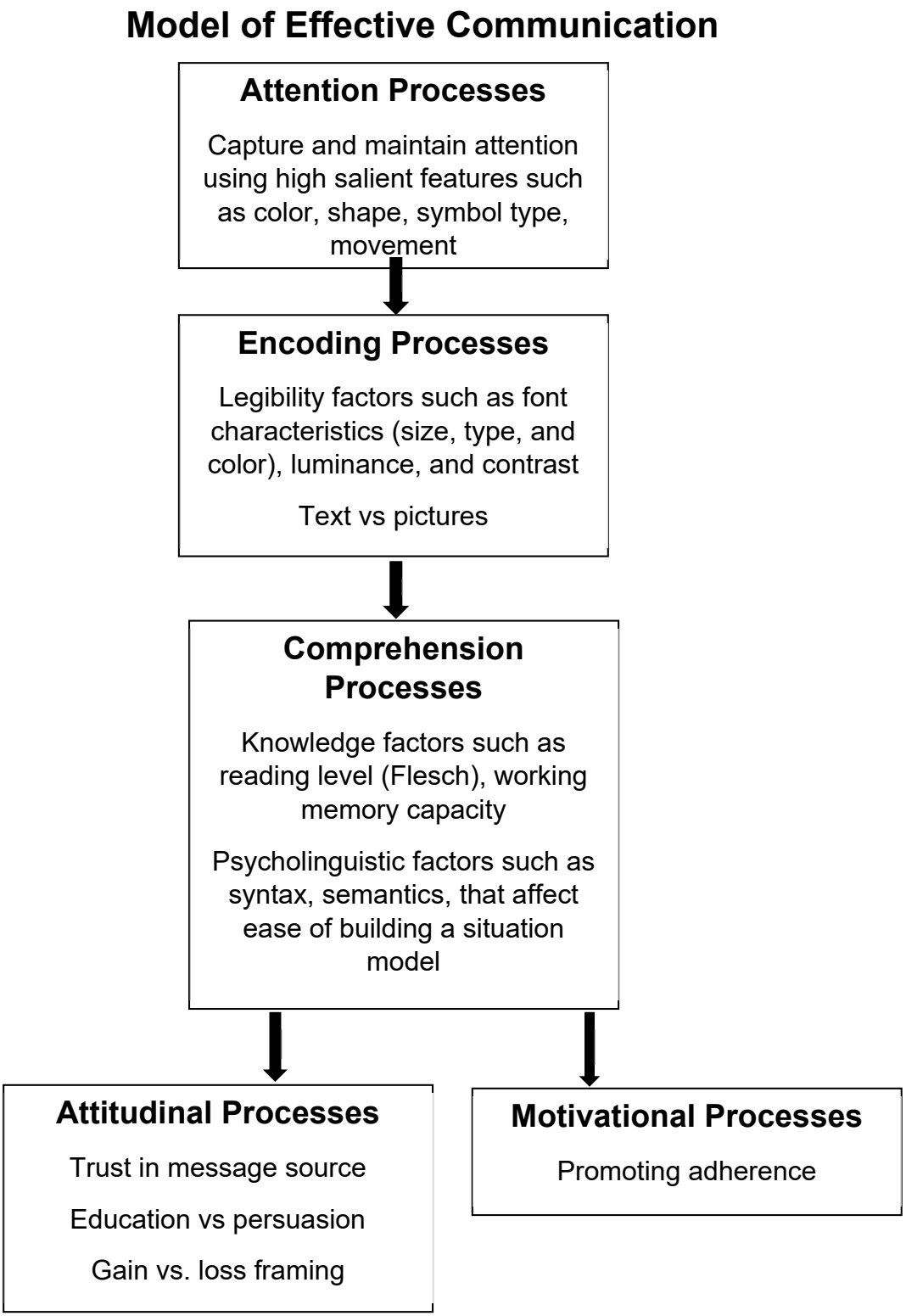

Figure 1. Model of effective communication

At the first stage of processing, a message must capture the target user's attention. Next, the information in the message must be encoded, comprehended, and remembered. Finally, messages need to be crafted to be trusted, and be consonant with and possibly change the user's attitudes toward and motivation to perform the target behaviors. A critical issue is how age-related changes affect those processes. An outline is provided in Figure 2.

Attention Processes Capture and maintain attention using high salient features such as color, shape, symbol type, movement	**Age & Attention** Decreased peripheral vision and Useful Field of View, greater distractibility (inhibition failure), slower detection of movement
Encoding Processes Legibility factors such as: font characteristics (size, type, and color), luminance, and contrast, Text vs pictures	**Age & Encoding** Poorer visual acuity and contrast sensitivity, weaker color perception in short wavelengths
Comprehension Processes Knowledge factors such as reading level (Flesch), working memory capacity Psycholinguistic factors such as syntax, semantics, that affect ease of building a situation model Memorability factors such as running a simulation, self-reference	**Age & Comprehension** Lower educational attainment, less working memory capacity, general slowing in processing of information, slower learning rate
Attitudinal Processes Trust in message source Education vs persuasion Gain vs. loss framing for risk	**Age & Attitude** Greater trust in authority, less risk taking than younger adults in gain and loss framing
Motivational Processes Promoting adherence	**Age & Motivation** More adherent, unless severe cognitive impairment

Figure 2. Factors for effective communication (left) and corresponding age-related changes (right).

Figure 2 outlines, on the right hand side, known age-related changes that should influence the design and framing of messages for older adults. Perceptual and cognitive changes (see Fisk, Rogers, Charness, Czaja, & Sharit, J., 2009) can be expected to slow processing of messages. Visual changes such as presbyopia,

yellowing of the lens, light scattering in the optical media that increases susceptibility to glare, and decreased pupillary excursion result in significantly poorer transmission of light through eye structures (decreased luminance at the retina) and poorer perception of short wavelength colors. Typically, light transmission to the retina by age 65 declines to one-third of the intensity experienced at age 20 for dim lighting conditions. An excellent source for older adult sensory capabilities based on a Japanese sample is available at: http://scdb.db.aist.go.jp/?lng=en . It can be used to compute values such as the minimum font size to be used under varying light conditions and distances of the text from the eye.

Attention Processes

Specifically, in the case of tip cards, we can assume that if handed or mailed a tip card, an older adult will be polite enough to accept it, so gaining attention is not likely to be problematic. However, making the card visually attractive is likely to be important to their retaining it and reading it at a later time. Having colored materials to retain attention may be important though there is very little literature on this topic. Most of the literature is concerned with visual onset effects (e.g., Pratt & Bellomo, 1999) and motion capture for attention (Carrasco, 2011). Such literature suggests that as long as materials are within the useful field of vision, as would be the case when reading a tip card, older adults are similar to younger adults. However, older adults are more likely to be influenced by irrelevant information and sidetracked from the main task (comprehension). As an example, Carlson, Hasher, Zacks, & Connelly (1995) asked older and younger adults to read sentences in a regular font that alternated with lines in italic font that were to be ignored. Reading times were more disrupted in older adults and spatial predictability was helpful in mitigating these effects. These types of findings are relevant to recommendations about print layout, arguing that crowded or cluttered materials are likely to impair older adults' comprehension.

Encoding Processes

A useful framework for understanding messaging effectiveness takes into account stages of information processing for visual and aural information. Take the example of a tip card intended to educate drivers about a new traffic control device, such as the flashing yellow arrow. First, the message must be attended (e.g., fixated with the eye), then the markings on the page must be encoded, likely first as letters forming words, then as semantic relations that are compiled into a situation model that enables the reader to imagine the situation described (simulate it) and if stored successfully in long-term memory, later reference in order to carry out the appropriate behaviors when perceiving a flashing yellow arrow while driving.

Decades of research have outlined some of the key factors for increasing awareness, legibility, comprehension, and memorability of information, In the following sections we will evaluate the best evidence and recommendations currently in place for designing effective materials through the optimization of: salience (e.g., is prominent information uniquely displayed to draw attention?); legibility (e.g., is the font size appropriate for the visual acuity of the target audience and given media?); readability (e.g., is the language used appropriate for the average reading level of the audience?);

and organization (e.g., are related pieces of information visual grouped together). Where possible, we emphasize research that takes into account age effects that can hamper processing of such messages by aging road users.

Optimizing Legibility

The clarity of a visual design of a single piece of information within a material can be considered to be just as important as the language of the information, since a lack of legibility can result in a great message being lost in translation. In this section we will explore evidence for each of the factors said to influence legibility (i.e., font weight/size/family/typeface, color selection, contrast, layout/organization), as well as the utility of pictures in making a message clearer and more memorable.

Font Choice. The classic work on print legibility was conducted by Tinker (1963) who examined a broad range of factors from font type, weight, point size, color, to luminance conditions, to angle of reading print. Of the many factors that influence the legibility of print, luminance (lighting level) is the most important (Tinker, 1963), showing far larger effects than print size, print color, typeface/font, orientation of print, etc. Given that one cannot easily control the luminance conditions where tip cards are read, and a study involving Leon County residents showed that homes in particular tend to have low luminance levels, about 40 cd/m^2 (Charness & Dijkstra, 1999), we concentrate on factors that are controllable in the production of those materials.

We are concerned here with factors of relevance to older adults who can be expected to have normative changes in vision that may impair reading processes. When choosing a font for educational materials, there are several considerations: size of the media the font will inhabit, font weight (i.e., how bold or thin), size, family (e.g., Helvetica, Times New Roman, Comic Sans) and typeface (i.e., serif, sans serif) all have unique influences on not only awareness, but also comprehension and recall -- differently so depending on whether the message is printed or digital. In one study, the researchers were interested in investigating the font selection most appropriate for prescription bottles. In this systematic study comparing several font families, weights, and sizes, it was found that bold, 12 point, Century Schoolbook font text was the most readable (at differing rates of reading) by both younger and older adults (Smither & Braun, 1994). Others would argue that the specificity of the font selection is not as important as its familiarity (“Bizarre or indistinct typefaces should be avoided”, Hartley, 1994).

In another study, participants were given a printed office memorandum about Tuberculosis -- printed in either serif or sans serif typeface, with either proportionally spaced (i.e., a letter “l” takes up less space than a letter “m”) or monospaced (i.e., each letter takes up an equal amount of space) letters -- and later tested for their recall of key points. Letter spacing (i.e., proportional or monospaced) was found to have no effect on recall, but serif font was found to result in a 9% improvement in recall for key points of the memorandum, an improvement the authors claim has “practical value” especially when the information is health or safety related (Gasser, Boeke, Haffeman, & Tan, 2005). There is an important caveat to consider with this improvement in recall; serif fonts become harder to read at small sizes. Overall, as is the literature surrounding font family, the literature on font typeface is divided with some groups of researchers

claiming benefits to readability and legibility for serifs and others for san-serif fonts, including the recently compiled Japanese database. (For a full literature review on the elements of text and message design, see Bix, 2002).

Color Choice & Contrast.

Similar to font selection, color choice for educational materials is a complex task, requiring an understanding of: color theory (e.g., hue, saturation, value model of color), contrast (high contrast: black text, white background; low contrast: red text, orange background), color associations (i.e., what feelings or emotions are associated with certain colors), color preferences (i.e., what colors are preferred by the intended audience), and the salience (i.e., uniqueness of a color within its context) of a given color. This section will highlight evidence for improvements in awareness, comprehension, and recall through those factors.

Optimizing Readability

A thorough review of the medical and public health literatures for several decades, demonstrated that a key issue with most health education materials is the inappropriateness of their language for the target audience, specifically when these materials are designed with a higher literacy level than the audience possesses (Rudd, Moeykens, & Colton, 1999). When the ultimate goal of designing effective educational materials is the transfer of knowledge to inform future behaviors, it is important to design messages that can be easily understood by the general public. Several recommendations have been offered by public health and safety organizations as to how best to format these messages (Doak, Doak & Meade, 1996; U.S. Department of Agriculture, 1988; U.S. Department of Health and Human Services, 1989; Szudy & Gonzalez-Arroyo, 1994; National Cancer Institute, 1994), with most guidelines focusing on the language and semantic structure of the message, and less on the overall design. One such recommendation is the translation of jargon-filled federally mandated language into plain language and bulleted lists (Rudd, Kaphingst, Colton, Gregoire, & Hyde, 2004). In this case study, Rudd and colleagues outlined the entire process (12 steps, see Table 1) for rewriting complex language into simple language, in addition to noting some roadblocks along the way.

Table 1. 12 steps for rewriting complex language into plain language. Reproduced from Rudd et al. (2004).

Table 1. 12 Steps for Re-Writing Complex Language into Plain Language

1. Conduct an initial readability assessment for baseline.
2. Highlight and develop options for complex vocabulary.
3. Substitute everyday words for multi-syllabic and unusual terms.
4. Re-write all complex sentences and, where needed, substitute two or three sentences.
5. Re-write all sentences in an active voice.
6. Insert words such as 'we' and 'our' to maintain a collaborative and personal voice.
7. Assess all tables, charts, and graphs for complexity.
8. Simplify complex tables, charts, and graphs.
    a. Substitute two or three simple charts in place of one complex chart.
    b. Consider use of color coding for more complex tables, charts, or graphs.
    c. Construct a glossary of terms for needed bureaucratic or scientific language.
9. Conduct a readability assessment of the text and of the documents within the text.
10. Pilot test: engage panels of reviewers. Include members of the intended audience as key reviewers.
11. Modify the report as needed to meet the needs and suggestions of members of the intended audience and other reviewers.
12. Avoid the temptation to re-insert jargon or unusual words.

One such road block involves the use of technical language that is difficult to simplify without altering the intended message. In order to verify the ease of reading educational materials, several formulas presently exist each with its own set of strengths and shortcomings, and underlying theoretical model. The most widely used is the Flesch reading ease formula, (Flesch, 1948), where the readability of a given passage is determined as a function of average sentence length and syllable count. Although language is an important aspect when considering the design of effective educational materials, it is only one piece to the puzzle. Older adults are a very diverse group in terms of reading skills. However, on average, about 70% of those age 60+ years scored in the two lowest levels (of 5) in the National Adult Literacy Survey (Brown et al., 1996). Such results suggest that reading materials be kept to grade 8 or lower levels.

Layout & Organization

Pictures and Illustrations. "A picture is worth ten thousand words" is a familiar saying. Cognitive scientists have made steady progress toward understanding when pictures or diagrams can be expected to be superior to text (e.g., Larkin & Simon, 1987), mainly through understanding how easily appropriate representations can be accessed and valid inferences generated. Empirically, one way to boost the comprehension of materials, especially when the removal of complex language is not possible or must be limited, is the integration of additional information through the use of visual imagery (i.e., dual-code theory; Paivio, 1991). In the medical literature, the use of symbols, illustrations, and pictures for improving patients' understanding of medical information, specifically for new devices, has been largely studied (Kools, van de Wiel, Ruiter, & Kok, 2006; Peregrin, 2010). One such study compared memory recall and ease of using asthma devices, after reading either a text-only description of these devices or textual descriptions containing illustrations (Kools, et al., 2006). In this study, it was found that images not only contribute to better comprehension of the written material, but also improve recall of more specific details than the textual information alone. This finding is in line with findings from several reviews of the literature, in that pictures are better than no pictures – but this issue is a bit more complex. Literacy was not assessed in the study previously mentioned, but others have investigated the influence of literacy on the impact of images for educational materials, finding that those with low literacy are likely to benefit the most (Peregrin, 2010) from images. But not all images are created equal; will a line drawing, a colored illustration, and a photograph all produce similar improvements in comprehension and recall? Reviews of the literature on this very topic have shed light on the answer to that question.

In their review of the text comprehension literature, Levin and Lentz found that images whose content did not closely match the text, did not improve comprehension, as they did not boost understanding of the given context (Levin & Lentz, 1982). The utility of an image depends on its context, as well as it's intended use. For a quick glance at the effectiveness of pictures as a function of their purpose in a material, see Figure 3; for a detailed review of these effects, see Levin, Anglin, & Carney (1987).

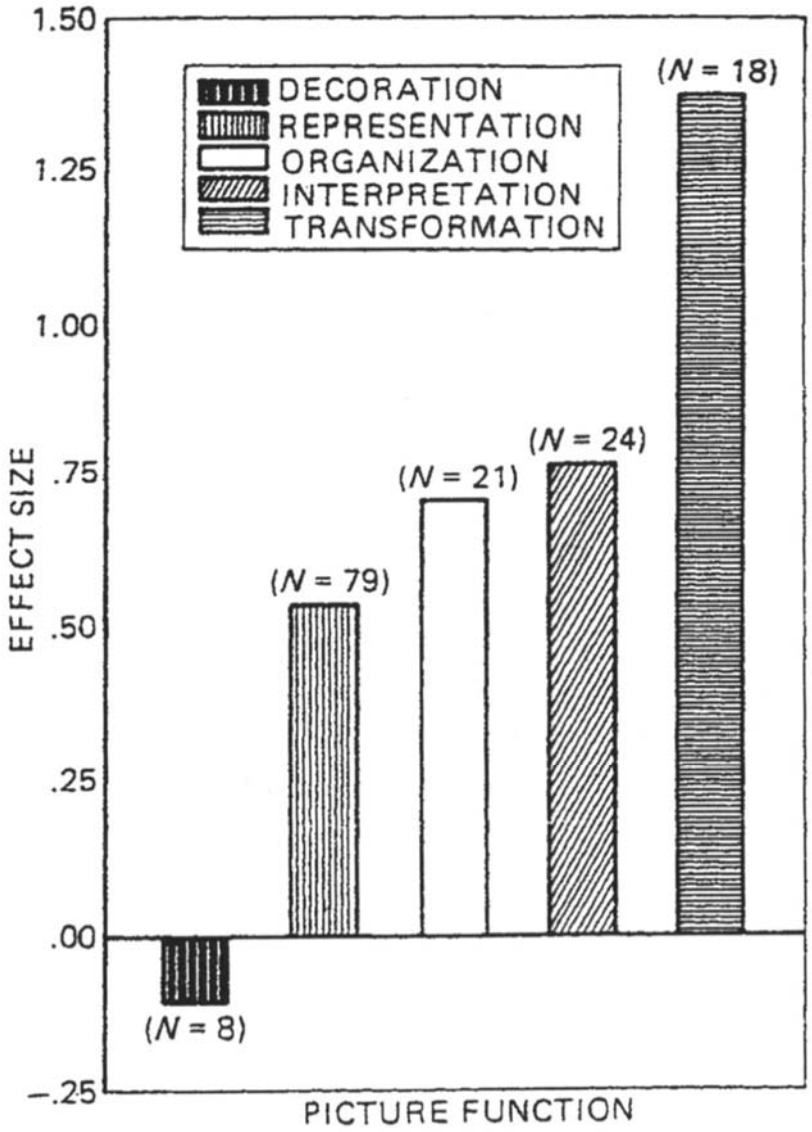

Figure 3. Average effect size by picture function. Reproduced from Levin et al. (1987).

Levin and Lentz also explained that when the use of complex pictures is required, it is important to cue observers to the most relevant information by the use of salient colors or lines/arrows; an overwhelming picture is equally as unhelpful as a jargon-filled document. In a more recent review, summarizing the findings from several decades of research on this topic, researchers explained that simple pictures are always best, avoiding abstract symbols, and superfluous details when possible (for a full list of recommendations, see Houts, Doak, Doak, & Loscalzo, 2006). This review also highlighted the importance of cultural sensitivity when designing messages (though their focus was in the medical literature), and including the target audience in the formative research of selecting appropriate images.

Benefit of Pictures for Memory

Picture Superiority Effect. There have been many studies over the last several decades that have provided evidence indicating that concepts learned by viewing pictures are more easily recalled than when the same concepts are presented via words (McBride & Dosher, 2002). For example, in one very early study, Shepard (1967) pre-exposed participants to groups of words, sentences, or pictures (in three separate experiments) and then showed the same participants pairs of stimuli (one old, or previously seen, and one new). Participants saw either two words, two sentences, or two pictures and were asked to identify which of the two was the old (previously viewed) stimulus. Results indicated that participants correctly identified the old stimuli for 98% of the picture pairs, 90% of the word pairs, and 88% of the sentence pairs.

In order to explain the picture superiority effect (PSE), researchers have turned to encoding theories, such as dual-coding theory and sensory-semantic theory, as well as a processing strategy called, transfer-appropriate processing (see McBride & Dosher, 2002). Dual coding theory suggests that pictures are remembered more easily than words because they elicit a dual coding process that engages both verbal and visual channels, whereas text engages just one coding process, the verbal channel (Paivio, 1991). Similarly, sensory semantic theory speaks to how pictures are encoded differently from text and points to two specific differences (Nelson, Reed, & McEvoy, 1977). First, pictures are perceived as more unique than words. These differences help to aid encoding and retrieval (i.e., searching the associative memory networks and activating a specific piece of content into working memory). Second, when pictures are encoded, a semantic connection between the picture and its label is engaged in order to garner meaning from the picture. This semantic connection allows for deeper encoding of the picture.

Where both dual-coding and sensory-semantic theories focus on the encoding process, transfer-appropriate processing (TAP) theory focuses on the interaction of encoding and retrieval and states that pictures are remembered more easily than words because there is an interaction between encoding and retrieval (Weldon & Roediger, 1987). Because encoding of pictures requires assessment of meaning more so than encoding of words, retrieval prompts that cue conceptual meaning are considered more closely aligned with the encoding process engaged in when encountering pictures. This overlap between encoding and retrieval accounts for better memory for pictures than words. McBride & Dosher (2002) examined PSE and have noted evidence of TAP, in that the PSEcan be explained by an interaction between the encoding and retrieval process.

Researchers have examined factors that might affect PSE, such as response time. Study findings have indicated that greater PSE was associated with instances where participants were given more time to respond to prompts (Boldini, Russo, Punia, & Avons, 2007). Specifically, when time to respond was manipulated, participants given a shorter time to respond (less than 200 msec) were more likely to remember words instead of pictures, yet participants given a longer response time (greater than or equal to 2,000 msec) were more likely to remember pictures instead of words. The researchers concluded that although the exact mechanisms underlying PSE require

further study, memory appears to be affected by both fast familiarity of elements as well as slow retrieval.

Age is another factor that affects PSE. Studies have found that PSE increases as people age from children, to adolescent to young adult. Whitehouse, Maybery, & Durkin (2006) studied children from grade 2 to grade 11 and found that, though all grade groups studied displayed better recall of pictures than words, the PSE increased with age (there was more of a discrepancy between recall of pictures versus words for older children than younger children). Defeyter, Russo, & McPartlin (2009) found similar results studying PSE in participants aged 6-23 in that they found evidence of PSE in almost all age groups (the youngest group was the exception) when given sufficient response time. With a short response time, PSE was detected in only older participants, ranging in age from 10 to 23. The researchers concluded that there is a developmental trend with regard to PSE.

Studies focusing on an older adult population have also yielded evidence of PSE, indicating that images can be used to aid memory in all adult age groups (Winograd, Smith, & Simon, 1982). For instance, Park, Puglisi, and Smith (1986) examined how varying image detail would affect image recall for older and younger adults. They recruited college students as their young adult sample and adults age 60 and over for the older adult sample. Participants were presented with images that varied in their degree of detail from photographs to line drawings. Regardless of age, all participants remembered the more elaborate (photographic) images better than less detailed images when asked immediately after presentation of the stimulus material, but the older adult sample remembered fewer images than the younger sample at the follow up assessment four weeks later. In an examination PSE for just older adults, Cherry, Moffatt, Rodriguez, & Dryden (2002) studied four age groups labeled: middle-age (ages 45-59), young-olds (ages 60-74), old-olds (ages 75 to 89), and oldest-olds (ages 90-97). Participants were shown either line drawings or word pairs and then recall was tested. Results indicated PSE for all age groups. These studies provide support for PSE across ages and extending into late adult years. Taking this research a step further, Ally et al. (2008), used an event-related potentials (ERPs; a measurement of brain responses) analysis to examine picture recall compared to word recall for adults aged 60-83 as compared to younger adults, aged 18-25. Results of this study indicated the PSE was stronger for the older adult sample than the younger adult sample. This finding was supported by the results of the ERPs in that early and late frontal effects and parietal effects for pictures were the same for younger and older participants. But, early frontal effects and parietal effects for words were significantly reduced for older adult participants compared to younger adults. The researchers concluded that older adults experience memory impairments as they age and that pictures might help them to compensate for such memory issues. Researchers have also found evidence of the PSE for patients with Alzheimer's disease and mild cognitive impairment (Ally, Gold, & Budson, 2009; Ally, McKeever, Waring, & Budson, 2009).

Guidelines influenced by Picture Superiority effect:

- PSE supports the use of graphics.
- PSE may be particularly important for aging adults because it can aid memory for new information.
- Longer response time aids PSE, such as self-paced reading of a tip card
- Elaborate (detailed) pictures are remembered better than line drawings lacking detail

A useful set of specific guidelines for text material is available from the National Institute on Aging: https://www.nia.nih.gov/health/publication/making-your-printed-health-materials-senior-friendly and we integrate them into our recommendations.

Legibility Recommendations

- Use fonts of at least 12 point (x-height), with 14 pt preferred, **preferably bolded**
- From the Japanese database site, using Ming-cho Gothic sans-serif, at a distance of 0.4 m from the eye, under 60 cd/m^2, **minimum** legible font size is 12 pt (4.2 mm) for a 65-year old; for an 80 year old the prediction is 16.5 pt (5.8 mm)
- Prefer serif fonts, if large enough point size (12-14 pt +) and sans-serif fonts to decorative ones. Mixed case is preferable to all lower or uppercase unless a contrast, such as all uppercase, is needed for EMPHASIS.
- Assume tip cards will be read under home lighting so pilot test legibility of printed products under 40 cd/m^2 of luminance rather than the typical 100 cd/m^2 found in office environments. A smartphone application that measures lux or luminance can guide setting test luminance levels.
- Black text on white background or white text on black background is preferred to assure high luminance and color contrast
- Avoid black text on grey or colored backgrounds
- Avoid colored fonts, except for needed emphasis, and when using avoid short wavelength colors such as blue and violet.
- Use left-justification for text
- Consider double-spacing text (increases white space and predictability for start of line fixations)
- Try to limit line lengths to 50-65 characters, if necessary by using multiple columns
- Avoid wrapping text around pictures
- Avoid glossy materials (glare risk is high in other than diffuse lighting conditions).

Effective layout and design. Basic design principles focus on layout and design that foster ease of use and enforce content understanding and learning. The Centers for Disease and Control and Prevention (CDC) published a report detailing guidelines to enhance understanding of communication materials focusing on health concerns (US Department of Health and Human Services: CDC, 2009). Their guidelines focus on readability and organization of material to maximize understanding. Steps for making a message clear include: providing important information first followed by details and an explanation of topic importance; limit messages to one idea at a time; keep lists to 3 to 7 items; clearly indicate what the audience is asked to accomplish; focus on the positive by indicating what the audience should do, not what they should not do; and use short sentences that are free of jargon and worded as if speaking to a friend.

With regard to text the CDC recommends the following: fonts that are 12 to 14 points (larger print for those who have trouble seeing); headings should be two points larger than main text; use serif fonts for body text as they are easier to read than sans-serif fonts and use sans-serif fonts for headings and sub-headings; avoid using italics and underlining because they are difficult to read; and keep contrast high with light text on dark background or dark text on light background.

With regard to layout: the cover of the project must be attractive and engaging in order to draw the audience to the piece; make the main message and intended audience clear either by text, images, or both; use headings and subheadings to chunk information into manageable sections; make sure more space is placed above a heading or subheading than below each; use white space to keep from overwhelming the audience (10 to 35% white space per page has been recommended by designers); make sure to keep at least a ½ inch border around the page; and use bulleted lists to break up paragraphs of text.

The CDC guidelines also offer some suggestions for the use of images: photographs are best for real-life events while illustrations can better portray complex information; impart only one message per image; use captions unless the image is evident enough to clearly impart the message (like a pictograph or infographic); use visuals that emphasize or explain the text; use culturally relevant images to which the audience can relate; visuals should be easy to understand; and use high quality visuals with good contrast. For brochures in particular, it is best to design content so that all visible panels work together as a complete unit (Wheeler & Wheeler, 2002). In other words, whatever flaps are open should look as though they have a sense of visual unity. Regarding content placement, it is recommended that the first panel (or front of the brochure) contain attention getting features, the first spread (the two panels visible when the cover flap is opened) contains a summary of highlighted material or important points, and the second spread (the inner two panels) contain detailed examples of the brochure topic.

There are certain design issues that have gained increased importance when designing for an aging population. Changes in visual abilities begin in our 40s and tend to get worse as we continue to age (Czaja & Sharit, 2012). For instance, older adults have more difficulty distinguishing an element of interest from its background because of a close similarity in color brightness, called loss of contrast sensitivity. Color also

presents a problem for the aging in that they find it difficult to distinguish between different colors, especially various shades of blue. This is particularly problematic if a graphic uses different colors to represent or impart information (ex. weather maps that use different colors to represent different weather patterns). Beyond visual issues interpreting color, aging adults encounter a decline in eyesight making it difficult to perceive and understand small objects and text, and this difficulty may persist even with the help of corrective lenses and procedures.

Often when brochures are produced for the benefit of helping people with information needs, mistakes are made that diminish the effectiveness of the material. One mistake is that material is sometimes written using complex wording that can be difficult to understand. Shieh & Hosei (2008) found that printed health materials were written at the 9th grade reading level, well above the recommended 5th grade level. To increase understanding, it is best to use simple, concise language. Also, it is helpful to include summary information, questions or problem statements to increase reader involvement, and descriptions of steps needed to model the desired behavior (Shieh & Hosei, 2008). Also, chunking information under headings and subheadings is effective in imparting important information (Young & Witter, 1994).

In addition to problems with visual perception, aging adults may also encounter issues learning new information (Czaja & Sharit, 2012). As we age cognitive abilities may suffer in terms of working memory, perceptual speed, and attention. For instance, working memory capacity in older adults is about 6 items, compared to 7 for young adults (Jastrzembski & Charness, 2007). Because of these issues, it may be difficult to learn new information if it is presented quickly or if too much is presented at once. Helping information consumers to elaborate on content by illustrating how new information connects to current knowledge can help to increase understanding and learning.

Readability and Memorability recommendations

- Use active voice and concentrate on actions to take
- Present 6 or fewer key points in a section
- Repeat the main points from the introduction in the main body and conclusion sections
- Avoid jargon by using everyday language (Flesch: grade 8 or lower).
- Use pictures to illustrate concepts and minimize word count

Guidelines for layout and design:

1. *Message Clarity*
    a. provide important information first followed by details and an explanation of topic importance
    b. limit messages to one idea at a time
    c. keep lists to 3 to 7 items
    d. clearly indicate what the audience is asked to accomplish and focus on the positive by indicating what they should do, not what they should not do
    e. use short sentences that are free of jargon and worded as if speaking to a friend

2. *Use of text*
    a. use fonts that are 12 to 14 points
    b. headings should be two points larger than main text
    c. use serif fonts for body text and use sans-serif fonts for headings and sub-headings
    d. avoid using italics and underlining
    e. use light text on dark background or dark text on light background
3. *Layout recommendations*
    a. the cover of the project must be attractive and engaging
    b. make the main message and intended audience clear either by text, images, or both
    c. use headings and subheadings to chunk information into manageable sections
    d. make sure more space is placed above a heading or subheading than below each
    e. use white space (10 to 35% white space per page is recommended)
    f. keep at least a ½ inch border around the page
    g. use bulleted lists to break up paragraphs of text
4. *Image use*
    a. photographs are best for real-life events while illustrations can better portray complex information
    b. impart only one message per image
    c. use captions unless the image is evident enough to clearly impart the message (like a pictograph or infographic)
    d. use visuals that emphasize or explain the text
    e. use culturally relevant images to which the audience can relate
    f. visuals should be easy to understand
    g. use high quality visuals with good contrast
5. *Brochure guidelines*
    a. all visible panels must work together as a complete unit
    b. the first panel (or front of the brochure) should contain attention getting features
    c. the first spread (the two panels visible when the cover flap is opened) should contain a summary of highlighted material or important points
    d. the second spread (the inner two panels) should contain detailed examples of the brochure topic.
6. *Designing Training and Instructional Programs for Older Adults*
    a. make sure to use high contrast colors
    b. avoid using shades of blue near each other as they may not be distinguished as different
    c. make sure text is large enough to read (at least 12 point, may want to consider 14 point for paragraph text)
    d. present information gradually to allow for processing and learning time
    e. chunk information

f. use simple, concise language and include summaries and/or questions or problem statements to engage users in the content
g. make connections between new and old information to aid elaboration of content

Comprehension Processes

The design of tip cards can be informed by developments in the field of cognitive science. For the purposes of this review, we will focus on two such developments: psycholinguistic approaches to language comprehension (and, age-related changes in comprehension processes), and embodied approaches to cognition.

Psycholinguistics. Although it may be sensible and intuitive to think that language comprehension is a rich, detailed process (i.e., that the endpoint of language processing is a detailed analysis of the content of the message that was received), research in psycholinguistics has consistently shown that this is not necessarily the case (e.g., Sanford & Graesser, 2006). One example of this comes from the work of Ferreira (2003), who studied college-age participants' comprehension of basic active and passive sentences (e.g., *The dog chased the cat* vs. *The cat was chased by the dog*). Even though the sentences were comparatively simple, and a set of participants drawn from a university setting should be expected to handle such sentences with little problem, Ferreira (2003) reported that participants made a surprising number of errors in identifying the who-did-what-to-whom elements of these situations. Based on these findings, and other work from her lab (e.g. Ferreira, Bailey, & Ferraro, 2002), Ferreira (2003) proposed that the default mode for most language comprehenders is to strive for "good enough" comprehension. That is, the comprehender uses a basic set of sentence processing heuristics to come up with a reasonable guess about what the sentence means, and may not notice that their guess does not entirely match with the content of the incoming message.

Ferreira's (2003) claims about "good enough" processing fits with ideas that have been advanced about the comprehension of texts. As outlined by Zwaan & Radvansky (1998), when comprehenders process a longer body of language (such as a newspaper article or book), the end-point of the comprehension process is to arrive at a representation of the gist of what they have read (i.e., a *mental model* of the situation), rather than a finely detailed representation of every element of the text. This is not to say that language comprehenders are not capable of achieving a rich, detailed, deep level of understanding for a sentence or story; rather, the content that is taken away from the incoming language will depend on the goals of the comprehender (e.g., Zwaan & Radvansky, 1998; Foertsch & Gernsbacher, 1994). For example, someone reading a story for fun will probably remember a different level of detail than someone reading the same story for the purposes of a literary analysis.

Language comprehension abilities change as people get older. As reviewed in Radvansky and Dijkstra (2007), older adults' performance on "good enough" elements of comprehension (e.g., getting the gist of a story; updating their representation of a story based on new information) tend to remain strong as compared to the performance

of younger adults. At the same time, older adults' performance on more demanding elements of language processing – such as discarding a representation of a situation once it has been shown to be wrong– tends to decline as compared to the performance of younger adults (e.g., Hamm & Hasher, 1992). Radvansky and Dijkstra (2007) discuss these changes as resulting in part from age-related changes in working memory.

These findings have clear implications for the design of tip cards for older (and younger) drivers and pedestrians:

- Because "good enough" comprehension is the default mode for most language comprehenders, and this tendency may be stronger for older adults, it is important that the linguistic content of the tip card be simple and focused on the key concepts to be taught.
- Where possible, the linguistic content of the tip card should be designed to take advantage of the processing heuristics used by comprehenders. For example, Ferreira (2003; Townsend & Bever, 2001) notes that comprehenders' first guess about a sentence is that it will be an active, subject-verb-direct object sentence (e.g., *The dog chased the cat*). Thus, tip card writers should avoid construction types (e.g., passive constructions) that may run afoul of these processing heuristics.
- Because older adults experience declines in comprehension performance related to declines in working memory, the structure and organization of the tip card should avoid complexity and ambiguity as much as possible. As noted earlier, older adults may find it particularly difficult to change any mistaken impressions they may have received from some component of the tip card.

Embodiment. The preceding section on psycholinguistics detailed some of the circumstances under which comprehension may be more or less successful, but did not make commitments to the contents of the cognitive elements that give rise to meaning and understanding. Our perspective on this matter comes from research on embodied cognition. Embodied cognition holds that cognitive processes are aimed at allowing the individual to take successful action in the world, and that higher-order cognitive processes (such as language comprehension, problem solving, and the like) are grounded in our bodies' systems of perception and action planning (e.g., Glenberg, 1997). As one example of this, it has been proposed that language is understood through the creation of sensorimotor simulations of the content that is being described. Comprehending a sentence such as, "You gave Joan the book", involves using the perceptual system to simulate what Joan and the book look like, and using the motor system to simulate what actions are required to transfer the book from you to Joan (e.g., Glenberg & Kaschak, 2002). The process of constructing a simulation is similar to what has been described in the previous section as developing a mental model or situation model of the text (e.g., Zwaan & Radvansky, 1998).

The idea that comprehension processes rely on the construction of sensorimotor simulations of what has been described in language has implications for the design of educational materials. Glenberg and Robertson (1999) demonstrate this in a study where the participants are asked to acquire a novel skill – using a compass to find the location of various target points in a room. Glenberg and Robertson (1999) showed that

participants' ability to succeed on the task, as demonstrated by their ability to actually find the target points, depended on their ability to accurately simulate the content of the instructions for using the compass. Those participants who were only given verbal instructions (and therefore were left to construct a simulation on their own) were not as successful at finding the target points as participants who were given visual and action-based aids to the simulation process (e.g., seeing a film clip of someone holding and using a compass). In addition, Radvansky, Zacks, and Hasher (1996) demonstrated that memory for pieces of information will be better to the extent that the different bits of information can be integrated into a simulation of a single event (rather than considering each bit of information as part of a separate event). Radvansky et al. (1996) note that this effect is more pronounced for older adults.

These ideas from embodied cognition lead to a further set of recommendations for the design of tip cards:

- Because comprehension is based on simulation processes, tip cards should be rich in visual detail. Where possible, the visual detail should contain elements that reflect the way the traffic control device or feature will be encountered in the environment. As shown by Glenberg and Robertson (1999), such visual aids allow the comprehender to ground their understanding of the linguistic content of the tip cards in an accurate simulation of what they will see on the road.
- The tip card should present information in such a way that different bits of information can be simulated within the structure of one event. Where this is not possible (e.g., when there are traffic control devices that have an "if/then" structure), an effort should be made to minimize the complexity of the event structure.
- The language that is used on the tip card should be focused on actions that should be taken, rather than things that should not be done. As Glenberg, Robertson, Jansen, and Johnson-Glenberg (1999) argue, negated situations (do *not* do X) are difficult to simulate because they are typically under-constrained – in most cases, not doing something does not tell you what action should be simulated.

Memory and Memorability

Learning is enhanced when new material can be linked to existing stored information or procedures, given the associative structure of human memory. If a motorist has seen a yellow arrow, information about a flashing yellow arrow signal will probably be linked in with prior information about symbols appearing on traffic signals, and will likely be easier to learn than, for instance, a totally unfamiliar mid-block flashing pedestrian beacon indicator. When considering aging road users, we need to be aware of age-related memory decline, a robust finding in the cognitive aging literature (Salthouse, 2009). All forms of memory probes (recall, cued recall, recognition) for episodic memory tasks (memory for personally experienced events) show significant negative age decline, whether for word lists or prose materials (Verhaeghen, Marcoen & Goossens, 1993). Even in a situation typical for reading a tip card, self-paced learning, older adults may be expected to take roughly twice as long to learn new information compared to younger adults (Charness, Kelley, Bosman & Mottram, 2001). Related to the work on

embodiment, it was thought that older adults would benefit more than younger adults in memory tasks by enacting or performing activities (such as “comb your hair”) than simply reading the same sentence, and that in some instances with recognition tasks, age differences might be eliminated (Lichty, Kausler & Martinez, 1986). However, later work suggested equal benefit across age groups for such sensorimotor enactments (Earles, 1996). Nonetheless, a simple conclusion is that arranging information in a way that encourages simulation processes should benefit all age groups.

The memory literature points to several ways to improve retention for declarative information (facts, such as those presented in a tip card) at least for the young adult population. Perhaps the most robust advice is to test the material (Roediger & Karpicke, 2006) which may draw on phenomena such as spaced practice enhancement of learning (Storm, Bjork & Storm, 2010) and the generation effect (Slamecka & Graf, 1978). Also, to support encoding, one of the most effective ways to support later recall is to have people encode information from a self-referential framework (Symons & Johnson, 1997). Making simultaneous use of testing, embodiment/simulation, and self-reference, though not yet tested within older adult populations, suggests the following recommendations for the design of tip cards to enhance memorability:

- Visual detail should support imagining the situation as it would appear in the road environment
- Support integrating information by keeping information that can be simulated within the structure of one event, for instance keep representations of two phases of an alternating display in close proximity
- Focus on actions that should be taken
- Encourage simulation activities by asking a question at the bottom of a tip card that prompts self-testing and enactment behavior, such as: “Imagine that you are approaching an intersection to make a left turn and see a flashing yellow arrow, what action will you take?”

Attitudes

Even if educational materials are attended to, comprehended, and well-remembered, they might fail to influence behavior if they do not also activate or influence beliefs and/or attitudes that are consistent with the recommended safety behavior (Conzola & Wogalter, 2001). Road user educational materials such as tip cards can be an important component of road safety campaigns, which typically attempt to influence safety behaviors via activation of or changes to relevant beliefs and attitudes. In this review, we adopt the following conceptualization of road safety campaigns:

A “purposeful attempt to inform, persuade and motivate a population (or subgroup of a population) to change its attitudes and/or behaviours to improve road safety using organised communications involving specific media channels within a given time period, often supplemented by other safety-promoting activities (enforcement, education, legislation, enhancing personal commitment, rewards, etc.)” (Phillips, Ulleberg, & Vaa, 2011, p. 1205).

Road safety campaigns can be considered a form of public communication

campaign (or, more specifically, a form of health campaign), and typical considerations associated with those campaigns apply to the road safety context. The literature on the effectiveness of public communication and health campaigns provides several recommendations for efforts to protect the health and well-being of given populations using messages and related interventions. Most importantly, campaigns and interventions typically are only effective (result in desired behavior change) to the extent that they follow contemporary, research- and theory-driven guidelines at all stages – from planning to assessment of effects (Atkin & Rice, 2013). In this review, we generally are forced to rely on studies that, for the most part, have ignored older road user populations.

Structural features of public communication campaigns and successful outcomes

At the outset, we need to note that there are very few examples in the literature of public communication campaigns aimed at older adults or older road users in particular. In general, campaigns that are based upon established theories of communication and human behavior are more successful than those that aren't, though exceptions have been found (e.g., for the transtheoretical model and obesity interventions: Mastellos, Gunn, Felix, Car & Majeed, 2014). Any number of theories can be used to guide attempts to change behavior through communication efforts, so choosing the most relevant one(s) is important. Theories that are commonly used to guide campaign message design and dissemination are social cognitive theory, the transtheoretical model/stages of change, theory of planned behavior/integrated model, diffusion of innovations, the health belief model, and the extended parallel process model (Atkin & Rice, 2013). More recent models and theories that have been used to inform message design are risk as affect, the limited capacity model of motivated mediated message processing (LC4MP), appraisal theory, the theory of normative social behavior, and gain vs. loss framing of behavioral outcomes. A recent framework has been proposed specifically for road safety campaigns and messages -- the step approach to message design and testing (SatMDT). The SatMDT incorporates variables from the theory of planned behavior, the extended parallel process model, and other theories related to audience responses to emotional appeals in messages (Lewis, Watson, & White, 2016). Consideration of audience characteristics and the behavior itself should inform the choice of appropriate theory/ies and/or model/s. Additionally, each behavior has distinct motivations, so campaign planners should attempt to understand likely motivations among the target audience for not/practicing the behavior (Hornik, 2013).

We first note that previous research and meta-analyses indicate that campaign planners and evaluators should have realistic expectations for campaign outcomes. Even if individuals have positive attitudes toward engaging in a behavior that is recommended in educational or campaign materials, behavior change can be slow and difficult to accomplish for a variety of reasons (Atkin & Salmon, 2013; Hornik, 2013). A meta-analysis of health campaigns conducted in the United States (Snyder et al., 2004) found that the average effect on behavior ranged from $r = 0.07$ to $r = 0.10$, with behavior

change among about 8% of the intended population. Effect sizes ranged from 0.03 to 0.20, but a size of 0.20 was rare. Although such outcomes might seem minimal, even small effect sizes are important in large populations – for example in a city of 500,000 adults an 8% increase would result in 40,000 more people practicing the desired behavior.

The above-described analysis (Snyder et al., 2004) identified characteristics of campaigns that significantly affected the outcomes. Topic accounted for the most variance, and topic is directly related to the type of behavior change sought. Campaigns encouraging commencement of a new behavior (r = 0.12; average change in percentage of population performing behavior = 12%) tend to be more successful than those that encourage prevention of undesirable new behavior (r = 0.06; average change in percentage of population performing behavior = 4%), which tend to be equally successful as those that encourage cessation of existing undesirable behavior (0.05; average change in percentage of population performing behavior = 5%). Of note, seat-belt-promotion campaigns were the most successful of all campaigns in the analysis, with average effects of r = 0.15. The review also found that campaigns work much better when accompanied by enforcement efforts and when the messages mention or describe enforcement activities.

A more recent synthesis of meta-analyses of health campaigns (Snyder & LaCroix, 2013) found that the average effect size for adults was r = 0.09 and that for youths was r = 0.05, indicating that youth are more difficult to influence (although the difference could be related to behavior targeted in campaigns directed at younger versus older audience members). Additionally, mass media campaigns that disseminated novel information were more effective than those disseminating better known or less novel information.

Across public communication campaigns (e.g., including those that encourage health, pro-social behavior, and pro-environmental behavior), evidence points to three types of campaigns that tend to have demonstrable influence (Hornik, 2013):

1. Those that promote low-cost (in terms of time, effort, and/or money), high reward behaviors
2. Those that are linked to substantial changes in the material environment, such as infrastructure improvements or enforcement, including campaigns initiated to publicize a new regulation or change to the structural environment (e.g., new bike lanes)
3. Those that are long-term campaigns, because of the need for multiple exposures to the message/s.

Message appeals in public communication campaigns and successful outcomes

Many health campaigns have attempted encourage health behaviors via persuasive appeals depicting either positive (health enhancing) or negative (consequential) outcomes in either the visual or audio (or both) track of the campaign's message. Research has indicated that emotional appeals (mainly negative) are effective in capturing audiences' immediate attention to the message, whereas positive appeals are likely to sustain attention throughout message exposure. When choosing to

employ a positive or negative appeal it is important to understand whether the message attribute will enhance or negate attention, as the goal of any campaign is to capture audiences' attention long enough for the content to be encoded into memory. Once stored in memory, the message has a greater chance of persuading audience members to accept the message's recommendations and to practice the advocated behavior.

Messages can include information designed to influence beliefs, such as perceived risk of not/performing a behavior, or can include incentive appeals that address existing values/ reinforce predispositions of audience members in an attempt to influence beliefs that they will get valued consequences by following recommendations (Atkin & Rice, 2013). Promises of "health" are becoming less common in campaign messages, which now often highlight other benefits or deterrents, such as social rewards, financial rewards, or freedom from guilt or regret (Atkin & Salmon, 2013). Although many campaign messages in the past have relied on negative information such as loss-framed messages or fear appeals (visual or audio content emphasizing harmful personal or social consequences of not taking recommended action), more recent efforts have embraced positive appeals including gain-framed messages, promises of positive social incentives (e.g., approval, respect, being a good role model), or positive emotions, such as hope or compassion (Atkin & Salmon, 2013; Chadwick, 2015; Myrick & Oliver, 2015).

A recent study (Chaurand, Bossart & Delhomme, 2015) showed that gain-framed messages compared to loss-framed ones about speeding resulted in lower highway speeds at a point 2 km distant from the messaging sign. As previously mentioned, the choice between a negative vs. a positive appeal should be well considered. Negative information tends to be better attended to and recalled and can be strongly tied to perceptions of personal risk but, if not communicated properly, can lead to defensive message processing, rejection of its content and message claims, evaluations of recommendations as ineffective, and failure to act on recommendations (Brown & Locker, 2009; Keller, 1999; Kessels, Ruiter, & Jansma, 2010; Witte, 1992; Witte & Allen, 2000; Spence & Pidgeon, 2010). Positive information might be less well attended or recalled, but can lead to greater perceived self-efficacy as well as more positive attitudes toward the behavior and important outcomes such as sharing of protective information with others (Myrick & Oliver, 2015; Myers, Nisbet, Maibach, & Leiserowitz, 2012). In short, health messages are generally categorized by a single distinct appeal, such as negative or positive with each showing favorable outcomes. However, carefully combining positive and negative persuasive appeals has also been found to briefly enhance attention and message processing (Lang, Sanders-Jackson, Wang, & Rubenking, 2013; Potter, Latour, Braun-Latour, & Reichert, 2006; Wang, Solloway, Tchernev, & Barker, 2012). Aside from emotional appeals, when the campaign focuses on enhancing self-efficacy (the belief that one can successfully engage in the recommended behavior) and response efficacy (the belief that engaging in recommended behavior will lead to desired outcomes), research has shown significant improvements in behavioral outcomes (Lewis, Watson, & White, 2010; Witte & Allen, 2000). Accordingly, messages should attempt to enhance audience perceptions that they can enact the recommended behavior and that doing so will lead to desired

consequences.

Effectiveness of road safety campaigns

As described above, road safety campaigns can be considered a form of public communication campaign, and can include a variety of message types – from mass mediated messages (e.g., public service announcements (PSAs) on radio or television, billboards, pamphlets) to direct educational information delivered in a classroom-like setting -- and related activities, such as enforcement and changes to infrastructure (e.g., traffic calming). As with most public communication campaigns, effect sizes tend to be small to moderate, although success rates vary depending on the outcome variables examined (e.g., crashes vs. other behaviors) (Hutchinson & Wundersitz, 2011). One systematic review found a 7% reduction in crashes attributable to campaigns (Morrison, Petticrew, & Thomson (2003). A more recent meta-analysis found an average 9% reduction in crashes associated with campaigns, with the range of effects in the population estimated to fall between a 6% and 12% reduction (Phillipset al., 2011). Safety education programs directed specifically at pedestrians have been found to improve pedestrians' attitudes and intentions regarding safe behaviors as well as their knowledge about road safety, but most studies examined effects on children, with a conspicuous absence of research on the effects of campaigns on older adults noted (Duperrex, Bunn, & Roberts, 2002). As with public communication campaigns in general, campaign effectiveness depends largely on the type of behavior targeted, with seat belt promotion campaigns being the most effective, as compared to the Department for Transportation's 'THINK!' campaigns on anti-speeding, drunk-driving, and anti-road rage (Hoekstra & Wegman, 2011; Stephens & Groeger, 2006). This is likely because seat belt campaigns encouraged a new, easy behavior, the type of behavior found to be associated with the largest effects in health campaigns.

Structural features of road safety campaigns and outcomes

Existing systematic reviews and meta-analyses of road safety campaign effects have identified several factors that influence their success, and many of these factors are similar to those that predict success of public communication campaigns in general. One review found that road safety campaigns with financial rewards were most effective, followed by campaigns that included enforcement and legislation combinations, and campaigns conducted in cities as opposed to rural settings (Morrison, Petticrew, & Thomson, 2003). A second review found that high crash and violation rates could be reduced, at least temporarily, by a variety of methods including simple warning letters, which were found to be the most effective component in terms of number of crashes prevented and net cost benefits (Masten & Peck, 2004). Another review noted the importance of enforcement along with sufficient education and publicity of enforcement efforts, noting that the combination of such efforts are necessary to reduce road crashes (Hoekstra, & Wegman, 2011). With respect to delivery of messages in road safety campaigns, one review noted no advantage of any particular form of media (Phillips et al. 2011), although mass-media (e.g., television, radio, newspaper) have obvious advantages in terms of reaching large segments of a

population. Others note that the effects of mass-mediated messages may lead to more wide-reaching social change over the long term, especially when multiple messages are delivered continually (Delhomme et al., 2009). Conversely, some evidence indicates that individuals with lower levels of education are less likely to be reached with mass mediated messages, due to lower levels of attention to such messages and related campaigns – personal contact or group meetings may be a more effective manner of reaching and influencing these individuals (Hoekstra & Wegman, 2011; Masten & Peck, 2004). Finally, it is important to consider a specific audience's communication preferences (e.g., print vs. audio vs. social media) when choosing the channels through which messages will be disseminated (Geber, Baumann, & Klimmt, 2016).

Persuasive appeals and road safety campaigns

The review by Morrison et al. (2003) suggests that persuasive rather than educative approaches are more effective in changing road safety behaviors, meaning that persuasive messages (relatively brief messages that include an appeal to audience members' motivations) should be preferred to more formal efforts that take a classroom-style approach. Further, a review of more than 300 campaigns conducted in more than 40 countries indicated that persuasive messages related to road safety were more effective when the persuasive appeals were chosen based on specific theoretical frameworks (Guttman, 2015). In this review, four main types of appeals were identified: appealing to reason (facts, logic or science based rationales for advocated behavior, analogies), appealing to 'negative' emotion (fear, anger, guilt), appealing to 'positive' emotions (caring for friends, family, and others, compassion for victims, positive role models, courtesy, and collective action/positive social norms), and the threat of enforcement. Recommendations for future campaigns and research included emphasizing pride and competence and considering how messages that appeal to positive emotions might contribute to the "viral success" of messages – messages that are shared with many others. Another review found that a combination of rational and emotional content can be effective (Phillips et al., 2011). Including a specific behavioral request in the message has also been found to be associated with increased influence of messages on road safety behaviors (Morrison et al., 2003).

Based on the reviews described above, as well as on the literature on appeals in public communication campaigns in general, we consider the approach of including both "rational" and "emotional" appeals in messages such as tip cards and appealing to positive vs. negative emotions when using appeals to emotions. Although historically, many road safety campaigns have relied on negative or fear appeals in messages, researchers and members of the public have called for a transition to positive appeals in messages (Lewis, Watson, & White, 2010). Some research suggests that audience members have become weary or desensitized of negative or fear-based appeals and that positive appeals might be especially effective for less novel risks or at later stages of a campaign (Lewis, Watson, Tay, and White, 2007; Nabi, 2002). Additionally, positive appeals to message recipients' pride were found to be related to both acceptance of the persuasive message and to intention to engage in the advocated road-safety behavior (Lewis et al., 2010).

Finally, when designing road-safety-campaign messages, the step approach to message design and testing (SatMDT) suggests that planners should consider pre-existing individual characteristics of road users (such as salient beliefs) as well as relevant theories regarding appropriate message characteristics for specific groups of users and should pilot proposed messages to examine both cognitive and affective responses to those messages before disseminating them to intended audiences (Lewis, et al., 2016). Similar to messages designed to change general health behaviors, messages attempting to encourage safe road behaviors should be tailored to address specific audiences' psychological motivations for not/taking action (e.g., print vs. audio vs. social media) (Gebe et al. , 2016).

Demographics and road safety campaigns

None of the reviews we identified focused on road user age as a predictor variable, although our examination of studies included in the reviews indicates that most analyzed effects of campaigns directed at specific age groups (e.g., young children, adolescents). One review indicated that younger, male drivers have been found to be less influenced than other groups by some campaigns such as anti-speeding campaigns (Hoekstra & Wegman, 2011). Another noted that anti-drinking-and-driving campaign effects have been larger for women than for men (Morrison et al., 2003).

Recommendations:

Based on the literature described above, we make the following recommendations regarding tip card design and distribution:

- In addition to the instructional information, include an emotional appeal
- Include information, including positive emotional appeals, likely to enhance self-efficacy among audience members
- Include a brief, non-threatening reference to regulations related to the behavior recommended by the tip card
- Ensure sufficient distribution of tip cards
- Create an electronic version to facilitate social sharing through channels such as Facebook and e-mail.
- Create an alternate version of each card that can be distributed at a later date
- Reinforce tip card information with road signs, advertisements, and/or public relations efforts that emphasize regulation or infrastructure changes associated with the counter-measures

Motivation

Optimizing Motivation for Adherence

Producing long-lasting behavioral change is the ultimate goal for many FDOT educational campaigns. For example, the Alert Today Alive Tomorrow Tip Card (http://www.alerttodayflorida.com/resources/ATAT_TipCard.pdf) has several messages for drivers, cyclists, and pedestrians. All road users should avoid distraction. Drivers should stop before turning right on red. Pedestrians should use crosswalks. Bicyclists should ride with traffic. Assuming these messages are attended, encoded, and remembered, a road user may initially engage in these behaviors for a short period of

time. However, the ultimate goal is to ensure that these rules are adhered to whenever the road user is on the road. That is, the ultimate goal is long-term adherence to the message. However, we know that long-term adherence to safety and health related messages is often difficult to achieve. Here we review what is known from related literatures focus on behavioral adherence, pulling from the domains of medication adherence and adherence to healthy behaviors such as exercise. These literatures often frame problems in the theory of planned behavior (Ajzen, 1985).

Exercise Adherence

Insight into factors that contribute to the adherence of FDOT safety messages might be derived from the exercise adherence literature. Although there are consistent messages encountered encouraging physical exercise, long-term adherence to this message is often quite low. Given the benefits of physical activity as we age, much of this work has specifically examined older adult adherence to exercise programs (e.g., Greaney, Lees, Blissmer, Riebe, & Clark, 2016). Implementation intentions appear to influence older adults' adherence to an exercise program. Implementation intentions can be thought of as "if-then" plans that link a physical or time-based cue with a goal-directed response to increase the likelihood that an action will be performed in the future (Gollwitzer, 1999). A vague goal of planning to exercise more (goal intention) will generally not be as effective as the formation of implementation intentions that specify what will be done and when (e.g., "After lunch each day I will walk around the block twice"). Translating this principle to FDOT safety messages related to distracted driving, a general message to avoid distraction may be less effective compared to messages framed as implementation intentions: "When I get into my car, I will turn my phone off."

Self-efficacy is another strong predictor of physical exercise, with older adults who are confident that they have the ability to engage in exercise and overcome barriers to exercise being more likely to engage in exercise activities. In general, the exercise literature supports the theory of planned behavior in that positive attitudes toward exercise and beliefs in the benefits of exercise among older adults successfully predict exercise behavior (Rhodes et al., 1999). Framing messages in terms of the benefits of adhering to the message (improving the safety of themselves and others), and emphasizing the ability of road users to make meaningful changes in their behavior (anyone who wishes to change their behavior can do so) are ways that similar principles might be implemented within the various FDOT educational campaigns.

Medication Adherence

Medication adherence is another example of the challenge of promoting continued beneficial behaviors (Osterberg & Blaschke, 2005). Here again, much of this work has focused on older adults since many older adults experience one or more chronic conditions that require medication. Older adults appear to be more adherent compared to younger adults (e.g., Barclay et al., 2007; Park et al., 1999). Similar to exercise adherence, medication adherence appears again to be partly explained by self-efficacy and aspects of the theory of planned behavior (Bane, Hughe, & McElnay,

2006). Self-efficacy predicts adherent and non-adherent patients. Patients with confidence that they can stick to a prescribed medication schedule are more likely to do so. Subjective norms also play a role, with patients who more strongly believe that others would want them to follow their medication schedule more likely to be adherent. Not surprisingly, intention to follow a prescribed medication schedule is also a significant predictor of medication adherence. Since the theory of planned behavior appears to be successful in predicting older adult's behaviors in these two domains (medication adherence and exercise adherence) it is likely a fruitful framework to apply to FDOT tip card messaging.

Framing of Health Messages

FDOT safety messages can be thought of as health messages. The use of tip cards and other educational campaigns often encourage drivers, cyclists, and pedestrians of all ages to either engage in behaviors to avoid injury or death or refrain from behaviors that put them at risk. With respect to health message framing (positive vs. negative), a large meta-analysis including data from 94 peer-reviewed papers provides some insight into the effect of framing on the persuasiveness of health messages (measured through attitudes, intentions, and behavior; Gallagher & Updegraff, 2012). This meta-analysis examined messages related to physical activity, smoking cessation, safe sex, and cancer prevention. As a reminder, a positively framed message for physical activity might emphasize weight loss as a result of exercise, while a negatively framed message would emphasize weight gains as a result of not being physically active. Overall, this meta-analysis found that with respect to behavioral change, gain-framed messages were more effective. However, this was only true for prevention messages (e.g., skin cancer prevention) and not for detection messages (e.g., breast cancer screening). This is relevant for many FDOT programs and goals; the message is often one of prevention (e.g., be aware of pedestrians to avoid a crash).

Recommendation:

- When possible, tip cards should specify implementation intentions rather than goal intentions.

Trust

We very briefly discuss issues in source credibility and trust because we strongly suspect that trust is not going to be problematic for FDOT educational materials. Attitude change for messages is likely to depend in part on trust in the credibility of the source (e.g., Giffin, 1967). If an anonymous source (e.g., web site) suggests that a flashing yellow arrow means that you have a permitted left turn, it may not be believed. If a message comes from FDOT concerning a sign or signal, it is more likely to be believed. There are potential barriers to trust in official messages from government sources. These fall into categories such as trust for privacy, trust in web sites, and trust in government.

Often governments are not seen as worthy of trust by older adults, compared to family members and friends, when it comes to privacy of information (Beach et al., 2009). There are also indications that older Americans are less likely to exhibit trust in web-based information than younger cohorts (Fox, 2000). Further, there appears to be

a deepening distrust in government by the general population over the past decades (Dimock, Doherty, Kiley & Krishnamurthy, 2014).

However, by having consistent layout, logos, and branding, tip cards from a government entity such as Florida DOT seem very likely to pass the initial hurdle of credibility.

Recommendation:

- Use a consistent layout and logos to promote branding for FDOT educational materials to enhance their credibility.

Table 2 gathers this large set of recommendations together in the form of a checklist when designing tip cards to benefit aging road users.

Table 2. Checklist for the design of tip cards and brochures, based on the recommendations proposed and literature reviewed.

Table 2. Checklist for Design of Tip Cards and Brochures for Aging Road Users.		
Factor	**Advice**	**Check**
Legibility		
	Font size minimum of 12-14 point x-height	
	Serif font if large, otherwise sans-serif	
	Prefer bolded text, particularly for headers	
	Avoid decorative font	
	Mixed case for body text except where emphasis is needed then uppercase	
	High enough contrast that can be read at <40 cd/m^2	
	Prefer black on white or white on black text	
	Consider colored text or backgrounds for emphasis but avoid blue/violet	
	Left-justify text for passages	
	Double-space text when possible	
	Limit line lengths to 50-65 characters for brochures	
	Avoid wrapping text around pictures and illustrations	
	Avoid glossy material for cards and brochures	
Pictorial Materials		
	Add pictures to text to convey complex instructions	
	Prefer high resolution photos to convey real-life events	
	Prefer high quality illustrations when conveying detailed information	
	Caption pictorial materials that are not easy to interpret	
	Try to use culturally relevant illustrations	
Layout		
	Provide key information first (top)	
	Use bulleted lists to break up paragraphs of text	
	Use color to make the material attractive and engaging	
	Use headings and subheadings to create visible sections	
	Try to keep 10-35% of the page as white space to reduce clutter	
Comprehension & Memory		
	Try to cover only one general topic per card	
	Chunk information and use short sentences	

Table 2, continued		
	Present 6 or fewer chunks of information in a section	
	Use active voice and avoid passive and negative phrases	
	Avoid jargon by using everyday language	
	Aim for a Flesch-Kincaid score of grade 8 or lower	
	Visuals should support imagining the actual road environment*	
	Keep alternating phase representations close together to support integration	
	Focus on actions for road users to take	
	Encourage simulation of the target behaviors	
	Encourage self-testing of memory for the target behaviors	
	Encourage self-reference by using terms such as I rather than driver	
Attitudes		
	Consider an emotional appeal to facilitate attention, memory, and positive attitudes toward the behavior	
	Try to enhance self-efficacy of the road user by using positive appeals	
	Remind road users in a non-threatening way about regulations	
	Consider generating alternate forms of the material to maintain attention	
	Create an electronic version for distribution through social media	
	Consider reinforcing information with road signs, ads, press releases	
Motivation		
	Try to specify implementation intentions rather than goal intentions by suggesting concrete steps to adhere to the regulation	
	Use consistent layout and logos to brand materials to enhance credibility	

Note. We added text to the starred (*) guideline in the Comprehension & Memory section, based on later results, to read as follows: “Visuals should support imagining the actual road environment, preferably using photo depictions of roadway environments”

Example of good tip card layout

In the next section we discuss an example tip card face and make suggestions based on the recommendations for improving its functionality.

Figure 4. Example of good tip card layout for “How to Use the Pedestrian Hybrid Beacon”. It is scored in Table 3.

This example, though it doesn't (and couldn’t) follow all the recommendations, has several strong features. Layout is uncluttered and leaves reasonable white space. Font sizes are generally large, and use heavy weights (bolded), and fonts contrast reasonably with background colors. Pictures are used to attract attention (top) and to

provide effective instruction (left). Language is at an appropriate grade level. The "see this, do this" organization supports easy mental simulations and uses easily understandable language. A classic way to model human cognition involves defining "condition-action" pairs. The condition side would represent an environmental state (here the beacon state) and the action represents the action that the person (driver) would take.

This example card might be improved by avoiding contrasting blue areas ("see this/do this" row) and improving contrast by substituting white background for the colored background for critical text (actions that the driver takes). It might also provide (on the opposite side) self-testing opportunities that involve mentally simulating the response in the roadway setting. Self-reference and implementation intentions could be supported by changing from the third person term “drivers” to “When I see” and “I will do”. To enhance trust, the card could be branded by FDOT logos. The title might be changed to frame the behaviors in a positive way by changing to something like “Pedestrian Hybrid Beacon: Safety and Efficiency”.

The tip card (one side only available here) would be scored approximately as shown below.

Table 3. Completed checklist for the design of tip cards and brochures, based on Figure 4.

Table 3. Completed Checklist for Design of Tip Cards and Brochures for Aging Road Users.		
Factor	**Advice**	**Check**
Legibility		
	Font size minimum of 12-14 point x-height	x
	Serif font if large, otherwise sans-serif	
	Prefer bolded text, particularly for headers	x
	Avoid decorative font	x
	Mixed case for body text except where emphasis is needed then uppercase	x
	High enough contrast that can be read at <40 cd/m^2	x
	Prefer black on white or white on black text	
	Consider colored text or backgrounds for emphasis but avoid blue/violet	
	Left-justify text for passages	
	Double-space text when possible	
	Limit line lengths to 50-65 characters for brochures	x
	Avoid wrapping text around pictures and illustrations	x
	Avoid glossy material for cards and brochures	?
Pictorial Materials		
	Add pictures to text to convey complex instructions	x
	Prefer high resolution photos to convey real-life events	
	Prefer high quality illustrations when conveying detailed information	x
	Caption pictorial materials that are not easy to interpret	
	Try to use culturally relevant illustrations	
Layout		
	Provide key information first (top)	x
	Use bulleted lists to break up paragraphs of text	
	Use color to make the material attractive and engaging	x
	Use headings and subheadings to create visible sections	x
	Try to keep 10-35% of the page as white space to reduce clutter	x

Table 3, continued

Comprehension & Memory		
	Try to cover only one general topic per card	x
	Chunk information and use short sentences	x
	Present 6 or fewer chunks of information in a section	x
	Use active voice and avoid passive and negative phrases	x
	Avoid jargon by using everyday language	x
	Aim for a Flesch-Kincaid score of grade 8 or lower	x
	Visuals should support imagining the actual road environment	x
	Keep alternating phase representations close together to support integration	x
	Focus on actions for road users to take	x
	Encourage simulation of the target behaviors	x
	Encourage self-testing of memory for the target behaviors	
	Encourage self-reference by using terms such as I rather than driver	
Attitudes		
	Consider an emotional appeal to facilitate attention, memory, and positive attitudes toward the behavior	
	Try to enhance self-efficacy of the road user by using positive appeals	
	Remind road users in a non-threatening way about regulations	
	Consider generating alternate forms of the material to maintain attention	
	Create an electronic version for distribution through social media	x
	Consider reinforcing information with road signs, ads, press releases	
Motivation		
	Try to specify implementation intentions rather than goal intentions by suggesting concrete steps to adhere to the regulation	x
	Use consistent layout and logos to brand materials to enhance credibility	

Chapter 3: Task 2a: Immediate Memory

Immediate Memory for Information: Overview

The first part of this project was a literature review that identified candidate “best practices” based on evidence accrued from decades of research on attention, learning, memory, language processing, attitudes and motivations. It translated those best practices into a human factors checklist for designing tip cards. Study 2a follows up on the literature review by putting these “best practices” to an initial empirical test. We present samples of younger (21-35), middle (50-64) and older (65+) adults with standard tip cards of the sort that are currently circulated by transportation agencies across the country (the flashing yellow arrow [FYA] tip card circulated by FDOT, and a tip card version of the rectangular rapid flashing beacon [RRFB] brochure circulated by the Arizona Department of Transportation), or with versions of these tip cards that are enhanced to incorporate some of the best practices illustrated in our literature review.

Our literature review provides an extensive set of features that constitute best practices for effective tip card design. Although many of these are incorporated into the enhanced tip cards used in the present research, we will limit our introductory comments to two of the design features aimed at improving comprehension and driver compliance: 1) *simulation-based* features, and 2) *motivational* features.

A growing body of research suggests that comprehension is achieved through the construction of internal sensorimotor simulations of the situation that is being described (e.g., Glenberg, 1997; Barsalou, 1999). For example, understanding a set of instructions for using a compass relies on being able to accurately simulate the actions required to hold and manipulate the compass (e.g., Glenberg & Robertson, 1999). The enhanced tip cards incorporate two simulation-based features. First, the tip cards present images that represent what a driver or pedestrian would actually see from their vantage point on the road. The images provide the tip card user with a model that they can use to simulate the situations in which they will encounter the FYA or RRFB. Second, the tip cards present language that is simple and action-oriented. By focusing the content of the tip card on action, and presenting the user with images that allow them to accurately simulate the circumstances under which the action should be taken, we aim to improve the comprehensibility of the tip card and increase the odds that tip card users will be able to respond appropriately to the FYA and RRFB when they are encountered on the roadway.

Just as comprehension of the tip card is important, it is equally important for tip card users to be motivated to act on the information they acquired. Thus, the enhanced tip cards contain persuasive appeals designed to motivate compliance with the FYA and RRFB. The persuasive appeals used on the front side of the tip cards were manipulated to elicit either positive or negative emotions, as compared to the control versions of the

cards, which did not include a persuasive appeal. The positive, discrete emotion of pride can result from attributing positive acclaim, outcomes, or achievement to one's self (Nabi, 2002; Weiss, Suckow, & Cropanzano, 1999; Williams & DeSteno, 2008). Based on a study of constructs found to be associated with feelings of pride (Tracy & Robins, 2007), we created a headline intended to elicit this anticipated emotion by focusing users on positive outcomes for which they could take credit: "Successful drivers like you can protect others." To create a contrasting headline likely to elicit an anticipated negative emotion such as guilt, we attempted to focus tip card users on negative outcomes for which they could be responsible: "Your actions could harm others."

Separate samples of younger, middle, and older adults were asked to read and respond to the standard (control) tip cards and the enhanced tip cards. After interacting with the tip cards, the participants were asked to evaluate the cards for the emotional response the cards elicited, their attitudes toward the cards, and other such dimensions. Participants' memory for the content of the tip cards was also assessed. These measures therefore provide an evaluation of the extent to which the enhanced tip cards are preferable to the standard tip cards with respect to their usability. Typical human factors facets of usability include learnability, memorability, efficiency, errors, and user satisfaction (https://www.usability.gov/what-and-why/usability-evaluation.html). Usability facets examined in this study include learnability, defined here as the ability to read and retain information after a short delay; efficiency, time to read the material; and user satisfaction, the user's feelings about the cards.

Methods

Participants

A total of 307 younger (21 to 35 years, M = 28.91, SD = 3.98), 298 middle-aged (50 to 64 years, M = 58.00, SD = 4.27), and 324 older (65 and above years, M = 71.36, SD = 5.25) participants were recruited for this study. The younger adults were sampled exclusively from Amazon Mechanical Turk (hereafter referred to as MTurk). It has been found that older adults (as classified here: 65+ yr) do not make up a large proportion of the MTurk population (Simons & Chabris, 2012; Stothart, Boot, & Simons, 2015). A pilot study conducted with archival MTurk data (Worker ID and Year of Birth) from our lab, as well as a recent sampling of the MTurk population, also found this to be true (Younger adults: N = 3,938; Middle adults: N = 669; Older adults: N = 97).

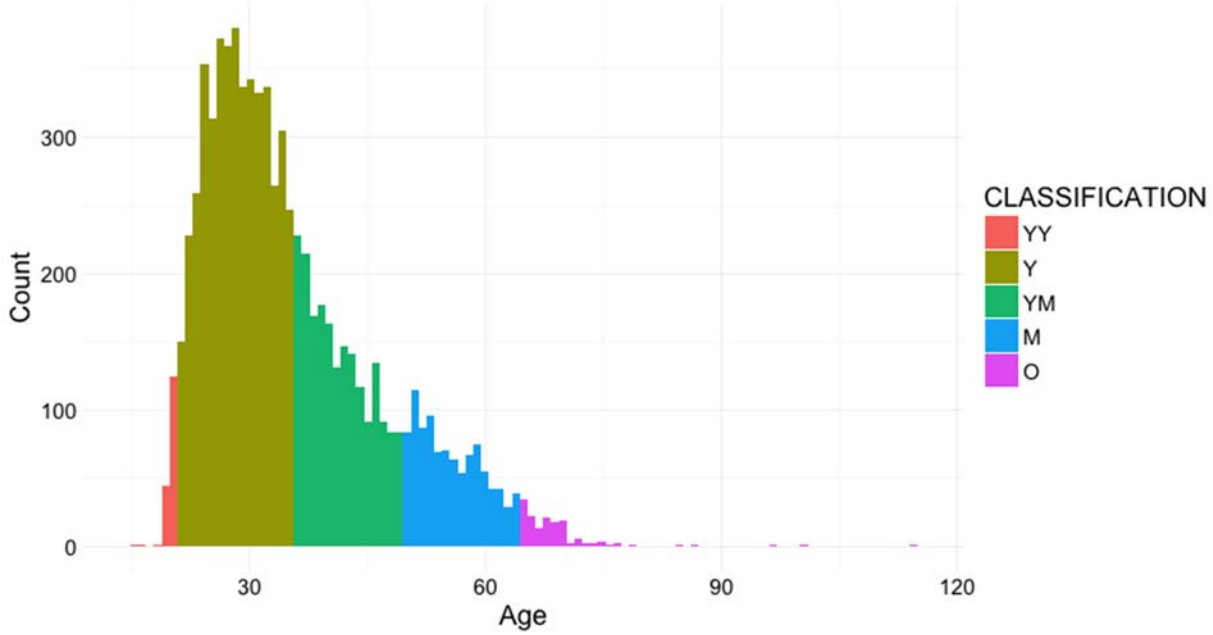

Figure 5. Breakdown of age for current and archival data combined. Classifications: YY = less than 21 years old; Y = 21 – 35 years old; YM = 36-49 years old; M = 50-64 years old; O = 65+ years old.

Taking this into account, we decided to recruit from both the MTurk population, as well as the Tallahassee area for this age group, as well as the middle-aged group. The subsequently presented analyses include middle-aged and older adults from MTurk (N = 248) and middle-aged and older adults registered with Florida State University's Institute for Successful Longevity participant registry (N = 374).

Age Specific Recruitment. Within the Amazon Mechanical Turk system, there is no way to recruit explicit age groups. By default, HITs (Human Intelligence Tasks) are open to the entire MTurk worker pool. Limitations for HITs can be set by location, workers approval ratings, and other worker statistics. The option is also available to create custom qualifications. This allowed us to create a qualification category for each age group.

In order to assign participants a qualification category, we combined data collected from a short, one-question survey asking for year of birth (compensation: $0.03 for approximately 15 seconds; collection of date of birth is not allowed under MTurk TOS), with the archival MTurk data previously mentioned (N = 4704). Ages were calculated as January 1st as the month and day of birth to the year given. As a result of this, our age classifications were shifted up by 1 year to ensure inclusivity of those at the lower bound if our age calculation underestimated (e.g., younger age group: 22-36). We used the R package *MTurkR (https://cran.r-project.org/web/packages/MTurkR/index.html)* to connect with the MTurk service in order to add the appropriate qualification to

participants, as well as to message them a link to the MTurk HIT they were pre-qualified for (i.e., final list of participant qualifications: United States resident, 95% HIT Approval Rate, given age group). For a summary of the age specific recruitment method, see Figure 2 below).

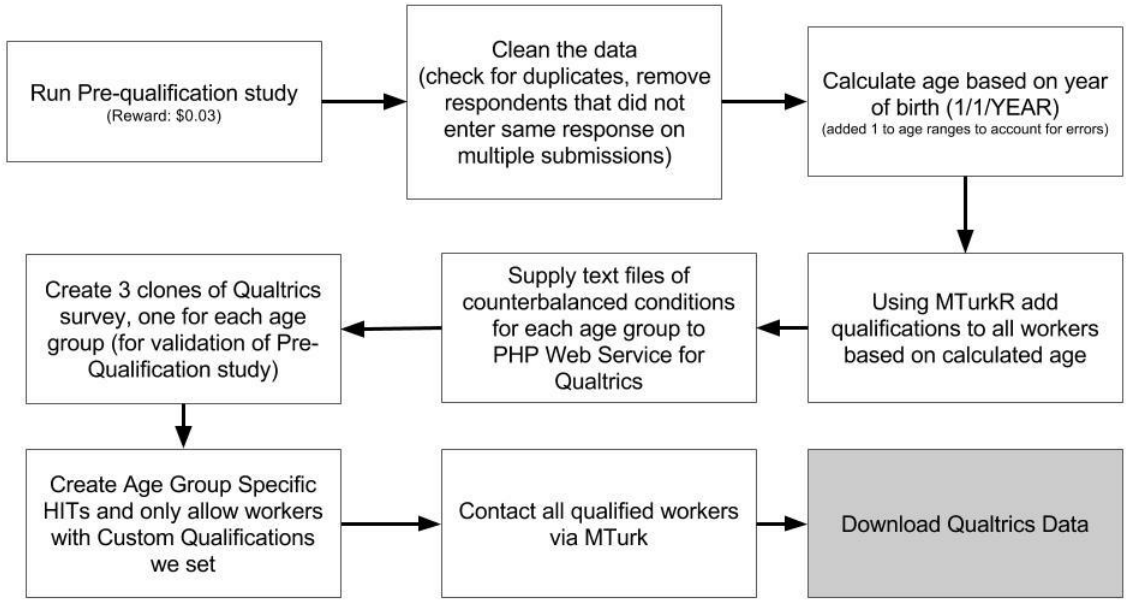

Figure 6. Summary of age-specific recruitment method used for this study.

Materials

Design of Tip Cards. The tip cards for the flashing yellow arrow (FYA) and the Rapid Rectangular Flashing Beacon (RRFB) were designed in Adobe Illustrator CC. A total of six two-sided tip cards were designed for use in the MTurk study. For each signal, we designed one control tip card, one tip card with a positive emotional appeal on the front side, and one tip card with a negative emotional appeal on the front side (see Figures 7-10). All tip cards contained a link for more information on the bottom portion of the back. All Florida Department of Transportation logo use guidelines were followed, allowing for extra margins around the logo where possible. All images not personally photographed were found on Google Images to facilitate study development.

Figure 7. Front side of flashing yellow arrow tip cards used in this study (left to right: control, positive emotional appeal, negative emotional appeal).

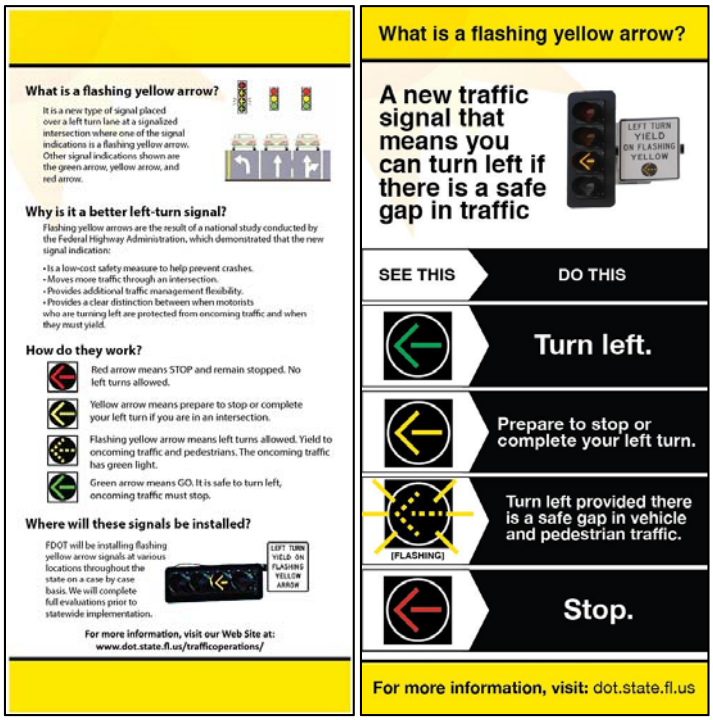

Figure 8. Back side of flashing yellow arrow tip cards used in this study (left: control; right: enhanced tip card).

Figure 9. Front side of rectangular rapid flashing beacon tip cards used in this study (left to right: control, positive emotional appeal, negative emotional appeal).

Figure 10. Back side of rectangular rapid flashing beacon tip cards used in this study (left: control; right: enhanced tip card).

Qualtrics Survey

For facilitating data collection, Qualtrics was used. This allowed us to collect data for all experimental conditions within one survey (separated with display logic). For purposes of validating the pre-qualification study year of birth data, we also collected year of birth in the Qualtrics survey, and made separate (but identical) surveys for each age group. In order to counterbalance participants into conditions, a PHP web service was used that read conditions directly from a randomized text file listing conditions one through six (for an example, see: http://cognitivetask.com/functions/generateCondition.php?conditions=conditions/test.txt) . When the text file was empty, the web service would then close the Qualtrics survey to additional responses. To account for cases where users opened the survey and did not complete it, extra rows above the total sample size were added to the condition files.

The entire survey consisted of 14 distinct blocks, described in more detail in the *Procedures* section. During the tip card study phase block, the front and back of the tip card were presented on separate screens, with no option to go back. This was done to simulate the case of someone looking at a physical tip card by reading the front, turning the card over and reading the back, then setting the card aside. All tip cards were

exported from Adobe Illustrator as 75% image quality jpegs to optimize page load times (lab testing with 100% image quality JPGs found slow page load times; no differences in legibility were reported between 75% and 100% image quality). The tip cards were 1,000 pixels in height and 491 pixels in width, requiring scrolling on some screen sizes (more so on smaller widescreens). In order to gauge difficulties with viewing tip cards, we asked for participant feedback at the end of the survey (3% responded having difficulties; these included: "I had to start this questionnaire over b/c the first time the tip card didn't download properly on my iPad. Second time was alright."; "The images took quite a while to load for me, but it probably had something to do with my own internet/computer."; "The print was relatively small."; "The first image was blurred at the top and was too small to easily see detail."). For both sides of the tip card, the button to continue did not appear for 15 seconds in order to establish a minimum evaluation time for the tip cards across participants. The same 15-second minimum was also used for the free-recall block described in the subsequent section. The Qualtrics survey for the MTurk sample gave participants a unique code upon completion of the survey, while the survey for the older adult sample recruited from the Institute for Successful Longevity registry forwarded them to a Google Forms survey that collected their name and address for purposes of compensation. Participants were explicitly informed that this was the case and that their tip card response data was completely separated from their personal information.

Procedure

The entire survey consisted of fourteen blocks: (1) informed consent; (2) tip card study phase; (3) rating current emotions; (4) rating attitudes toward tip card; (5) rating attitudes toward tip card behaviors; (6) ratings of self-efficacy and behavioral intention; (7) System Usability Scale; (8) tip card experience questions; (9) ratings about social sharing of tip card information; (10) free recall about the tip card; (11) multiple-choice recall about the tip card; (12) demographics data collection; (13) Ten Item Personality Inventory (TIPI); (14) feedback about the survey. These procedures are described in more detail below.

Those who agreed to the consent form continued on to the full survey while those that did not agree were thanked for their time. For the second section, participants were given instructions about the tip card viewing phase, then shown the front and back of the tip cards on two separate screens. Immediately following their exposure to the tip cards, participants were asked to rate how much they are experiencing each emotion. Following the emotion ratings, participants were asked to rate their feelings about the tip cards. They were then asked to rate their attitudes toward the behaviors explained in the tip cards, and their perceptions of self-efficacy and intentions to take the actions suggested. In the subsequent section, users were presented with a version of the

System Usability Scale adapted for use with tip cards. Following this section, users were asked to rate experiences with the tip cards. Ratings of their likelihood of sharing the tip card information with friends and family were included in the section that followed the experience ratings. We assessed memorability of tip card information in free-recall format, followed by multiple-choice format. Multiple choice items included, selecting the image that matched the signal they saw and selecting the meaning of the signal amongst distracting items. The TIPI was used to investigate personality differences in emotional appeal ratings. Lastly, to assess any technical issues with the survey, we asked participants whether they had any issues viewing the tip cards. If they did, they were asked to describe these difficulties.

Results

We used R version 3.1.2 to analyze the data. Except where we note otherwise, we analyzed all measures using a 3 (appeal type: control, positive, negative) by 3 (age group: young, middle, old) ANOVA. We further analyzed any significant main effects and interactions using a set of comparisons. For appeal type, two comparisons were created: one that compared the mean of the non-simulation-based control card with the mean of the simulation-based card (the combined mean of the negative and positive simulation-based cards), and one that compared the mean of the negative simulation-based card with the mean of the positive simulation-based card. We also created two comparisons for the age group variable: one that compared the mean of younger participants with the combined mean of middle-aged and older participants, and another that compared the mean of middle-aged participants with the mean of older aged ones. We set alpha to .05; therefore, we considered *p* values less than .05 to be statistically significant. Here and for other analyses we present Tables and Figures for significant results and some trends (significance at $p < .10$). We present Tables and Figures for statistically non-significant factors in the Appendices.

Samples Analyzed

Out of the 929 participants recruited for the study, data from 20 of them (1 younger, 1 older in the FYA condition, 6 younger, 3 middle and 9 older in the RRFB condition) were excluded because they failed to recall what traffic sign or signal the tip card described. Participants were asked “what was the name of the traffic sign or signal in the tip card you read?” and were given 5 response alternatives to choose from including FYA and RRFB. This question was asked after participants rated how likely they were to share the information provided on the tip card and was used to determine if they were paying attention to the survey (as opposed to aimlessly clicking through the survey screens). Out of the 909 remaining participants, 300 were young adults ($M = 28.94$, $SD = 3.97$), 295 were middle-aged adults ($M = 58.00$, $SD = 4.26$), and 314 were older-aged adults ($M = 71.28$, $SD = 5.22$).

Analyses

Memorability.

We assessed the amount of information participants retained from the tip card using both multiple choice and free recall questions. Tables 4 and A6-A8 display the multiple choice results for the FYA and RRFB cards. For the FYA card, there was a significant main effect for age group, $F(2, 445) = 5.79$, $p = .003$, but no main effect for appeal type, $F(2, 445) = 1.23$, $p = .292$, nor an interaction between the two variables, $F(4, 445) = 0.74$, $p = .564$. The age group effect was such that middle-aged participants

remembered more about the tip card than older participants, $t(445) = 3.03$, $d = 0.29$, $p = .003$. For the RRFB card, there was no main effect for age group, $F(2, 446) = 1.13$, $p = .326$, or appeal type, $F(2, 446) = 1.37$, $p = .260$, and no interaction between the two variables, $F(4, 446) = 0.43$, $p = .784$.

Table 4. Memorability accuracy on the multiple choice questions for the FYA tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	72%	13%	80%	20%	151
Negative	73%	11%	80%	20%	162
Positive	71%	11%	80%	20%	141
Age Group					
Young	74%	11%	80%	20%	152
Middle	74%	11%	80%	20%	143
Old	70%	13%	80%	20%	159

Perceived Usability.

We assessed usability of the tip cards with the System Usability Survey, which provides a single usability measure. In the current dataset, internal reliability of this measure was 0.94 (Cronbach's alpha), which suggests excellent reliability. Tables 5, A9-A12 display the usability results for the FYA and RRFB cards. For the FYA card, neither appeal type, $F(2, 445) = 0.05$, $p = .955$, age group, $F(2, 445) = 0.51$, $p = .604$, nor the interaction between these two variables, $F(4, 445) = 0.43$, $p = .785$, predicted usability. The same was true for the RRFB card where age group, $F(2, 446) = 1.77$, $p = .172$, appeal type, $F(2, 446) = 0.25$, $p = .782$, and their interaction, $F(4, 446) = 1.87$, $p = .115$, failed to predict usability.

Impact on Emotion.

Three measures were created using the emotion ratings participants provided: pride, guilt, and anger. These measures were intended to assess whether the emotional appeals used in the cards induced the most relevant and intended emotions (i.e., whether the positive appeal induced pride, and the negative appeal induced guilt and/or unintentionally induced anger). All three of these measures had at least acceptable internal reliability (pride = 0.86, guilt = 0.77, anger = 0.88). In order to assess whether the appeals induced the intended emotions, two sets of comparisons different from the one described at the beginning of this section were required: one to use for the anger

and guilt analyses, and one to use for the pride analysis. For the anger and guilt analyses, the negative card was compared to the control card and the positive card separately. For the pride analysis, the positive card was compared to the control card and negative card separately. For all measures, the young age group was compared to the middle-age group and older age group separately.

Tables 5-8 display self-reported pride after viewing the FYA and RRFB cards. For the FYA card, there was a significant main pride effect for age group, $F(2, 445) = 12.18$, $p < .001$, but no significant main effect for appeal type, $F(2, 445) = 0.62$, $p = .540$, nor a significant interaction between age group and appeal type, $F(4, 445) = 0.59$, $p = .670$. The age group effect was such that both middle-aged, $t(445) = 4.38$, $d = 0.42$, $p < .001$, and older participants, $t(445) = 4.08$, $d = 0.39$, $p < .001$, had significantly higher amounts of self-reported pride than younger participants. For the RRFB card, there was a main effect for appeal type, $F(2, 446) = 3.57$, $p = .029$, a main effect for age group, $F(2, 446) = 20.34$, $p < .001$, and a significant interaction between the two variables, $F(4, 446) = 2.83$, $p = .024$. The difference in the amount of pride elicited between the positive card and both the negative card, $t(446) = 2.33$, $d = 0.22$, $p = .02$, and the control card, $t(446) = 3.02$, $d = 0.29$, p = .003, differed between younger and older participants. Whereas the positive card elicited more pride in older participants than both the negative card and the control card, the opposite was true for younger participants. Additionally, the difference between the positive card and the control card differed between younger and middle-aged participants, $t(446) = 2.53$, $d = 0.24$, $p = .012$. The positive card elicited more pride than the control card for middle-aged participants, but the reverse was true for younger participants. These effects were of small magnitude and are difficult to interpret.

Table 5. Pride after seeing the FYA tip card by age group and appeal type

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	11.00	5.96	10.0	10.00	50
Negative	12.00	5.21	13.0	7.25	52
Positive	10.80	5.84	10.5	8.75	50
Middle					
Control	15.78	6.04	17.0	9.00	50
Negative	15.57	5.64	17.0	9.00	49
Positive	16.11	5.63	17.0	6.00	44
Old					
Control	16.08	6.32	18.0	9.50	51
Negative	15.00	5.58	16.0	8.00	61
Positive	15.66	6.53	17.0	12.00	47

Table 6. Pride after seeing the FYA tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	14.30	6.50	15	11.0	151
Negative	14.21	5.66	15	8.0	162
Positive	14.08	6.45	15	10.0	141
Age Group					
Young	11.28	5.66	11	9.0	152
Middle	15.81	5.74	17	8.5	143
Old	15.54	6.09	17	10.0	159

Table 7. Pride after seeing the RRFB tip card by age group and appeal type.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	13.00	6.64	14.0	9.50	52
Negative	11.98	6.31	11.0	10.00	49
Positive	9.94	5.76	9.0	8.50	47
Middle					
Control	14.50	4.99	15.0	6.00	46
Negative	15.21	6.19	15.5	9.00	56
Positive	15.62	4.74	16.0	5.00	50
Old					
Control	15.35	5.73	16.0	9.00	65
Negative	15.25	5.85	16.0	7.75	44
Positive	17.15	5.32	18.0	7.75	46

Table 8. Pride after seeing the RRFB tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	14.36	5.90	15.0	9.5	163
Negative	14.16	6.28	15.0	10.0	149
Positive	14.24	6.09	15.0	9.0	143
Age Group					
Young	11.69	6.35	11.5	11.0	148
Middle	15.13	5.37	16.0	7.0	152
Old	15.86	5.68	17.0	8.0	155

Tables 9, 10, A13 and A14 display self-reported guilt after viewing the FYA and RRFB cards. For the FYA card, there was a significant main guilt effect for age group, $F(2, 445) = 4.046$, $p = .018$, such that older participants had lower levels of guilt than younger participants, $t(445) = 2.78$, $d = 0.26$, $p = .006$. However, there was no significant main effect for appeal type, $F(2, 445) = 2.036$, $p = .132$, nor a significant interaction between appeal type and age group, $F(4, 445) = 0.81$, $p = .519$. For the RRFB card, there was a significant main guilt effect for age group, $F(2, 446) = 7.73$, $p = .001$, a significant main effect for appeal type, $F(2, 446) = 6.26$, $p = .002$, and a significant interaction between the two variables, $F(4, 446) = 3.57$, $p = .007$. Whereas the negative card elicited more guilt than the control card for younger participants, the opposite was true for middle-aged participants, $t(446) = 3.69$, $d = 0.35$, $p < .001$. And, the difference in the amount of guilt elicited between the negative card and the control card was greater for younger participants than older participants, $t(446) = 2.20$, $d = 0.21$, $p = .028$

Table 9. Guilt after seeing the RRFB tip card by age group and appeal type.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	3.40	1.03	3	0	52
Negative	4.65	3.59	3	1.0	49
Positive	4.36	2.58	3	2.5	47
Middle					
Control	4.02	2.15	3	0	46
Negative	3.34	1.07	3	0	56
Positive	3.66	1.44	3	0	50
Old					
Control	3.32	1.02	3	0	65
Negative	3.43	1.13	3	0	44
Positive	3.50	1.26	3	0	46

Table 10. Guilt after seeing the RRFB tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	3.55	1.46	3	0	163
Negative	3.80	2.31	3	0	149
Positive	3.84	1.88	3	0	143
Age Group					
Young	4.12	2.64	3	1	148
Middle	3.65	1.60	3	0	152
Old	3.41	1.12	3	0	155

Tables 11, 12, A15 and A16 display self-reported anger after viewing the FYA and RRFB cards. For the FYA card, there was a main effect for appeal type, $F(2, 445) = 5.40$, $p = .005$, such that the negative card elicited more anger than the control card, $t(445) = 3.21$, $d = 0.30$, $p = .002$. And, there was a main effect for age group, $F(2, 445) = 8.11$, $p < .001$, such that younger participants reported higher levels of anger than both middle-aged, $t(445) = 3.07$, $d = 0.29$, $p = .002$, and older participants, $t(445) = 3.81$, $p < .001$. However, there was no interaction between age group and appeal type, $F(4, 445) = 1.40$, $d = 0.36$, $p = .232$. For the RRFB card, there was no significant main effect for appeal type, $F(2, 446) = 2.50$, $p = .083$, or age group, $F(2, 446) = 1.97$, $p = .141$, and no interaction between the two variables, $F(4, 446) = 1.26$, $p = .286$.

Table 11. Anger after seeing the FYA tip card by age group and appeal type.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	6.12	3.58	4	3.00	50
Negative	8.87	5.64	7	7.25	52
Positive	8.06	6.05	5	6.50	50
Middle					
Control	5.84	4.18	4	1.00	50
Negative	6.22	3.79	4	4.00	49
Positive	5.89	4.69	4	1.00	44
Old					
Control	5.37	3.12	4	1.00	51
Negative	5.75	3.50	4	2.00	61
Positive	5.49	3.52	4	1.00	47

Table 12. Anger after seeing the FYA tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	5.77	3.64	4	2	151
Negative	6.90	4.56	4	4	162
Positive	6.52	5.00	4	2	141
Age Group					
Young	7.70	5.30	5	5	152
Middle	5.99	4.19	4	2	143
Old	5.55	3.37	4	1	159

Attitude toward the Tip Card. Cronbach internal reliability for the attitude measure was excellent (0.96). Tables 13, A17-A19 display attitude toward the FYA and RRFB cards. For the FYA card, there was no main effect for age group, $F(2, 445) = 2.24$, $p = 0.108$, no main effect for appeal type, $F(2, 445) = 1.59$, $p = 0.206$, and no interaction between the two variables, $F(4, 445) = 0.78$, $p = 539$. Likewise, the negative and positive FYA cards did not differ in attitude, $t(445) = 0.68$, $d = 0.07$, $p = 0.497$. For the RRFB card, there was no significant main effect for age group, $F(2, 446) = 2.04$, $p = 0.132$, nor an interaction between age group and appeal type, $F(2, 446) = 1.69$, $p = 0.151$. However, there was a significant main effect for appeal type, $F(2, 446) = 3.56$, $p = 0.029$, such that attitude toward the simulation-based card was more negative than attitude toward the control card, $t(446) = 2.03$, $d = 0.19$, $p = 0.043$. There was, however, no difference between the positive and negative cards, $t(446) = 1.72$, $d = 0.16$, p =.087.

Table 13. Attitude toward the RRFB tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	17.04	3.80	18	6.50	163
Negative	15.81	4.91	17	7.00	149
Positive	16.74	4.32	18	6.50	143
Age Group					
Young	16.37	3.96	17	5.25	148
Middle	17.06	4.32	18	6.00	152
Old	16.21	4.76	18	8.50	155

Attitude toward the Behavior Recommended by the Tip Card. The measure that assessed participants' attitudes toward executing the behavior recommended by the tip card had good internal reliability (0.83). Tables 14, 15, A20 and A21 display the results of the survey for the FYA and RRFB cards. For the FYA card, there was no main effect for appeal type, $F(2, 445) = 1.45$, $p = 0.235$, but there was one for age group, $F(2, 445) = 3.04$, $p = 0.049$. There was also an age group by appeal type interaction, $F(4, 445) = 2.45$, $p = 0.046$. Younger participants had a greater positive attitude toward executing the behavior recommended by the negative card than the behavior recommended by the positive one, but the reverse was true for middle-aged and older participants, $t(445) = 2.49$, $d = 0.24$, $p = 0.013$. For the RRFB card, there was no main effect for age group, $F(2, 446) = 1.87$, $p = 155$, or appeal type, $F(2, 446) = 0.55$, $p = 0.577$, and no interaction between the two variables, $F(4, 446) = 1.09$, $p = 0.363$. Likewise, there was no difference between the positive and negative cards, $t(446) = 1.00$, $d = 0.10$, $p = 0.316$.

Table 14. Attitude toward the behavior recommended by the FYA tip card by age group and appeal type.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	16.76	3.44	17.5	5.75	50
Negative	18.10	3.36	20.0	5.25	52
Positive	15.80	3.70	16.0	4.00	50
Middle					
Control	17.76	3.82	19.0	5.75	50
Negative	17.92	3.75	19.0	5.00	49
Positive	17.61	4.56	20.0	6.00	44
Old					
Control	17.51	4.02	18.0	5.00	51
Negative	16.02	4.15	17.0	7.00	61
Positive	16.55	4.84	18.0	8.50	47

Table 15. Attitude toward the behavior recommended by the FYA tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	17.34	3.77	18	6.00	151
Negative	17.26	3.89	18	6.00	162
Positive	16.62	4.41	18	7.00	141
Age Group					
Young	16.90	3.60	18	6.25	152
Middle	17.77	4.01	19	5.50	143
Old	16.65	4.35	18	8.00	159

Behavioral Intent. Internal reliability of the behavioral intent measure was 0.79, which suggests acceptable reliability. Tables 16-19 display behavioral intent ratings for the FYA and RRFB cards. For the FYA card, there was no main effect for age group, $F(2, 445) = 0.38$, $p = 0.684$, nor a significant interaction between age group and appeal type, $F(4, 445) = 0.66$, $p = 0.624$. However, there was a significant main effect for appeal type, $F(2, 445) = 5.62$, $p = 0.004$, such that participants reported having more intent to execute the behavior recommended by the control card than the behavior recommended by the simulation-based card, $t(445) = 2.58$, $d = 0.24$, $p = 0.01$. They also reported having more intent to execute the behavior recommended by the negative card than the behavior recommended by the positive card, $t(445) = 2.24$, $d = 0.21$, $p = 0.025$.

For the RRFB card, there was no significant main effect for age group, $F(2, 446) = 0.74$, $p = 0.478$, nor a significant age group by appeal type interaction, $F(4, 446) = 0.63$, $p = 0.642$. However, there was once again a main effect for appeal type, $F(2, 446) = 8.58$, $p < 0.001$, such that participants reported having more intent to execute the behavior recommended by the simulation-based card than the behavior recommended by the control card, $t(446) = 4.05$, $d = 0.38$, $p < .001$. This time, however, there was no difference between the positive and negative cards, $t(446) = 0.93$, $d = 0.09$, $p = 0.353$.

Table 16. Behavioral intent toward the FYA tip card by age group and appeal type.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	11.88	1.80	12	3.75	50
Negative	11.85	1.96	12	3.00	52
Positive	11.24	2.46	12	3.00	50
Middle					
Control	11.82	2.78	13	4.00	50
Negative	11.80	2.23	12	4.00	49
Positive	10.80	3.43	12	5.00	44
Old					
Control	12.10	1.82	12	3.00	51
Negative	11.23	2.23	12	3.00	61
Positive	10.96	2.80	11	5.00	47

Table 17. Behavioral intent toward the FYA tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	11.93	2.17	12	3	151
Negative	11.60	2.15	12	4	162
Positive	11.01	2.89	12	5	141
Age Group					
Young	11.66	2.10	12	4	152
Middle	11.50	2.85	12	4	143
Old	11.43	2.34	12	4	159

Table 18. Behavioral intent toward the RRFB tip card by appeal type and group.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	11.60	2.02	12.0	4.00	52
Negative	12.12	1.80	12.0	3.00	49
Positive	12.21	2.04	13.0	3.00	47
Middle					
Control	11.39	2.19	11.5	3.75	46
Negative	12.52	1.69	13.0	2.25	56
Positive	12.54	1.68	13.0	2.00	50
Old					
Control	11.82	2.30	12.0	3.00	65
Negative	12.20	2.33	13.0	2.25	44
Positive	12.74	1.54	13.0	2.00	46

Table 19. Behavioral intent toward the RRFB tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	11.63	2.17	12	4.0	163
Negative	12.30	1.93	12	3.0	149
Positive	12.50	1.77	13	2.0	143
Age Group					
Young	11.97	1.96	12	3.0	148
Middle	12.18	1.91	12	3.0	152
Old	12.20	2.13	13	2.5	155

Self-Efficacy. Unlike the other measures, the self-efficacy measure had poor internal reliability (0.45). Tables 20, 21 A22 and A23 display the self-efficacy results for the FYA and RRFB cards. For the FYA card, there was no main effect for age group, $F(2, 445) = 0.06$, $p = .944$, no main effect for appeal type, $F(2, 445) = 0.06$, $p = 0.939$, and no interaction between the two variables, $F(4, 445) = 1.92$, $p = 0.106$. Likewise, the negative and positive cards did not differ from each other, $t(445) = 0.35$, $d = .03$, $p = 0.727$. The results were the same for the RRFB card where there was no main effect for age group, $F(2, 446) = 0.26$, $p = 0.773$, no main effect for appeal type, $F(2, 446) = 2.64$, $p = 0.073$, and no interaction, $F(4, 446) = 0.04$, $p = 0.997$. There was no difference between the negative card and the positive card, $t(446) = 0.78$, $d = 0.07$, $p = 0.435$.

Table 20. Self-Efficacy with the RRFB tip card by age group and appeal type.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	18.06	2.13	18.0	2.25	52
Negative	17.31	2.75	18.0	5.00	49
Positive	17.53	2.52	18.0	4.00	47
Middle					
Control	17.85	2.72	18.0	4.00	46
Negative	17.20	2.88	16.5	5.00	56
Positive	17.56	2.60	18.0	4.75	50
Old					
Control	17.86	2.89	18.0	5.00	65
Negative	17.07	3.42	18.0	5.00	44
Positive	17.26	3.51	18.0	5.00	46

Table 21. Self-Efficacy with the RRFB tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	17.92	2.60	18	4	163
Negative	17.19	2.99	18	5	149
Positive	17.45	2.88	18	5	143
Age Group					
Young	17.64	2.47	18	4	148
Middle	17.51	2.74	18	5	152
Old	17.46	3.23	18	5	155

Social Sharing. The measure that assessed participants' likelihood of sharing the information provided by the tip card had excellent internal reliability (Cronbach's alpha = 0.96). Tables 22-24 and A24 display the social sharing results for the FYA and RRFB tip cards. For the FYA card, there was no main effect for appeal type, $F(2, 445) = 1.59$, $p = 0.206$. However, there was a main effect for age group, $F(2, 445) = 3.94$, $p = 0.02$, as well as a significant interaction between age group and appeal type, $F(4, 445) = 2.86$, $p = 0.023$. Whereas younger participants reported a greater likelihood of sharing the information on the enhanced card than the information on the control card, the opposite was true for middle-aged and older participants, $t(445) = 2.21$, $d = 0.21$, $p = 0.028$. And, the difference in likelihood of sharing the information between the control card and the

simulation-based card was greater for older participants than middle-aged ones, $t(445) = 2.18$, $d = 0.21$, $p = 0.03$. For the RRFB card, there was no main effect for appeal type, $F(2, 446) = 0.78$, $p = 0.457$, nor a significant interaction between age group and appeal type $F(4, 446) = 1.81$, $p = 0.127$. However, there was a significant main effect for age group, $F(2, 446) = 7.63$, $p = 0.001$, such that middle-aged and older participants combined reported a higher likelihood of sharing the information on the tip card than younger participants, $t(446) = 3.80$, $d = 0.36$, $p < 0.001$.

Table 22. Social sharing likelihood for the FYA tip card by age group and appeal type.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	8.14	4.45	9.0	7.75	50
Negative	9.04	3.78	10.0	5.25	52
Positive	8.54	4.26	9.0	6.00	50
Middle					
Control	10.10	4.44	12.0	7.25	50
Negative	9.51	4.43	10.0	5.00	49
Positive	10.25	4.50	11.5	5.50	44
Old					
Control	11.20	3.68	12.0	4.00	51
Negative	8.28	4.72	8.0	8.00	61
Positive	9.06	4.56	9.0	7.00	47

Table 23. Social sharing likelihood for the RRFB tip card by age group and appeal type.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	8.25	4.77	9.5	9.25	52
Negative	8.43	5.32	10.0	10.00	49
Positive	7.47	4.68	8.0	9.00	47
Middle					
Control	10.26	4.69	11.0	6.00	46
Negative	9.07	4.66	9.0	8.50	56
Positive	10.78	4.14	11.5	6.00	50
Old					
Control	8.78	4.36	10.0	7.00	65
Negative	9.36	4.21	10.0	6.00	44
Positive	10.54	4.39	12.0	7.50	46

Table 24. Social sharing likelihood for the RRFB tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	9.03	4.63	10.0	9	163
Negative	8.95	4.75	10.0	9	149
Positive	9.62	4.63	11.0	7	143
Age Group					
Young	8.06	4.91	9.5	10	148
Middle	9.99	4.53	10.5	8	152
Old	9.47	4.36	10.0	7	155

Tip Card Reading Times

For each side of the tip card, reading times were collected via the built-in question timer in Qualtrics. In order to investigate the question of whether or not there is a reading time advantage for the enhanced tip cards as compared with the control tip cards, both the positive and negative appeal conditions timing data were collapsed into an "enhanced" condition.

A mixed between-within subjects ANOVA was conducted to assess the influence of the tip card condition and age group (between-subjects factors) on tip card reading times, across both sides of the tip card (within-subjects factor). There was not a significant interaction between the experimental condition and age group ($F(2,922) = 0.264$, $p = 0.768$), but there was a significant main effect of experimental condition ($F(1,922) = 82.127$, $p < .001$). Collapsing the reading times for the front and back of the card, enhanced cards were read in 31.1 seconds on average, whereas control tip cards were read in 46.3 seconds.

There was a significant interaction between card side and the experimental condition ($F(1,922) = 184.150$, $p < 0.001$), as well as a significant interaction between card side and age group ($F(1,922) = 6.179$, $p = 0.002$), but the three-way interaction was not significant ($F(1,922) = 0.429$, $p = 0.651$).

Table 25 breaks down the card side by experimental condition interaction, showing a 32.7-second reading advantage for the back of the tip card in the enhanced condition. That is, the back of the enhanced card was read in half the time, hence, much more efficient in conveying information.

Table 25. Mean reading times (s) for each experimental condition by side of the tip card (SD in parentheses).

Condition	Front	Back
Control	25.52 (19.2)	67.15 (43.0)
Enhanced	27.81 (29.2)	34.36 (28.7)

Table 26 breaks down the card side by age-group interaction. Younger adults read the back side of the tip card 12.2 seconds slower than the front of the tip card, middle-aged adults, 17.9 seconds slower than the front, and older adults, 24.8 seconds slower than the front of the tip card.

Table 26. Mean reading times (s) for each age group, across both sides of the tip card (SD in parentheses).

Age Group	Front	Back	Mean Difference
Young adults	27.79 (37.8)	40.01 (42.8)	12.2
Middle-aged adults	27.16 (18.9)	45.06 (35.7)	17.9
Older adults	26.20 (16.9)	51.04 (33.1)	24.8

Open Response Data

In the survey, we also asked participants to tell us everything they could about the device they saw, and mentioned that we were interested to know what they remembered about the device's appearance, what it means, and how they are to respond if they see it. Two research assistants coded whether or not these responses mentioned how to respond to the device and related devices. These coded responses are shown in Tables 27 and 28 along with the percentage of participants who mentioned them. Only participant responses that had 100% agreement between coders were included in the tables and analyses.

For the FYA device, middle-aged rather than older participants were more likely to mention what to do in response to a flashing yellow arrow, $\chi^2 = 8.32$, $p = 0.016$. For the RRFB device, there was a main effect of appeal type, $\chi^2 = 17.09$, $p < 0.001$, such that

participants who saw the control card were more likely to mention needing to be alert in response to an RRFB device, *OR* = 0.54, *p* = 0.029. Among middle-aged participants, mention of the need to prepare to respond in response to seeing a flashing signal was greater in the enhanced card conditions than in the control condition, but the same was not true for older participants, *OR* = 2.81, *p* = 0.002. Among younger participants, mentions of the need to stop when there are pedestrians present in a crosswalk were fewer in the control condition than in the enhanced card conditions, but the opposite was true for middle-aged and older participants, *OR* = 2.19, *p* < 0.001. No other main effects or interactions were significant.

Table 27. Features mentioned by participants when asked to share their knowledge on FYA devices.

Condition		When you see a green arrow, turn left	When you see a red arrow, stop	When you see a yellow arrow, prepare to stop	When you see a yellow arrow, complete your left turn	When you see a flashing yellow arrow, turn left if there is a safe gap in traffic (pedestrians and vehicles)
Young						
	Control	12%	10%	12%	4%	88%
	Negative	12%	14%	18%	10%	96%
	Positive	0%	2%	12%	8%	92%
Middle						
	Control	16%	14%	15%	2%	87%
	Negative	13%	17%	17%	9%	98%
	Positive	14%	16%	14%	14%	95%
Old						
	Control	14%	16%	14%	0%	81%
	Negative	13%	14%	7%	10%	82%
	Positive	17%	16%	11%	5%	88%

Table 28. Features mentioned by participants when asked to share their knowledge on RRFB devices.

Condition		When you see an RRFB, be alert	When you see an RRFB, be ready to stop	When the light is flashing, be ready to stop	When there are pedestrians present in the crosswalk, stop	When the crosswalk is completely clear, go!	Don't pass if another car is stopped at flashing light
Young							
	Control	48%	19%	40%	44%	2%	6%
	Negative	10%	16%	63%	21%	35%	0%
	Positive	22%	28%	53%	30%	28%	0%
Middle							
	Control	36%	17%	31%	20%	0%	15%
	Negative	20%	12%	59%	50%	38%	0%
	Positive	20%	25%	77%	42%	35%	0%
Old							
	Control	23%	17%	37%	35%	2%	23%
	Negative	14%	32%	35%	50%	34%	0%
	Positive	22%	24%	40%	48%	22%	0%

Safety-relevant Interpretation Errors Uncovered in Open-Responses

As coders reviewed the open-response data collected for Task 2a, a few safety-relevant interpretation errors were uncovered in participants' open responses. Table C1 shows the responses flagged by our coders for each traffic control device.

Safety-relevant misinterpretations fell into two main categories. We combine results from Study 2a and 2c (described below) as these misinterpretations occurred rarely. For the RRFB traffic control device, people made erroneous assumptions that where the beacon was flashing (left versus right side of the road) indicated different behaviors. For the FYA, though such responses were very rare (2 cases, 1 middle 1 older), it appeared that drivers thought that the FYA traffic control device detected opposing traffic or pedestrians and flashed to signal their presence. There was one case for the RRFB that indicated a similar misunderstanding (automatic triggering of the device by pedestrian presence in the crosswalk).

Task 2a Conclusions

The results of this initial study show that the re-designed tip cards did not consistently affect outcomes relating to learnability and user satisfaction. There were statistically reliable effects on particular measures (as discussed above), but many of these effects did not appear consistently across both the FYA and RRFB cards, and many of them were comparatively small. The striking exception is the reading efficiency measure which showed a very large advantage for the enhanced tip cards on the second side of the card containing the critical information. Although ideally better memory would be associated with the enhanced tip cards, it is notable that our much more concise, redesigned cards were able to convey the same information (equal memory performance) in much less text and hence, take less time to read. Thus the enhanced cards can be considered to be more efficient at conveying important information about new traffic control devices and safety countermeasures. Although additional work is necessary to elaborate on this finding, for instance through the use of focus group studies in realistic settings (where aging drivers are presented with these cards at seniors' events), these concise messages are more likely to be read completely.

Although the results of this study did not strongly demonstrate an advantage for the re-designed tip cards for outcomes other than reading times, we believe that these results should be interpreted in the context of several limitations of the study design. First, participants interacted with a computer facsimile of the tip cards, not an actual tip card. Second, the recognition memory test used to assess learning from the cards was not the best test of the effectiveness of the cards. There is a limited amount of information on each card, and participants only needed to retain this information for a short period of time. As such, a recognition test may not have been challenging enough

to reveal differences in learning between tip cards. The open-ended responses are a converging measure of memory, but given limitations in how willing people are to type long responses, they don't provide ideal data. Our subsequent studies, in which participants were asked to retain information from the tip cards over a longer period of time and to employ this knowledge in the driving simulator provided a stronger test of the educational value of the enhanced tip cards compared to the standard cards. Finally, whereas we found differences in attitudes across the tip card designs, the nature of the present study does not allow us to tease out the particular nature of these effects. Of note, however, among middle-aged and older participants who viewed the RRFB card, feelings of pride were greatest when they received the card with the positive emotional appeal. Additional analyses indicated that for these participants, feelings of pride were significantly and positively correlated (at $p < 0.05$) with attitude toward the tip card ($r = 0.34$), attitude toward the behavior ($r = 0.31$), and behavioral intent ($r = 0.28$). These findings suggest further study of the influence of positive emotional appeals on tip card responses may be informative.

Specific Recommendations Based on Study Findings

Inconsistent results across most of the usability outcome variables for the two tip card variants (control vs. enhanced) make it difficult to make specific recommendations based on memory measures or on user satisfaction. In general, for memory assessed with multiple choice questions, which may be the most central variable for influencing future interactions with a road sign or signal (you recognize the meaning when you see it), all designs were equally effective. All FYA designs yielded 70% or greater accuracy, and the RRFB tip card designs yielded 63% or greater accuracy immediately following tip card exposure. However, the backs of the enhanced cards were read in half the time compared with the standard cards, so we strongly recommend their adoption based on their efficiency for conveying information to aging road users.

Chapter 4: Task 2b: Delayed Memory

In our prior study (Task 2a), we developed tip cards that were expected to be superior to existing ones and assessed aspects of their usability, including legibility, comprehension of actions to take, and attitudes related to adherence. We tested control versus enhanced tip card designs immediately after exposure. We found few advantages for the redesigned tip cards when people read them and were tested immediately for comprehension and attitudes aside from finding that speed of reading was much better for enhanced cards. Participants were able to extract the same amount of information from both tip cards, but were able to extract that information much more quickly for the enhanced tip cards. We did not test for memorability following a long delay. This is an important aspect of evaluation as it may be days, weeks, or even longer between when a road user reads a tip card about a traffic control device and when they encounter it on the road.

In this study, we again tested different tip cards (or no tip card) with aging road users with a combination of both survey and experimental techniques. The cards explained the flashing yellow arrow (FYA) and rectangular rapid flashing beacon (RRFB). Using a computer-based task in which participants viewed both real-world and computer-generated scenes featuring the FYA or RRFB, we measured their reaction time to and accuracy for responding to these traffic control devices. Participants received either a control tip card or an enhanced tip card for either of these traffic control device types, and were asked to respond to these traffic control devices under a variety of conditions, most importantly including delayed testing one week following exposure to the cards. We also introduced a control condition of not showing any tip card to assess base understanding for these traffic control devices without tip card information. The major difference between task 2a and task 2b is that in this study (2b) we tested an important aspect of usability for a tip card, memorability, by assessing comprehension of the information following a one-week delay compared to immediate testing in Task 2a.

Method

This task presented enhanced tip cards -- based on the Human Factors guidelines established in Task 1 -- related to the flashing yellow arrow (FYA) or the Rectangular Rapid Flashing Beacon (RRFB) to participants, and asked them for the appropriate response (as indicated by pressing one of three keyboard keys) in a simulated driving decision situation. To test the memorability of the tip cards created for this project, participants in each age group (middle-aged, older) were randomly assigned to one of five conditions: (1) control tip card with immediate testing, (2) control tip card with a one-week delay before testing, (3) enhanced tip card with immediate testing, (4) enhanced tip card with a one-week delay before testing, and (5) no tip card with immediate testing.

In addition to responses collected in a simulated driving situation, we also collected survey responses related to basic demographics, driving behavior, attitudes toward the tip card they were exposed to, self-efficacy and intention to take the recommended actions, the System Usability Scale, and personality measures (to be described in more detail below).

Participants

A total of 158 middle-aged (50 to 64 years, M = 59.9, SD = 3.53), and 161 older adult (65 and above years, M = 71.7, SD = 5.09) participants were recruited from the Tallahassee, FL area. Those in the one-week delay condition showed some attrition, totaling 4 dropouts. The final dataset included 203 participants (Middle-aged adults: N = 148, M Age = 59.8, SD = 3.56; Older adults: N = 155, M Age = 71.7, SD = 5.05). All were licensed drivers. None of the participants in our final dataset had participated in previous studies in our laboratory involving the flashing yellow arrow (FYA) or Task 2a where they were exposed to the control and enhanced tip cards in an earlier form.

Materials

Tip Cards

Participants were exposed to either a control tip card, or an enhanced tip card based on the Human Factors guidelines established in Task 1 for this project (except in the case of the no tip card condition), related to either the FYA or the RRFB. Tip cards to which participants were exposed can be seen in Figures 11 through 14 below.

Figure 11. Control tip card for the flashing yellow arrow (FYA). Side 1 is shown to the left and side 2 to the right.

Figure 12. Tip card for the flashing yellow arrow (FYA) enhanced based on the guidelines established in Task 1 and the results of Task 2a. Side 1 is shown to the left and side 2 to the right.

RECTANGULAR RAPID FLASHING BEACONS (RRFB)

FDOT

Safety is Golden
Safe Mobility for Life Coalition

What you need to know!

WHAT IS THE RRFB

A new traffic control device to make it safer and easier for pedestrians to cross streets. This new device is called a Rectangular Rapid Flash Beacon (RRFB). RRFBs are activated by pedestrians and people riding bicycles by manually pushing a button. Once the button is pushed, a highly visible flashing pattern, similar to emergency flashers on police vehicles, alerts drivers that a person wants to cross the street.

BENEFITS OF RRFB

RRFBs can enhance safety by increasing driver awareness of people who want to cross the street at a crosswalk. When installed at unsignalized crosswalks, the RRFBs have been shown to be more effective than standard signing and pavement markings alone.

HOW THE RRFB WORKS

1. The pedestrian activates the RRFB by pressing the button.
2. The RRFB begins to flash to alert drivers that a pedestrian wants to cross the street in the crosswalk.
3. Flashing lights facing the pedestrian confirm the activation of the RRFB.
4. The RRFB flashes for a set time that allows a pedestrian adequate time to cross the street.
5. After the allocated time has passed for the pedestrians to complete their crossing, the RRFB turns off.

DRIVER TIPS

1. Be alert and reduce speed in areas with crosswalks.
2. Come to a complete stop if pedestrians are crossing or preparing to cross.
3. Never pass another vehicle that has stopped or is slowing down at a crosswalk.

For more information, visit:
FLsams.org

Figure 13. Control tip card for the rectangular rapid flashing beacon (RRFB). Side 1 is to the left and side 2 is to the right.

Figure 14. Tip card for the rectangular rapid flashing beacon (RRFB) enhanced based on the guidelines established in Task 1 and the results of Task 2a. Side 1 is to the left and side 2 is to the right.

Qualtrics Survey

Using the Qualtrics survey platform, we collected additional information such as attitudes toward the tip card, self-efficacy, and intention to take recommended actions, participants' personality and demographics, as well as other measures not captured in the main experimental task across a total of nine blocks:

During the first survey block, participants completed questions about basic demographics (i.e., gender, date of birth, vision). During the second block of the survey, participants answered questions relating to driving behavior (i.e., driver's license status, frequency and length of driving in an average week). The third block of the survey asked participants to complete the Ten Item Personality Inventory (TIPI -- Gosling, Rentfrow, & Swann, 2003). The fourth block consisted of questions gauging the participants' evaluations of the tip card as well as self-efficacy to perform and attitudes toward the behaviors encouraged by the tip card. Next participants completed the System Usability Scale (SUS -- Brooke, 1996) to assess the usability of the tip cards investigated. After completing the SUS, participants were asked to rate their experiences with the tip card, and give ratings of their likelihood of sharing the information in the tip card with others. The next block was an attention check to validate that participants remembered which tip card they were exposed to, which asked them to select the card from a list of alternatives, and describe its appearance. The eighth block asked participants two free response questions:

1. In the space provided below, please tell us what purpose the [flashing yellow arrow (FYA) or rectangular rapid flashing beacon (RRFB)] serves our roadways.
2. In the space provided below, please tell us what drivers should do when they see a [flashing yellow arrow (FYA) or rectangular rapid flashing beacon (RRFB)]

In the ninth, and final, block, participants were asked multiple-choice questions related to the tip card they were exposed to; this included selecting the signal from a pictorial set of alternatives, identifying the primary purpose of the signal, and the meaning of certain situations (i.e., "When you see a flashing yellow arrow, it means you should…").

Practice and Experimental Tasks

For Task 2b, two tasks were programmed in Psychopy (Peirce, 2007), a Python-based experiment programming software package. The first task was a practice task that trained participants on the keyboard mappings that would be used in the real experiment for a total of 18 trials (randomly distributed equally amongst all response options; 6 per each response). The word presented in the center of the screen could be either STOP, YIELD/CAUTION, or GO. Appropriate responses were the left arrow key, middle arrow key, and right arrow key respectively. These response options and

keyboard mappings were subsequently used in the experimental task. A sample stimulus from this task is shown in Figure 15. After each trial, participants received a feedback screen that indicated if their response was Correct (written in green) or Incorrect (written in red).

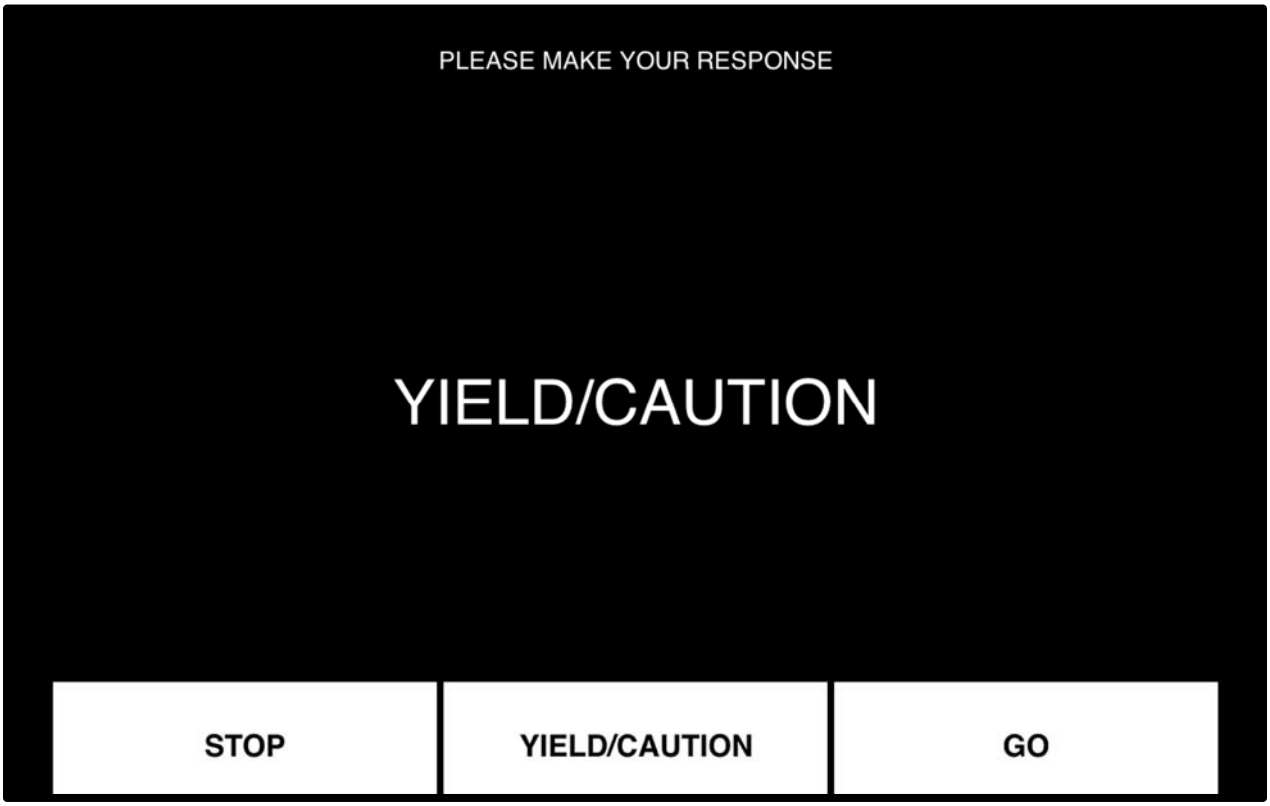

Figure 15. Depiction of one trial in the practice task created to reinforce keyboard mappings in the experimental task.

The experimental task, presented participants photographs of scenes of intersections in North Florida (Tallahassee, FL for the RRFB; Jacksonville, FL for the FYA) and scenes created in Google Sketchup. The order in which participants saw the two types of images (photos vs. Sketchup images), was counterbalanced, whereby participants with an even participant number saw Sketchup images in the first block, and photographs in the second block; for participants with an odd participant number, the ordering was the exact opposite.

These scenes varied in pedestrian presence, pedestrian location within the crosswalk in question (left, left middle, middle, right middle, right), and signal mode (FYA: green arrow, red arrow, flashing yellow arrow; RRFB: flashing on, flashing off), but across both image types, all conditions experienced were identical. Since the combinations of factors were not equivalent for the RRFB and FYA conditions, this resulted in similar, but not equal, total trial counts for each condition (i.e., 96 trials for the FYA condition, 90

trials for the RRFB condition). Figure 16 compares the Sketchup and Photograph conditions for the FYA and Figure 17 compares the conditions for the RRFB.

For scenes with a flashing yellow arrow, timings were based on FDOT installations (500 ms on, 500 ms off). For the rectangular rapid flashing beacon, timing and flash patterns were based off a study conducted by Fitzpatrick and colleagues at the Texas A & M Transportation Institute, where it was determined that no one pattern significantly captured more attention than another, and flashing of the beacon occurred for 25 milliseconds (Fitzpatrick, Avelar, Robertson, & Miles, 2014). For a full explanation of the flash pattern used for the RRFB, see Figure 18 (for a GIF animation of the pattern, see: http://bit.ly/RRFB_25ms).

Figure 16. Comparison of the photograph (left) and Google Sketchup (right) conditions within the experiment for the flashing yellow arrow (FYA).

Figure 17. Comparison of the photograph (left) and Google Sketchup (right) conditions within the experiment for the rectangular rapid flashing beacon (RRFB).

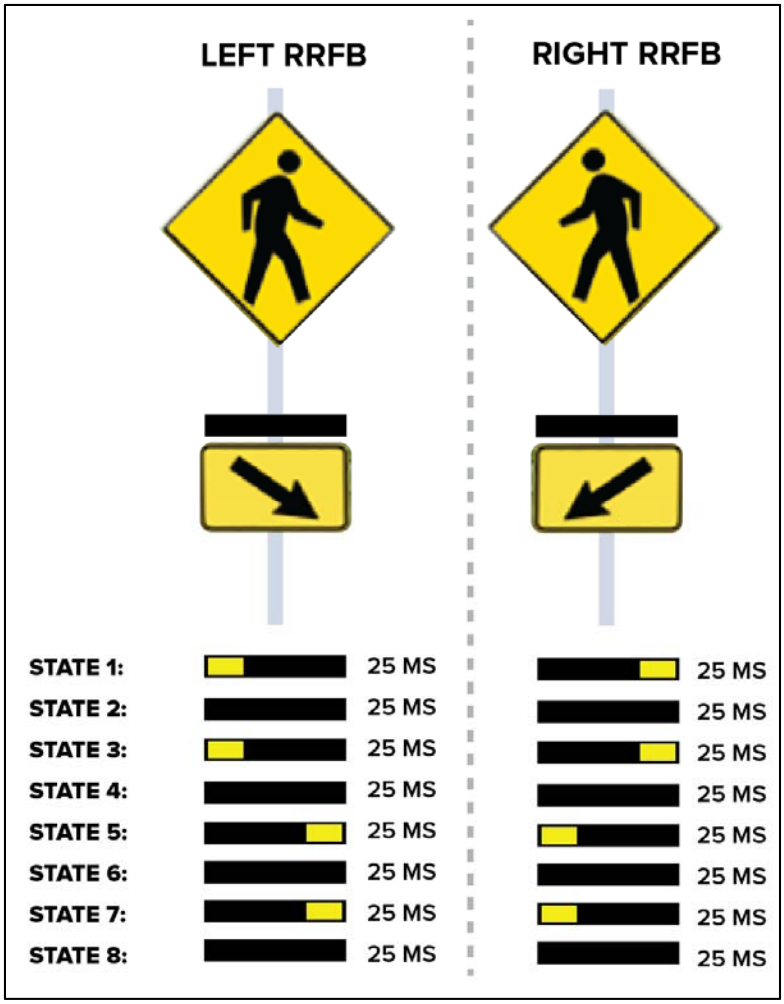

Figure 18. Flash pattern used in experimental task for RRFB condition. Based on Fitzpatrick et al. (2014). For a GIF animation of the pattern, see: http://bit.ly/RRFB_25ms

Procedure

Upon entering the laboratory, participants provided informed consent, then were assigned to their experimental condition. Those in the no tip card condition, were given a general Qualtrics survey with no questions related to either the FYA or the RRFB. Those in the immediate condition viewed the tip card for four minutes, then proceeded to answer the Qualtrics survey. Participants in the one-week delay condition only saw the tip card for four minutes, received payment for their first session, then went home, and returned exactly one-week later, beginning their session with the Qualtrics survey. During piloting of this task, it was determined that no lighting configuration in the experimental rooms avoided glare on the screen, so immediately following the Qualtrics

survey, the lights in the experimental room were shut off in order for participants to adapt to the darkness in the room, which helped enhance visibility of the onscreen stimuli. Participants then completed 18 trials of practice with the keyboard mappings in the practice task, before proceeding to the experimental task. In the experimental task, as mentioned previously, due to the differences in combinations of experimental factors (i.e., signal mode, pedestrian presence and location) trial counts for the FYA condition and RRFB condition were similar but not identical (i.e., 96 vs 90 trials respectively). Of these trials, the first block of trials for each stimulus block (i.e., Sketchup vs Photographs) emphasized accuracy over speed in the instructions to be able to look at untimed accuracy in response to several situations presented. The second block for each stimulus block, emphasized speed over accuracy in the instructions, in order to be able to look at speeded decisions to each situation. After completing the accuracy emphasis and speed emphasis block for each stimulus type (Sketchup and Photographs) the experiment was complete, and participants were given their payment, as well as a debriefing about the nature of this study.

Results

R (Version 3.1) was used to conduct the analyses.

Qualtrics Survey Data

In our initial analyses of the Qualtrics survey data, we found no main effect for age group as well as no interactions between age group and any other variables. Therefore, we collapsed our analyses across age (see Appendix A, tables A29-A37). Except where we note otherwise, we analyzed the Qualtrics data using a 2 (tip card condition: control vs. enhanced) by 2 delay period (no delay vs. one week) ANOVA. We calculated this ANOVA separately for each type of tip card. We present Tables that show the full cross-breaks for age group, card type, and delay conditions in the text for significant effects, and in the Appendices for non-significant effects.

Memorability

Tables A25 and A26 display the memorability scores for the FYA and RRFB tip cards. The delay between the times participants first saw the tip card and the time they were tested on it as well as the type of card they saw had no significant effect on their ability to remember either type of card (all $p > 0.156$). Overall, performance was quite good across all conditions.

Perceived Usability

Tables A27 and A28 display the perceived usability scores for the FYA and RRFB tip cards. In the current dataset, internal reliability of the measure was 0.91 (Cronbach's alpha), which suggests excellent reliability. For both the FYA and RRFB cards, the time between when participants first saw the card and the time they were tested on it as well as the type of card they saw had no effect on perceived usability (all $p > 0.079$). For the FYA card, there was a trend for participants to perceive the usability of the enhanced card to be greater than that for the control card ($p = 0.079$; all other ps > 0.147). Usability was generally rated as high across all tip cards, averaging about 85% of the maximum possible score.

Attitude Toward Tip Card

Tables 29 and A29 display attitude toward the FYA and RRFB tip cards. Internal reliability for the attitude measure was excellent (Cronbach's alpha = 0.94). The delay between the time participants first saw the tip card and the time they were tested on it as well as the tip card they saw had no effect on their attitude towards either the FYA or RRFB card (all $p > 0.094$). Attitude towards the enhanced version of the RRFB card was slightly more negative than that for the control version of the same card, but this was not significant ($p = 0.094$; all other $p > 0.122$). Again, averaged across tip cards, attitudes were quite positive, averaging about 85% of the maximum score.

Table 29. Attitude toward the RRFB tip card (min. possible score: 3, max: 21).

	Condition		*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	19.17	1.85	19.00	3.00	12
		Enhanced Card	17.93	3.95	19.00	4.50	15
	One Week Delay						
		Control Card	18.31	3.77	21.00	3.00	13
		Enhanced Card	18.10	2.85	18.00	2.50	10
Older Participants							
	No Delay						
		Control Card	19.56	2.06	21.00	3.00	16
		Enhanced Card	18.07	3.59	19.00	3.50	15
	One Week Delay						
		Control Card	17.86	2.66	17.00	3.50	14
		Enhanced Card	17.00	3.76	18.00	5.00	15

Attitude Toward the Behavior Recommended by the Tip Card

Tables A30 and A31 display participants' attitudes toward the behavior recommended by the FYA and RRFB cards. Internal reliability of the measure was 0.79 (Cronbach's alpha), which is acceptable. For both FYA and RRFB cards, the delay between the times participants first saw the tip card and the time they were tested on it as well as the type of card they saw had no significant effect on their attitude toward the behavior recommended by the card (all $p > 0.147$). Attitudes toward the behavior were again overwhelmingly positive, averaging about 90% of the maximum score across tip cards.

Behavioral Intent

Tables A32 and A33 display participants' intent to practice the behavior recommended by the FYA and RRFB cards. Internal reliability for this measure was questionable (Cronbach's alpha = 0.66), in part because it was composed of only 2 items. For both cards, the delay period between the time participants first saw the card and the time that they were tested on it as well as the type of card they saw had no effect on their behavioral intent for the behavior recommended by the card (all $p > 0.106$). Behavioral intent was also quite high across tip cards, averaging about 85% of the maximum score.

Self-Efficacy

Tables A34 and A35 display participants' self-efficacy to take the actions recommended by the FYA and RRFB cards. Internal reliability for this measure was excellent (Cronbach's alpha = 0.92). Participants' self-efficacy with the enhanced RRFB card (M = 13.3) was greater than that for the control RRFB card (M = 12.7), $t(106) = 2.38$, $p = 0.019$. All other results were non-significant (all $p > 0.142$). In general, self-efficacy was modest across cards and conditions, averaging about 60% of maximum.

Social Sharing

Tables A36 and A37 display participants' social sharing scores for the FYA and RRFB cards. The internal reliability of this measure was good (Cronbach's alpha = 0.87). For both cards, the time between when participants first saw the card and the time they were tested on it as well as what card they saw had no effect on their intentions to share the information provided by the card (all $p > 0.082$). Participants were slightly less likely to indicate they would share the information provided by the enhanced RRFB card than that provided by the control RRFB card, but this was not significant ($p = 0.082$; all other $p > 0.170$). On average across cards and conditions, intent to share was at about 70% of the maximum score.

Open Response Data

In the survey, we also asked participants several questions about the device they saw: 1) what the device looked like, 2) what its purpose was, and 3) how to correctly respond to it. Two research assistants coded these responses and the results from this coding are shown in Tables 30 to 35. Only participant responses that had 100% agreement between coders were included in the tables and analyses. In the analyses below, we only report effects that were statistically significant.

Regarding the appearance of the FYA device, the likelihood of mentioning a green or red arrow was greater with the control rather than enhanced card in the no delay group, but the opposite was true in the one-week delay group, green arrow: $OR = 1.70$, $p = 0.019$; red arrow: $OR = 1.70$, $p = 0.021$.

Table 30. Responses from participants when asked to recall the appearance of the FYA device

Condition			Green Arrow	Yellow Arrow	Red Arrow	Flashing /Blinking	Left
Middle-Aged Participants							
	No Delay						
		Control Card	44%	53%	44%	50%	50%
		Enhanced Card	7%	67%	7%	67%	43%
	One Week Delay						
		Control Card	36%	54%	29%	54%	14%
		Enhanced Card	50%	60%	50%	50%	20%
Older Participants							
	No Delay						
		Control Card	50%	60%	38%	60%	27%
		Enhanced Card	20%	67%	20%	40%	57%
	One Week Delay						
		Control Card	43%	50%	38%	64%	31%
		Enhanced Card	40%	87%	40%	67%	54%

Regarding the perceived purpose of the FYA device, there was a three-way interaction between all three conditions for judging one of the purposes to be to “signal the driver to wait for a safe gap in traffic before turning,” $\chi^2 = 4.48$, $p = 0.034$. This effect was driven by a low endorsement of this purpose by older participants in the no delay, control card condition.

Table 31. Responses from participants when asked to recall the purpose of the FYA device

	Condition		Safety for All Traffic (Peds, Drivers, or Cyclists)	Warning/Alerting	Safe Gap
Middle-Aged Participants					
	No Delay				
		Control Card	27%	12%	44%
		Enhanced Card	20%	7%	53%
	One Week Delay				
		Control Card	15%	17%	36%
		Enhanced Card	10%	11%	60%
Older Participants					
	No Delay				
		Control Card	31%	19%	8%
		Enhanced Card	33%	20%	79%
	One Week Delay				
		Control Card	23%	0%	50%
		Enhanced Card	13%	7%	67%

Regarding the perceived correct response to the FYA device, middle-aged rather than older participants were more likely to mention that drivers should complete their left turn when they see a yellow arrow, $\chi^2 = 6.43$, $p = 0.011$.

Table 32. Responses from participants when asked what to do when they see an FYA device.

Condition	No passing	Incorrect Information	When you see a green arrow, turn left	When you see a red arrow, stop	When you see a yellow arrow, prepare to stop	When you see a yellow arrow, complete your left turn	When you see a flashing yellow arrow, turn left if there is a safe gap in traffic (pedestrians and vehicles)
Middle-Aged Participants							
No Delay							
Control Card	0%	0%	0%	0%	67%	7%	100%
Enhanced Card	0%	0%	7%	0%	46%	7%	100%
One Week Delay							
Control Card	0%	0%	0%	0%	57%	29%	79%
Enhanced Card	0%	11%	0%	0%	89%	10%	78%
Older Participants							
No Delay							

Table 32, continued

Control Card	0%	7%	0%	0%	67%	0%	81%
Enhanced Card	0%	0%	0%	0%	67%	0%	93%
One Week Delay							
Control Card	0%	14%	0%	0%	64%	0%	93%
Enhanced Card	0%	7%	0%	0%	67%	7%	93%

Regarding the perceived appearance of the RRFB device, participants who saw the enhanced rather than control card were more likely to recall that the device included the representation of a pedestrian, $OR = 0.54$, $p = 0.014$.

Table 33. Responses from participants when asked to recall the appearance of the RRFB device.

Condition		Rectangular	Yellow/ Amber	Lights	Cross walk Sign	Arrows	Stop	Flashing	Pedestrian
Middle-Aged Participants									
	No Delay								
	Control Card	55%	25%	56%	17%	0%	0%	50%	9%
	Enhanced Card	67%	43%	57%	29%	0%	14%	60%	43%
	One Week Delay								
	Control Card	46%	17%	64%	33%	0%	8%	50%	18%
	Enhanced Card	78%	33%	70%	60%	10%	0%	78%	56%
Older Participants									
	No Delay								
	Control Card	40%	38%	31%	19%	6%	0%	40%	12%
	Enhanced Card	80%	36%	31%	43%	21%	7%	33%	33%

Table 33, continued

	One Week Delay								
	Control Card	15%	0%	75%	42%	0%	8%	62%	36%
	Enhanced Card	50%	50%	33%	40%	13%	0%	54%	36%

Regarding the perceived purpose of the RRFB device, middle-aged participants who saw the enhanced rather than control card were more likely to mention that one of the purposes of the RRFB device is to increase safety, but the opposite was true for older participants, *OR* = 1.59, *p* = 0.033. Additionally, participants who saw the enhanced rather than control card were more likely to mention that one of the purposes of the RRFB device is to warn the driver about possible pedestrians, *OR* = 0.59, *p* =0.025.

Table 34. Responses from participants when asked to recall the purpose of the RRFB device

	Condition		Safety	Warning/alert
Middle-Aged Participants				
	No Delay			
		Control Card	17%	67%
		Enhanced Card	53%	80%
	One Week Delay			
		Control Card	31%	62%
		Enhanced Card	30%	90%
Older Participants				
	No Delay			
		Control Card	73%	36%
		Enhanced Card	53%	60%
	One Week Delay			
		Control Card	69%	62%
		Enhanced Card	43%	79%

Regarding the correct response to take when encountering the RRFB device, participants in the no delay rather than the one-week delay condition were more likely to mention that one of the actions drivers should take when they see an RRFB is to be ready to stop, $\chi^2 = 8.16$, $p = 0.004$.

Table 35. Things mentioned by participants when asked what do when they see an RRFB device.

Condition	Incorrect Information	No Passing	When you see an RRFB, be alert	When you see an RRFB, be ready to stop	When the light is flashing, stop	When there are pedestrians present in the crosswalk, stop	When the crosswalk is completely clear, go!
Middle-Aged Participants							
No Delay							
Control Card	0%	17%	42%	17%	42%	33%	17%
Enhanced Card	0%	0%	62%	33%	64%	36%	33%
One Week Delay							
Control Card	0%	23%	23%	31%	55%	25%	33%
Enhanced Card	10%	0%	30%	56%	33%	30%	20%
Older Participants							
No Delay							
Control Card	12%	0%	33%	13%	53%	15%	31%
Enhanced Card	0%	0%	47%	36%	40%	47%	33%

Table 35, continued

	One Week Delay							
		Control Card	0%	8%	23%	46%	50%	8%	38%
		Enhanced Card	0%	0%	7%	33%	57%	31%	33%

Experimental Task Data

Speed and Accuracy by Delay Period and Tip Card Condition

Tables A38 and A39 display participants' response accuracies for the FYA and RRFB cards. There was no effect of age in any of the accuracy analyses; therefore, we collapsed across this variable. For both cards, the time between when participants first saw the tip card and when they completed the task as well as the card they saw had no effect on their response accuracies (all $p > 0.165$). The same was true when the analysis was restricted to FYA trials (for the FYA device) and flashing trials (for the RRFB device) and calculated separately for comprehension and speed emphasis blocks (all $p > 0.062$). Accuracy averaged about 77% for the FYA tip cards and 88% for the RRFB tip cards.

Table 36 and Figure 19 display the results that include an analysis indicating age group as a significant factor. Older participants were a quarter of a second slower at responding in the RRFB condition than middle-aged participants, $t(106) = 3.62$, $p < .001$. Moreover, when the RRFB analysis was restricted to flashing trials, older participants responded 0.23 seconds slower than middle-aged participants for the speed emphasis block, $t(106) = 3.77$, $p < .001$). For the comprehension block, older participants responded 0.72 seconds slower than middle-aged participants when there was no delay between tip card viewing and testing $t(55) = 2.55$, $p = .014$, but there was no significant difference when the delay was one week (difference = 0.11 with middle-aged participants being slower), $t(55) = 0.44$, $p = .662$, interaction: $F(1, 106) = 5.35$, $p = .022$. There were no other effects of age.

Table 36. Speed in responding by age group and trial type for the RRFB card (measured in seconds).

Condition		*M*	*SD*	*Mdn*	*IQR*	*N*
All Trials						
	Middle-Aged	1.60	0.34	1.60	0.44	56
	Older	1.84	0.42	1.77	0.53	58
Flashing Trials Only						
	Middle-Aged	1.49	0.30	1.51	0.28	56
	Older	1.72	0.37	1.63	0.47	58

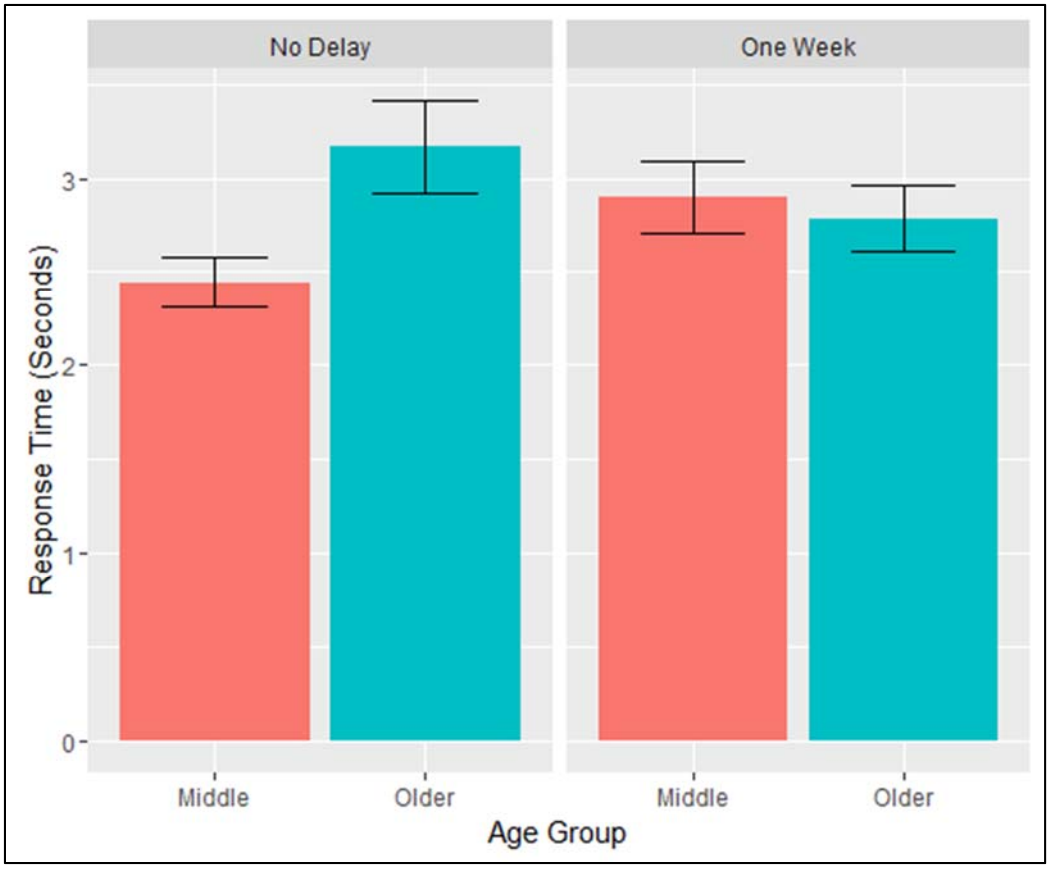

Figure 19. Speed in responding on the flashing trials by age group and delay for the RRFB card (measured in seconds). Error bars represent +/- 1 standard error of the mean.

Table A40 and A41 display participants' response speeds for the FYA and RRFB cards. For both cards, the time between when participants first saw the card and when they completed the task as well as the card they saw had no impact on their response speeds (all $p > .116$). The same was again true when the analysis was restricted to FYA and flashing trials and calculated separately for comprehension and speed emphasis blocks (all $p > .117$).

Speed and Accuracy by Previous Tip Card Experience

Tables A42 and A43 display participants' response accuracies in responding to both devices. For both speed and accuracy, age group had no effect. For both devices, previous experience with a tip card (either control or enhanced) had no effect on response accuracy in the task (all $p > 0.518$).

Table A44, A45, and A46 display participants' response speeds to both devices. As with response accuracy, response speed in the task was also not impacted by previous experience with a tip card (all $p > 0.203$)

We performed an exploratory analysis for the type of stimulus presented, photo or Sketchup stimuli. Table A47 shows speed and accuracy as a function of stimulus presentation format for the flashing trials. The two presentation formats did not differ significantly for response speed, $t(286) = 1.57$, $p = .0118$, but did for accuracy: Participants tended to be 3% more accurate on photo trials than Sketchup trials, $t(286) = 3.55$, $p < 0.001$.

Conclusions

We did not find consistent significant advantages for the enhanced cards compared to the control cards when it came to memorability measures testing knowledge of their content using multiple choice questions (Tables A25 and A26) or with open-ended responses. Nor did we find any advantages for speed and accuracy of performance when drivers were asked to respond to representative roadway scenes with a rapid judgment of whether to stop, go, or yield (Tables A38 – A46) Surprisingly, there was little forgetting of the information even after a one-week interval occurred between reading the tip cards and responding to road scenes (Tables A46 and A47). Nor were there differences in rated usability of the control versus enhanced cards nor in attitudes toward carrying out the behaviors taught by the cards (Tables A27 and A28). However, greater self-efficacy to take the actions recommended by the RRFB tip card was reported by participants who viewed the enhanced card as compared to those who viewed the control card (Tables A34 and A35). Greater self-efficacy beliefs can be associated with greater duration of effort, resilience, or perseverance in the face of unexpected challenges or during stressful situations (Bandura, 1997; Pajares, 2002; Schwarzer, 2001). Therefore, the potential for the enhanced version of the tip cards to increase drivers' self-efficacy to take recommended actions should be considered in future studies and card designs.

One age effect was seen showing faster responding by middle-aged drivers compared to older ones when tested immediately following tip card reading (Figure 19), but even

that age effect was no longer evident after a one-week delay.

One noteworthy finding is that photos of actual scenes compared to Sketchup versions promoted slightly, but significantly better accuracy on the part of drivers in the testing of their memory using roadway scenes (though not the speed of their decision: Table A47). This finding suggests that tip card information is encoded into memory in a way that more closely matches the format that is actually encountered on the road, given that photos are closer to real world scenes than Sketchup pictures. It may be that photos used in tip cards (both control and enhanced versions) are important for conveying information about actions to carry out. However, this advantage for photos was true for all age groups.

Specific Recommendations Based on Study Findings

Future tip cards should consider using realistic depiction of traffic control device scenarios, possibly photos of the scenes or situations being discussed rather than sketches of the scenes to promote better memory of the information, according to the findings related to participants' rapid decisions when presented with representative road scenes.

Although exposure to enhanced tip cards was associated with few benefits as compared to exposure to standard ones for the RRFB and FYA signals, the enhanced versions should still be preferred based on their reading time advantage found in Study 2a.

Chapter 5: Task 2c: Simulator Study Evaluation of Tip Cards

Introduction

In our prior study (Task 2b), we tested tip cards for their comprehension and memorability using a combination of both survey and computer-based experiments. We presented different tip cards (or no tip card) either to participants immediately before testing or one week prior. The cards explained the flashing yellow arrow (FYA) and rectangular rapid flashing beacon (RRFB). Using a computer-based task in which participants viewed both real-world and computer-generated images featuring the FYA or RRFB, we measured their reaction time to and accuracy for these signals. Participants received either a control tip card or a revised, "enhanced" tip card for either signal type, and were asked to respond to the signals under a variety of conditions. The enhanced tip cards conformed to human factors guidelines that we synthesized from our literature review. We also tested a control condition of not showing any tip card. We found little forgetting of the information presented by tip cards even after a one-week interval occurred between reading the tip cards and responding to road scenes, but did find that participants who viewed the enhanced tip cards reported greater self-efficacy to take the actions recommended by the cards than those who viewed the standard card. One noteworthy finding is that photos of actual scenes compared to simulated 3-D environment versions created in Google Sketchup, a 3-D modeling program, promoted better accuracy on the part of drivers in the testing of their memory using roadway scenes (though not the speed of their decision), which suggests that tip card information is better encoded into memory when the information is presented in a way that more closely matches the format that is actually encountered on the road.

In the currently reported study, we exposed drivers to 2 of 4 tip cards developed during the previous studies, then they experienced a driving-simulator scenario in which they had the opportunity to use the information to which they were exposed on the tip cards. Drivers were exposed to either the No-Turn-On-Red tip card or the flashing yellow arrow tip card, plus an irrelevant filler card (either the Roundabout or rectangular rapid flashing beacon card) to provide additional memory load. Following a short practice task, drivers encountered intersections with the FYA signal and a right turn with and without a No Turn On Red sign. They encountered intersections with and without oncoming traffic. We measured wait time before executing a turn (left for FYA, right for permissible right-turn-on-red) as well as recorded any risky turns (inter-vehicle distance) when there were

opposing vehicles present. Immediately following the simulator scenario, we evaluated their response to the tip cards via a questionnaire.

Method

This task presented tip cards -- based on the Human Factors guidelines established in Task 1 -- related to the flashing yellow arrow (FYA), the Rectangular Rapid Flashing beacon (RRFB), Turning Right on Red, and Roundabout to participants (i.e., middle-aged [50-64 years old] and older adults [65+]).

Participants

A total of 101 participants (40 middle-aged, 50 to 64 years, M = 60.02, SD = 3.54; 61 older adults (65 and above years) M = 71.68, SD = 6.06) were recruited from the Tallahassee, FL area.

All were licensed drivers. None of the participants in our final dataset had participated in previous studies in our laboratory involving the flashing yellow arrow (FYA), Task 2a, Task 2b, where there was exposure to the control and enhanced tip cards in an earlier form.

The final dataset included 62 participants (middle-aged adults: N = 30, M = 59.86, SD = 3.53; older adults: N = 32, M = 70.53, SD = 5.69). Participants were not included in analyses for any of the following reasons (number of participants that met criteria listed in parentheses): (1) simulator sickness (N=30); (2) participants opting out of the experiment before its completion (N=6); (3) terminating the driving scenario by making a wrong-turn (N=5); (4) software crash (N=1); and (5) experimenter error (N=1).

Table 37. Total exclusions by age group for Task 2c.

Reason Excluded	Middle-Aged (50-64)	Older Adults (65+)
Simulator sickness	9	21
Opting out of study after consent	0	6
Wrong-turn terminated scenario	0	5
Software crash	0	1
Experimenter error	1	0

Materials

Tip Cards

Participants were exposed to two tip cards, one that was relevant (FYA or Turning Right on Red) to the driving simulator scenario, and one that was irrelevant (RRFB or Roundabout), designed based on the Human Factors guidelines established in Task 1 for this project. Tip cards to which participants were exposed can be seen in Figures 20 through 23 below.

Figure 20. Tip card for the flashing yellow arrow (FYA) enhanced based on the guidelines established in Task 1 and the results of Task 2a/2b

Figure 21. Tip card for the rectangular rapid flashing beacon (RRFB) enhanced based on the guidelines established in Task 1 and the results of Task 2a/2b.

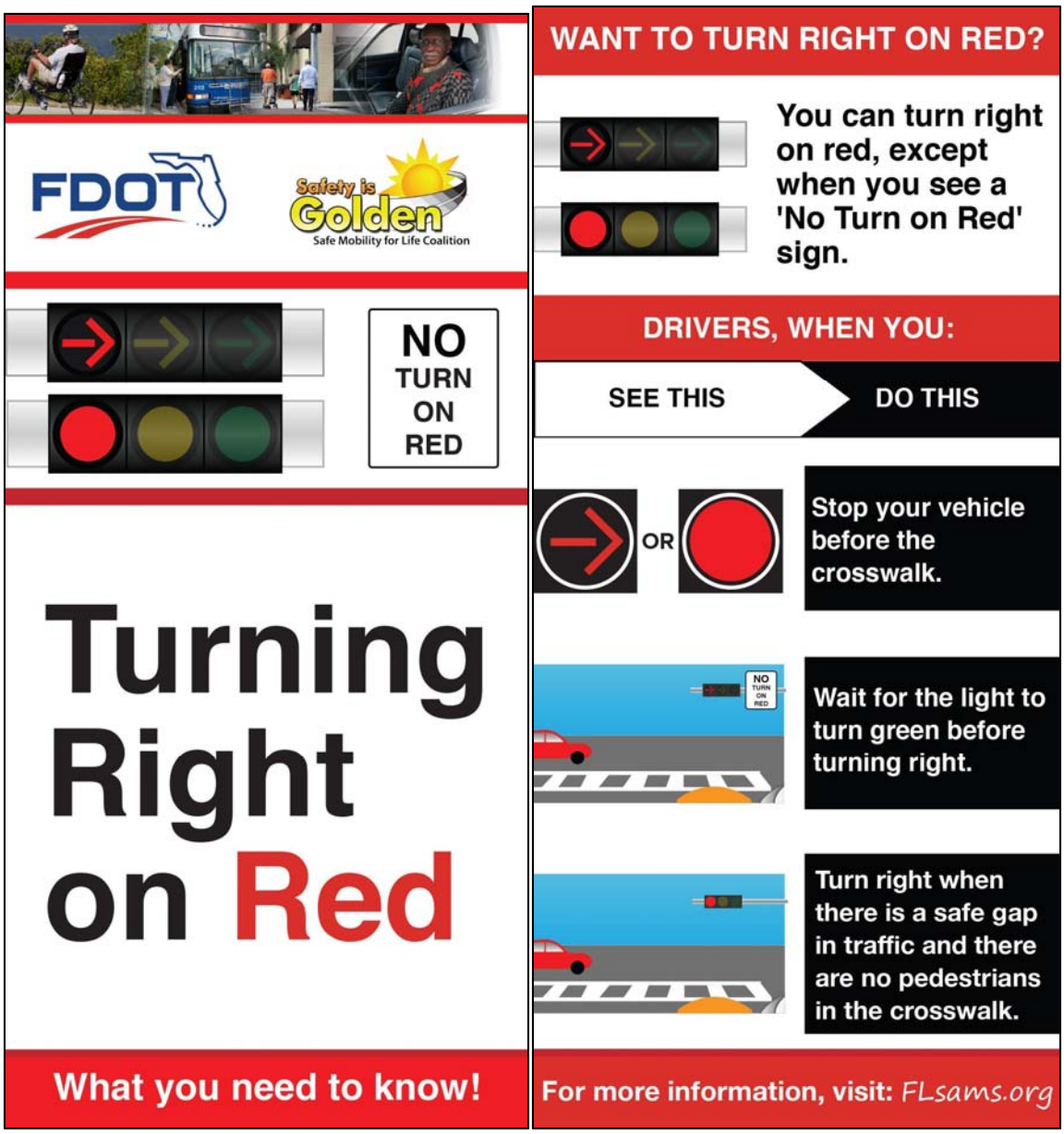

Figure 22. Tip card for Turning Right on Red created based on the guidelines established in Task 1.

Figure 23. Tip card for "How to Safely Navigate a Roundabout" created based on the guidelines established in Task 1.

Qualtrics Survey

Immediately after exposure to the simulator task, using the Qualtrics survey platform, we collected additional information from participants, such as, evaluations and perceptions of the traffic control device for the tip card they viewed, participants' personality and demographics, as well as other measures, not captured in the main experimental task, across a total of three blocks:

During the first survey block, participants completed questions related to either the flashing yellow arrow (FYA) or Turning Right on Red, depending on which set of tip cards they viewed.

During the second survey block, participants completed questions about basic demographics (i.e., gender, date of birth, vision) and answered questions relating to driving behavior (i.e., driver's license status, frequency and length of driving in an average week). This block included the Ten Item Personality Inventory (TIPI – Gosling et al., 2003).

The final block consisted of the Simulator Sickness Questionnaire (SSQ), in which participants rated any symptoms (e.g., nausea, eye strain, sweating) of simulator sickness they may have experienced on a 4-point scale from None to Severe. This included free-response questions related to the last time they experienced motion sickness or if they had eaten prior to the experiment.

Practice Driving Simulator Task

In order to acclimate participants to the controls (i.e., gas, brake, steering) in the driving simulator, all participants completed a short practice task. During this practice drive, participants were asked to follow the GPS audio instructions provided, initially driving straight for one mile. If participants were unable to hear the audio instructions, the experimenter would increase the volume until the instructions were audible. After maintaining position in the left lane for the entirety of the drive (coming to a stop at a red light along the way -- in order to acclimate participants to the vestibular responses of stopping in the simulator), the practice task terminated after participants completed a right turn (in order to acclimate participants to the feeling of turning in the simulator).

Experimental Driving Simulator Task

For the experimental simulator task, participants were initially prompted via GPS instructions to continue driving straight for 1.5 miles. Approximately 1500 feet prior to the first target intersection, GPS instructions prompted participants to turn left at an intersection with a flashing yellow arrow (FYA). At this first target intersection, an oncoming vehicle was triggered to approach the participant in the opposing travel lane, driving at 50 mph, leaving little room to turn in front of the oncoming vehicle. Although a speed of 50 mph is not typical for signalized intersections, the speed of this oncoming vehicle was intentionally matched to that of our previous simulator experiment where we investigated the FYA signal (Boot, Charness, Mitchum, Landbeck, & Stothart, 2014) in order to make comparisons between the two studies for tip card effectiveness. If participants were aware of the regulations related to the FYA, the correct decision in this situation would be to wait for the oncoming vehicle to cross, then turn left as soon as a safe gap in traffic appeared. In our scenario, a safe gap was immediately available once the triggered car cleared the intersection.

Figure 24. First flashing yellow arrow (FYA) intersection.

After making this left turn, approximately 1500 feet before the next target intersection GPS instructions prompted participants to turn right at an intersection with a dedicated right-turn lane, with a red arrow, and an oncoming vehicle, travelling perpendicular to the participant at 50 mph -- to be consistent with the other intersection that had an oncoming vehicle.

Figure 25. First turning right on red intersection.

Similar to the first target intersection, the correct behavior in this situation was to wait for the oncoming vehicle to pass, then turn right because no traffic was present after this vehicle. The rightmost signal at the intersection was programmed to turn to a green arrow after 20 seconds from when the participant reached a virtual trigger placed in the scenario before the stop bar. Once participants completed the right turn, approximately 1500 feet before the next target intersection, GPS audio instructions, prompted participants to turn left, at another FYA intersection (no oncoming vehicle). Since no oncoming vehicle was present at this intersection, wait times to turn are expected to be shorter than the first FYA intersection.

Figure 26. Second flashing yellow arrow (FYA) intersection and expanded view of the signal mast.

Again, approximately 1500 feet before the final target intersection (intersection with a dedicated-right turn lane**)**, participants were prompted via GPS instructions to complete a right-turn. A “No Turn on Red” sign was present at this intersection, so the appropriate response was to come to a complete stop, and wait for the red arrow to turn green.

Figure 27. Second turning right on red intersection and expanded view of the signal mast.

Similar to the first Right on Red intersection, 20 seconds after reaching a virtual trigger placed before the stop bar, the red arrow was triggered to turn to a green arrow. The correct response at this intersection is to wait for that signal before initiating the right turn. Once participants completed that right turn, a GPS instruction prompted them to park on the right, at which point the scenario terminated.

Procedure

Upon entering the laboratory, participants provided informed consent, then were randomly assigned to one of 8 experimental conditions as shown in the table below. Participants in each condition received one tip card related to a traffic control device to be encountered during the simulator task (i.e. FYA or Right on Red), and one tip card unrelated to the traffic control devices to be encountered in the simulator (i.e .RRFB or Roundabout), with the intention of increasing information load before driving in the simulator.

Table 38. Tip card type and order of presentation by condition

Condition	1st Tip Card Viewed	2nd Tip Card Viewed
A	FYA	RRFB
B	RRFB	FYA
C	FYA	Roundabout
D	Roundabout	FYA
E	Right on Red	RRFB
F	RRFB	Right on Red
G	Right on Red	Roundabout
H	Roundabout	Right on Red

Participants were exposed to each tip card for two minutes. During this time, in order to get a measure of total reading time, experimenters observed the participants' behavior, stopping the timer whenever a participant did something other than read the tip card, restarting it when and if they looked at the tip card again. All timings were collected in Psychopy, "an open-source application allowing you run a wide range of neuroscience, psychology and psychophysics experiments" (Peirce, 2007).

Once participants were exposed to the two tip cards in their randomly assigned condition, they began the practice simulator task to get acquainted with the controls of the simulator and resulting vestibular sensations associated with accelerating, braking, and moving the steering wheel.

After completing the short practice scenario, participants completed the experimental simulator task, with the four target intersections (two FYA intersections; two Right on Red intersections).

Whether or not participants completed both driving simulator tasks, they were asked to complete the Qualtrics survey, in order to capture information related to their perceptions of/attitudes toward the tip cards, as well as assessing the level of simulator sickness they may have experienced.

After completing the Qualtrics Survey, the experiment was complete, and participants were given their payment and were debriefed about the nature of this study.

Results

R (Version 3.1) was used to conduct the analyses.

Tip Card Reading Times

The amount of time participants spent reading a card did not depend on the type of card they read, $F(3, 51) = 0.044$, $p = .988$ (see Table A48). Additionally, the reading times for the filler cards (RRFB and RA) did not significantly differ from the reading times for the critical cards (FYA and ROR), $F(1, 53) = 0.011$, $p = .917$. There was no effect of age group, $F(1, 52) = 1.735$, $p = .194$, and age did not interact with either card, $F(3, 48) = 1.184$, $p = .326$, or card condition (control vs. critical), $F(1, 52) = 2.745$, $p = .104$, in predicting reading time (thus any potential age differences in performance cannot be attributed to age differences in reading times.)

Qualtrics Survey Data

Evaluation of the Traffic Device Described

Participants' evaluations of how effectively the FYA device allowed them to navigate a left-hand turn as compared to a standard left-turn arrow are shown in Table A49. There was no effect of age group on these evaluations, $t(28) = 0.687$, $p = .498$. (An error in our survey prevented us from analyzing similar evaluations for the No Turn on Red sign.)

Table A50 shows participants' evaluations of how effectively the FYA device and No

Turn on Red sign let them know when to turn. Age group did not predict these evaluations for either the FYA device, $t(28) = 0.393$, $p = .697$, or No Turn on Red sign, $t(27) = 1.547$, $p = .134$.

Open Response Data

In the survey, we also asked participants to tell us 1) what they know about the device they saw, 2) if it could help them navigate an intersection more safely, and 3) its pros and cons. Two research assistants coded these responses, and the results of this coding are shown in Tables A51 and A52. Only participant responses that had 100% agreement between coders were included in the tables and analyses. For both devices and all questions, the age group of the participant did not impact how participants responded.

Driving Simulator Data

Intersection Wait Times

Consistent with our previous tip card study, intersection wait times were calculated as the time between when a participant reached their minimum speed prior to the stopbar, and when their acceleration crossed a threshold value (Boot et al., 2014).

For the FYA intersections, the log-transformed amount of time participants waited at the intersections depended neither on the presence of an oncoming vehicle, $F(1, 59) = 0.904$, $p = .346$, nor the tip card participants read (see Table A56 and Figure A1), $F(1, 59) = 1.159$, $p = .286$. These variables also did not interact to predict wait time, $F(1, 59) = 2.686$, $p = .107$. Furthermore, the wait times did not significantly differ between middle and older participants (see Table A57 and Figure 29), $F(1, 59) = 1.810$, $p = .184$, and age group did not moderate the relationship between vehicle presence and response time, $F(1, 59) = 0.475$, $p = .494$.

For the ROR intersections, log-transformed wait time did not depend on no-turn-on-red sign presence, $F(1, 56) = 0.210$, $p = .648$, or the tip card participants read (see Table A60), $F(1, 59) = 0.248$, $p = .620$. These variables, however, did interact to predict wait time, $F(1, 56) = 5.666$, $p = .021$, such that participants who saw the ROR tip card waited at ROR intersections for a shorter period of time, compared to those who saw the FYA tip card when the intersection did not have a no-turn-on-red sign (permissible turn), $t(56) = 2.844$, $p = .006$, whereas there was little difference in waiting time for impermissible right turns, $t(59) = 0.481$, $p = .632$. The wait times did not depend on age group, $F(1,$

59) = 3.584, p =.063, but they did depend on the interaction between age group and no-turn-on-red sign presence, $F(1, 56) = 5.531$, p = .022, such that older participants waited at ROR intersections longer when the no-turn-on-red sign was present than when it was not, $t(27) = 2.559$, p = .016, but the same was not true for middle-aged participants (see Figure 30), $t(29) = 0.502$, p = .620. None of the other higher order interactions between vehicle presence, tip card, intersection device, and age group were significant.

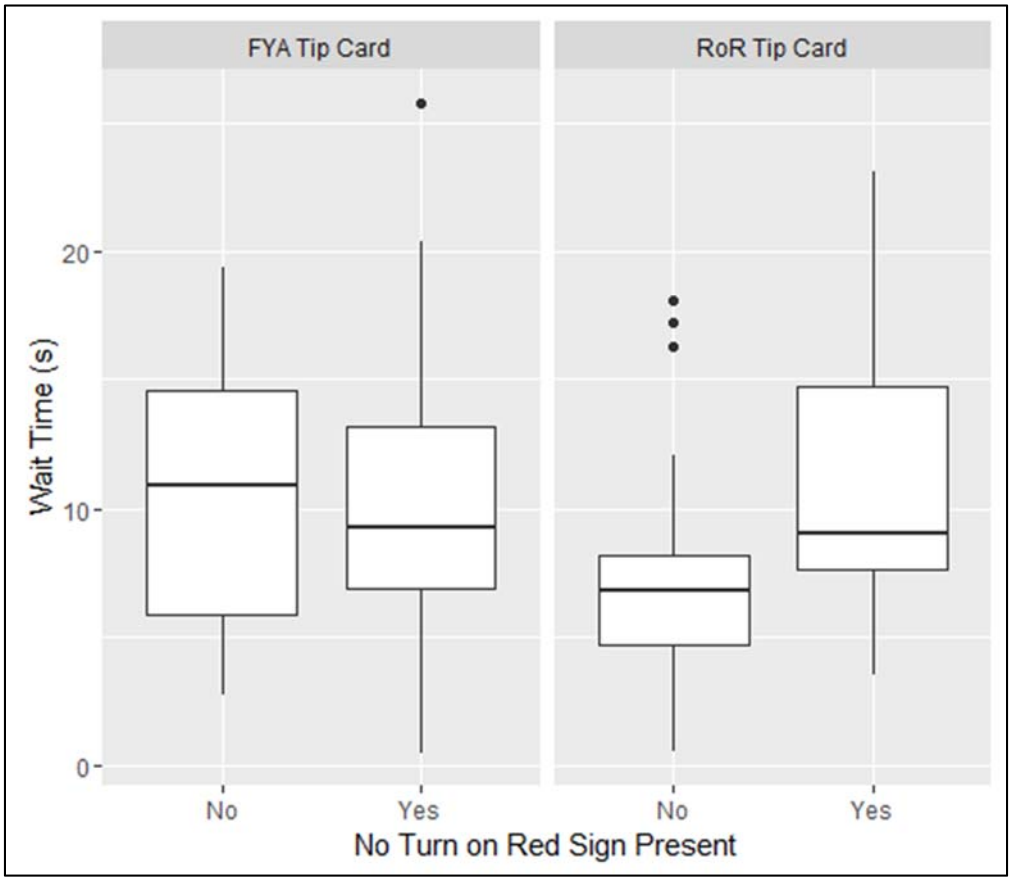

Figure 28. Box plot showing wait time as a function of tip card and no-turn-on-red-sign presence

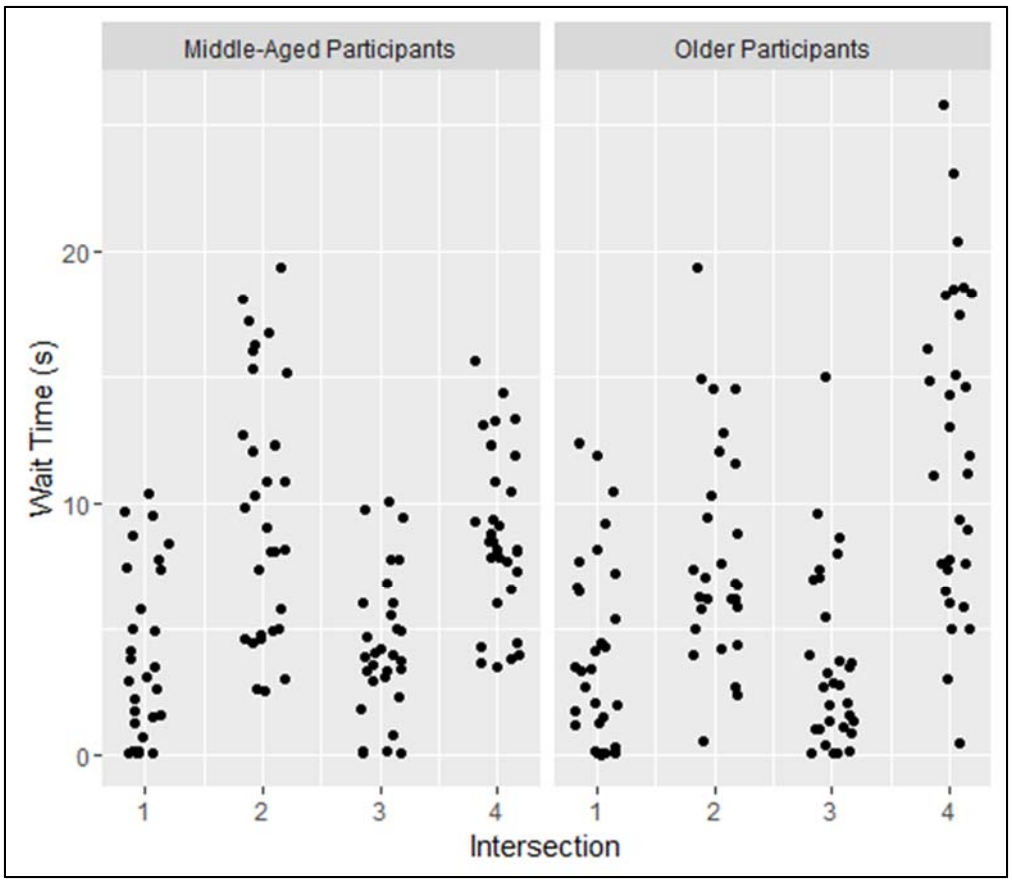

Figure 29. Dot plot of wait time by intersection and age group. Each point represents a single participant's wait time.

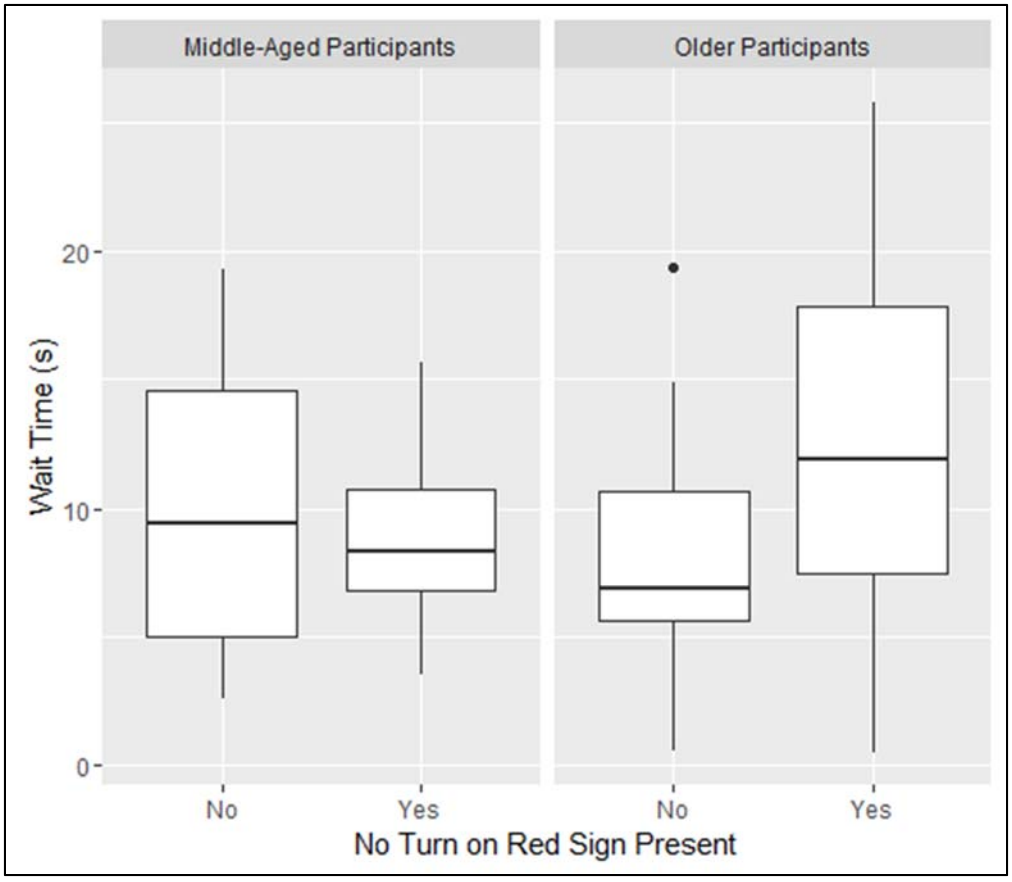

Figure 30. Box plot showing wait time as a function of age group and no-turn-on-red sign presence.

Distance to the Oncoming Vehicle

There were only 3 occasions in which participants turned in front of the opposing vehicle (see Tables A58 and A59). Because of this small sample, we were not able to conduct any statistical analyses on oncoming vehicle distance. Drivers were very conservative at intersections.

Timing of Right-Hand Turns

Ninety-eight percent of participants waited for the signal to turn green before making a right hand turn when the no-turn-on-red sign was present, and 40% waited for the signal to turn green when the sign was not present, $z = 4.326$, $p < .001$. Neither tip card, $z < .001$, $p = .999$ nor age group, $z = 0.046$, $p = .963$, moderated this effect (see Tables A60 and A61).

FYA intersections always had a flashing yellow arrow correctly triggered and everyone made a left turn during the FYA phase.

Discussion

We experienced higher than expected attrition with our sample, primarily because of simulator sickness, likely due to the number of turns (4) required with our scenarios. So we were somewhat below expected power to detect small effects. In general, we did not observe consistent direct benefits for the enhanced tip cards for driver actions such as for wait times or turn completions at intersections with the flashing yellow arrow, or in percent turns made when permissible with right-on-red tip cards. We did see a significant benefit for right turns at right-turn-on-red-permissible intersections; drivers who read the ROR tip card waited less time, about 3 s, before turning right compared to those who saw the FYA tip card. Further if you restrict analysis to the case of permissible right-on-red turn opportunities only, a chi-square indicates that those who read the ROR tip card made more turns than those who read the FYA tip card, X^2 (1) = 5.84, $p < .02$, two-tailed. However, this can only be considered a trend when taking into account the initial omnibus z-test shown above.

Older adults (and middle-aged ones) tend to be conservative in their decisions to traverse intersections when permissible under the right turn on red traffic control device. As noted above, there were only 3 instances of drivers risking a turn in front of opposing traffic.

As was the case in our prior studies, drivers rated the tip cards as being very helpful in informing them about traffic control device functioning, with scores of 6 or higher on a 0-10-point scale where 0 represented not effective and 10 meant most effective. We can conclude that the design for the tip cards was successful in this respect, though

providing a relevant tip card did not generally result in effects such as consistently shorter wait times before executing permissible left and right turns at intersections during the simulator drive. However, having read either an FYA or ROR tip card, all drivers executed left turns during the FYA signal phase (though few in front of an opposing vehicle).

Specific Recommendations Based on Study Findings

Similar to the case for study 2b, we judge the newly designed tip cards as effective in terms of driver ratings for the effectiveness of the information being conveyed about traffic control devices. Here the drivers completed their ratings after experiencing the FYA and ROR traffic control devices in a simulated drive so made their judgments following actual experience with the target traffic control devices. However, unlike the case for a prior investigation of the FYA traffic control device using the same simulator, the knowledge derived from reading the FYA tip card did not result in significantly shorter wait times at the intersection for the FYA sign when it was safe to turn left. However, all of the drivers turned left during the flashing yellow arrow, indicating that both tip cards and/or prior knowledge led to correct actions. Exposure to the ROR tip card did significantly benefit drivers for permissible ROR cases, in which they traversed the intersection with a shorter wait time and showed a trend to traversing it more often during the red light phase, likely because they recognized they could make a right on red whereas those who viewed the FYA card did not as quickly understand that they could make the turn.

There were differences between the earlier FYA study (Boot et al., 2014) and this one, particularly the use here of multiple tip cards, with a filler card provided to increase memory load for the driver simulating the case of being given and then reading multiple tip cards at once. Additionally, the prior study had a no-tip-card condition. Middle-aged and older drivers drove conservatively in the simulator, with many drivers failing to avail themselves of turns for permissible right on red situations. Conservative driving was observed in our prior studies and in those of other investigators.

Thus, our recommendation is to continue using the enhanced tip cards designed for the study, based primarily on good ratings in this and prior studies, the interaction observed for no right-turn-on-red sign situations, making safe left turns for FYA phases, and with the finding in a prior study that the enhanced tip cards were read more quickly than the standard cards.

We tentatively recommend that when presenting multiple tip cards to middle aged and older drivers it may be beneficial to recommend that they read and then later review them to help promote better memory for the information across the cards. Reading multiple tip cards at once may result in less effective memory for information about all traffic control devices compared to reading a single relevant card and then encountering that new traffic control device or reading multiple cards multiple times.

Specific Recommendations

We first conducted an extensive literature review to identify data and theories about designing public service transportation materials. That review culminated in recommendations for design in the form of a human factors checklist. Next we attempted to validate those recommendations by providing redesigns of existing tip cards educating users about the FYA, RRFB, and ROR traffic control devices. The enhanced tip cards were compared to the standard ones for usability, first in a study of learnability, efficiency, and user satisfaction. Study 2a used large samples of younger, middle-aged, and older adults and found the main advantage for enhanced tip cards in card reading time (efficiency in encoding the information).

Recommendation 1: Based on our detailed review of theories and data about the design of information materials for aging road users and our usability testing, we recommend FDOT's using the human factors checklist shown in Table 39 to guide design of future tip cards and to modify current tip card designs for redistribution.

Table 39. Checklist for design of tip cards and educational materials

Checklist for Design of Tip Cards and Brochures for Aging Road Users		
Factor	**Advice**	**Check**
Legibility		
	Font size minimum of 12-14 point x-height	
	Serif font if large, otherwise sans-serif	
	Prefer bolded text, particularly for headers	
	Avoid decorative font	
	Mixed case for body text except where emphasis is needed then uppercase	
	High enough contrast that can be read at <40 cd/m^2	
	Prefer black on white or white on black text	
	Consider colored text or backgrounds for emphasis but avoid blue/violet	
	Left-justify text for passages	
	Double-space text when possible	
	Limit line lengths to 50-65 characters for brochures	
	Avoid wrapping text around pictures and illustrations	
	Avoid glossy material for cards and brochures	
Pictorial Materials		
	Add pictures to text to convey complex instructions	
	Prefer high resolution photos to convey real-life events	
	Prefer high quality illustrations when conveying detailed information	
	Caption pictorial materials that are not easy to interpret	
	Try to use culturally relevant illustrations	
Layout		
	Provide key information first (top)	
	Use bulleted lists to break up paragraphs of text	
	Use color to make the material attractive and engaging	
	Use headings and subheadings to create visible sections	
	Try to keep 10-35% of the page as white space to reduce clutter	
Comprehension & Memory		
	Try to cover only one general topic per card	
	Chunk information and use short sentences	
	Present 6 or fewer chunks of information in a section	

Table 39, continued

	Use active voice and avoid passive and negative phrases	
	Avoid jargon by using everyday language	
	Aim for a Flesch-Kincaid score of grade 8 or lower	
	Visuals should support imagining the actual road environment, preferably using photo depictions of roadway environments	
	Keep alternating phase representations close together to support integration	
	Focus on actions for road users to take	
	Encourage simulation of the target behaviors	
	Encourage self-testing of memory for the target behaviors	
	Encourage self-reference by using terms such as I rather than driver	
Attitudes		
	Consider an emotional appeal to facilitate attention, memory, and positive attitudes toward the behavior	
	Try to enhance self-efficacy of the road user by using positive appeals	
	Remind road users in a non-threatening way about regulations	
	Consider generating alternate forms of the material to maintain attention	
	Create an electronic version for distribution through social media	
	Consider reinforcing information with road signs, ads, press releases	
Motivation		
	Try to specify implementation intentions rather than goal intentions by suggesting concrete steps to adhere to the regulation	
	Use consistent layout and logos to brand materials to enhance credibility	

Recommendation 2. We also recommend the use of the templates for designing effective tip cards shown in this report. They are available to download in the following formats (Illustrator, Publisher, InDesign, PDF, Powerpoint) at http://www.flsams.org/Roadway.htm#Research

Recommendation 3. Based on findings that accuracy of responses in a rapid decision task in task 2b was slightly but significantly better with photos than 3-D Sketchup images, we recommend further study of the relative effectiveness of photos versus 3-D images in educational materials distributed to aging road users. Experimental studies and focus groups may be effective approaches. In-vehicle studies, though not simulator studies (that use only 3-D graphics), should also be considered.

Recommendation 4. Asking participants to recall the actions to take for traffic control devices occasionally, though rarely, showed that aging road users misinterpreted the information in ways that could compromise safety. Faulty recall could be due to a number of sources including misreading the tip card, mistyping the open-ended response, and actual failures in memory following correct encoding of information initially (memory decay). We recommend further research into this issue, even though very few safety-compromising errors were committed on experimental or simulator tasks. Focus group and experimental studies of changes in wording for FYA and RRFB tip cards could be conducted to try to isolate the source of confusion.

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Appendices

Appendix A – Additional Data

Task 1

Table A 1. Pilot Testing Reading Times (read aloud)

	Pilot Reading Times (in seconds)					
	Original		Positive		Negative	
	Front	Back	Front	Back	Front	Back
FYA	8	87	8	25	7	25
RRFB	6	84	8	23	7	23

Table A 2. Tip card reading times (seconds) by card.

Card	***M***	***SD***	***Mdn***	***IQR***	***N***
FYA	89.93	29.53	94	52.24	28
RA	88.08	28.14	90	50.45	24
RoR	84.19	32.18	85	61.27	26
RRFB	85.64	29.98	95	53.20	30

Table A 3. Participants' evaluations of how effectively the device let them know when to turn (possible values: 0 [not effective at all] through 10 [most effective]).

Device	***M***	***SD***	***Mdn***	***IQR***	***N***
FYA	7.07	2.69	8	3.25	30
RoR	7.69	3.29	10	4.00	29

Table A 4. Wait time (s) by intersection.

Int. #	**Turn Type**	**No Turn on Red Sign**	***M***	***SD***	***Mdn***	***IQR***	***N***
FYA	1	N/A	4.01	3.53	3.37	6.08	61
ROR	2	No	8.97	4.82	7.84	7.24	58
FYA	3	N/A	3.88	3.18	3.40	4.22	61
ROR	4	Yes	10.60	5.47	9.13	7.05	61

Table A 5. Wait time (s) by age group, tip card type, and intersection category (turn type, presence of a no-turn-on-red sign, vehicle presence).

Age Group	Tip Card	Int. #	Turn Type	No Turn on Red Sign	Vehicle Presence	*M*	*SD*	*Mdn*	*IQR*	*N*
Middle	FYA	1	FYA	N/A	Yes	4.29	3.00	3.45	5.34	16
Middle	FYA	2	ROR	No	Yes	11.13	4.72	11.45	7.87	16
Middle	FYA	3	FYA	N/A	No	4.27	2.96	3.52	2.65	16
Middle	FYA	4	ROR	Yes	No	9.05	3.11	8.66	3.61	16
Middle	ROR	1	FYA	N/A	Yes	3.84	3.88	2.56	6.82	14
Middle	ROR	2	ROR	No	Yes	8.43	5.33	7.76	5.31	14
Middle	ROR	3	FYA	N/A	No	4.32	2.73	4.35	2.46	14
Middle	ROR	4	ROR	Yes	No	8.25	3.69	8.17	5.15	14
Older	FYA	1	FYA	N/A	Yes	4.66	4.32	3.48	6.92	15
Older	FYA	2	ROR	No	Yes	10.11	5.05	10.32	8.62	13
Older	FYA	3	FYA	N/A	No	2.37	2.41	2.00	2.51	15
Older	FYA	4	ROR	Yes	No	11.87	7.26	11.93	11.67	15
Older	ROR	1	FYA	N/A	Yes	3.26	3.05	2.40	3.79	16
Older	ROR	2	ROR	No	Yes	6.16	2.68	6.25	2.13	15
Older	ROR	3	FYA	N/A	No	4.53	4.10	3.52	5.76	16
Older	ROR	4	ROR	Yes	No	13.02	5.78	12.75	8.88	16

Task 2a

Memorability

Table A 6. Memorability accuracy on the multiple choice questions for the FYA tip card by age group and appeal type.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	73%	13%	80%	15%	50
Negative	75%	9%	80%	0%	52
Positive	72%	11%	80%	20%	50
Middle					
Control	72%	13%	80%	20%	50
Negative	75%	10%	80%	0%	49
Positive	75%	10%	80%	5%	44
Old					
Control	71%	15%	80%	20%	51
Negative	70%	13%	80%	20%	61
Positive	68%	11%	60%	20%	47

Table A 7. Memorability accuracy on the multiple choice questions for the RRFB tip card by age group and appeal type.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	63%	16%	60%	25%	52
Negative	62%	15%	60%	20%	49
Positive	64%	15%	60%	20%	47
Middle					
Control	63%	17%	60%	20%	46
Negative	67%	14%	60%	20%	56
Positive	65%	14%	60%	20%	50
Old					
Control	63%	13%	60%	20%	65
Negative	67%	15%	80%	20%	44
Positive	66%	12%	60%	20%	46

Table A 8. Memorability accuracy on the multiple choice questions for the RRFB tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	63%	15%	60%	20%	163
Negative	66%	15%	60%	20%	149
Positive	65%	14%	60%	20%	143
Age Group					
Young	63%	15%	60%	20%	148
Middle	65%	15%	60%	20%	152
Old	65%	14%	60%	20%	155

Usability

Perceived Usability.

Table A 9. Usability ratings for the FYA tip card by age group and appeal type.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	63.88	13.81	65.50	15.50	50
Negative	65.27	13.88	70.50	22.00	52
Positive	65.64	11.18	67.00	11.75	50
Middle					
Control	64.38	12.43	68.00	19.00	50
Negative	64.43	13.32	68.00	16.00	49
Positive	63.16	15.27	64.50	20.25	44
Old					
Control	64.88	12.21	66.00	17.50	51
Negative	62.30	12.22	63.00	16.00	61
Positive	63.09	15.38	67.00	24.50	47

Table A 10. Usability ratings for the FYA tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	64.38	12.75	66.0	17.5	151
Negative	63.90	13.09	65.5	18.0	162
Positive	64.01	13.95	67.0	20.0	141
Age Group					
Young	64.93	12.97	67.5	15.5	152
Middle	64.02	13.57	67.0	19.5	143
Old	63.36	13.19	65.0	21.0	159

Table A 11. Usability ratings for the RRFB tip card by age group and appeal type.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	64.54	11.46	67.0	12.00	52
Negative	61.04	15.89	65.0	20.00	49
Positive	66.09	10.44	69.0	13.50	47
Middle					
Control	64.26	11.72	67.0	16.00	46
Negative	67.20	11.83	69.0	11.25	56
Positive	63.56	17.19	68.5	19.50	50
Old					
Control	64.98	11.03	67.0	17.00	65
Negative	67.95	10.81	71.0	15.50	44
Positive	66.96	12.24	70.0	14.00	46

Table A 12. Usability ratings for the RRFB tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	64.64	11.30	67.0	14	163
Negative	65.40	13.32	69.0	15	149
Positive	65.48	13.67	69.0	15	143
Age Group					
Young	63.87	12.90	67.0	14	148
Middle	65.11	13.80	68.5	16	152
Old	66.41	11.34	69.0	16	155

Self-report

Guilt

Table A 13. Guilt after seeing the FYA tip card by age group and appeal type.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	4.06	2.46	3	1.00	50
Negative	5.00	3.32	3	2.25	52
Positive	4.76	3.66	3	1.00	50
Middle					
Control	3.66	2.13	3	0	50
Negative	4.06	2.12	3	1.00	49
Positive	4.16	2.84	3	0	44
Old					
Control	3.59	1.61	3	0	51
Negative	3.72	1.66	3	0	61
Positive	3.21	0.98	3	0	47

Table A 14. Guilt after seeing the FYA tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	3.77	2.09	3	0	151
Negative	4.23	2.48	3	1	162
Positive	4.06	2.81	3	0	141
Age Group					
Young	4.61	3.19	3	2	152
Middle	3.95	2.36	3	0	143
Old	3.53	1.48	3	0	159

Anger

Table A 15. Anger after seeing the RRFB tip card by age group and appeal type.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	5.27	1.91	4	2.00	52
Negative	6.61	4.19	4	4.00	49
Positive	5.98	3.11	4	2.50	47
Middle					
Control	6.00	3.67	4	3.00	46
Negative	5.61	3.45	4	1.25	56
Positive	5.14	2.76	4	0.75	50
Old					
Control	5.09	2.32	4	1.00	65
Negative	5.52	3.15	4	1.00	44
Positive	4.89	2.01	4	0	46

Table A 16. Anger after seeing the RRFB tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	5.40	2.68	4	2	163
Negative	5.91	3.64	4	2	149
Positive	5.34	2.70	4	1	143
Age Group					
Young	5.94	3.21	4	3	148
Middle	5.57	3.31	4	2	152
Old	5.15	2.50	4	1	155

Table A 17. Attitude towards the FYA tip card by age group and appeal type.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	16.34	3.67	17	5.00	50
Negative	16.12	3.93	17	4.25	52
Positive	15.36	3.93	15	4.00	50
Middle					
Control	16.76	4.43	18	6.00	50
Negative	15.61	4.69	16	7.00	49
Positive	17.00	4.43	18	8.25	44
Old					
Control	16.12	5.56	18	8.50	51
Negative	14.72	5.00	15	6.00	61
Positive	15.17	5.28	15	9.50	47

Attitude Towards Tip Card

Table A 18. Attitude towards the FYA tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	16.40	4.61	18	7	151
Negative	15.44	4.59	16	7	162
Positive	15.81	4.61	17	9	141
Age Group					
Young	15.94	3.85	16	5	152
Middle	16.44	4.53	18	8	143
Old	15.30	5.27	17	9	159

Table A 19. Attitude towards the RRFB tip card by age group and appeal type.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	17.10	3.71	18.0	6.00	52
Negative	15.31	4.48	16.0	6.00	49
Positive	16.68	3.48	18.0	4.50	47
Middle					
Control	18.02	3.09	18.5	6.00	46
Negative	15.70	5.03	17.0	5.25	56
Positive	17.70	4.12	19.0	6.00	50
Old					
Control	16.31	4.20	17.0	7.00	65
Negative	16.52	5.24	18.0	8.00	44
Positive	15.76	5.10	18.0	8.75	46

Table A 20. Attitude towards the behavior recommended by the RRFB tip card by age group and appeal type.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	18.25	2.71	18	4.00	52
Negative	17.22	3.08	17	4.00	49
Positive	18.02	3.22	19	5.00	47
Middle					
Control	18.28	3.13	19	5.00	46
Negative	18.30	3.24	19	3.25	56
Positive	18.90	2.61	20	4.00	50
Old					
Control	17.98	3.54	19	5.00	65
Negative	18.73	2.41	19	3.25	44
Positive	18.46	4.18	20	3.00	46

Table A 21. Attitude towards the behavior recommended by the RRFB tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	18.15	3.16	19.0	5	163
Negative	18.07	3.01	19.0	4	149
Positive	18.47	3.38	20.0	4	143
Age Group					
Young	17.84	3.01	18.0	5	148
Middle	18.49	3.01	19.5	4	152
Old	18.34	3.47	20.0	4	155

Table A 22. Self-Efficacy with the FYA tip card by age group and appeal type.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Young					
Control	17.18	2.56	18.0	2.75	50
Negative	17.54	2.50	17.5	3.25	52
Positive	16.88	3.04	17.0	4.00	50
Middle					
Control	16.64	2.97	17.0	4.00	50
Negative	17.61	2.46	18.0	4.00	49
Positive	17.34	4.28	18.0	4.25	44
Old					
Control	17.65	2.58	18.0	3.50	51
Negative	16.54	3.00	16.0	4.00	61
Positive	17.11	3.45	17.0	5.50	47

Self- Efficacy

Table A 23. Self-Efficacy with the FYA tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	17.16	2.72	18	4	151
Negative	17.19	2.72	18	4	162
Positive	17.10	3.58	18	5	141
Age Group					
Young	17.20	2.70	17	3	152
Middle	17.19	3.29	18	5	143
Old	17.06	3.03	18	4	159

Social Sharing

Table A 24. Social sharing likelihood for the FYA tip card.

Condition	*M*	*SD*	*Mdn*	*IQR*	*N*
Appeal Type					
Control	9.82	4.36	10.0	7.50	151
Negative	8.90	4.35	10.0	6.00	162
Positive	9.25	4.46	10.0	7.00	141
Age Group					
Young	8.58	4.16	9.5	6.25	152
Middle	9.94	4.44	11.0	6.00	143
Old	9.45	4.51	10.0	7.50	159

Task 2b

Memorability

Table A 25. Memorability accuracy (proportion correct) on the multiple choice questions for the FYA tip card.

	Condition		*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	0.88	0.22	1.00	0.20	16
		Enhanced Card	0.91	0.15	1.00	0.20	15
	One Week Delay						
		Control Card	0.76	0.21	0.80	0.35	14
		Enhanced Card	0.84	0.18	0.90	0.35	10
Older Participants							
	No Delay						
		Control Card	0.82	0.19	0.80	0.25	16
		Enhanced Card	0.89	0.18	1.00	0.20	15
	One Week Delay						
		Control Card	0.80	0.23	0.80	0.40	13
		Enhanced Card	0.85	0.19	1.00	0.20	15

Table A 26. Memorability accuracy on the multiple choice questions for the RRFB tip card.

Condition			*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	0.93	0.13	1.00	0.05	12
		Enhanced Card	0.93	0.12	1.00	0.10	15
	One Week Delay						
		Control Card	0.85	0.23	1.00	0.20	13
		Enhanced Card	0.90	0.19	1.00	0.15	10
Older Participants							
	No Delay						
		Control Card	0.81	0.14	0.80	0.05	16
		Enhanced Card	0.87	0.12	0.80	0.20	15
	One Week Delay						
		Control Card	0.81	0.28	0.90	0.20	14
		Enhanced Card	0.79	0.16	0.80	0.30	15

Table A 27. Perceived usability for the FYA tip card (min. possible score: 16, max: 80).

	Condition		*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	69.56	7.77	70.50	14.25	16
		Enhanced Card	69.40	10.62	73.00	11.00	15
	One Week Delay						
		Control Card	72.79	5.51	72.50	5.75	14
		Enhanced Card	60.90	13.08	61.50	8.50	10
Older Participants							
	No Delay						
		Control Card	62.62	15.12	69.50	26.00	16
		Enhanced Card	73.27	3.83	74.00	3.50	15
	One Week Delay						
		Control Card	60.85	16.36	64.00	17.00	13
		Enhanced Card	69.20	11.25	73.00	8.50	15

Table A 28. Perceived usability for the RRFB tip card (min. possible score: 16, max: 80).

	Condition		*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	68.75	7.94	68.00	8.75	12
		Enhanced Card	66.73	8.73	65.00	12.50	15
	One Week Delay						
		Control Card	70.15	8.12	72.00	12.00	13
		Enhanced Card	64.00	13.97	69.00	15.75	10
Older Participants							
	No Delay						
		Control Card	71.81	6.26	71.00	8.75	16
		Enhanced Card	67.87	12.98	74.00	10.50	15
	One Week Delay						
		Control Card	68.71	7.33	70.00	10.00	14
		Enhanced Card	66.13	10.93	66.00	15.00	15

Attitude Toward the Tip Card

Table A 29. Attitude towards the FYA tip card (min. possible score: 3, max: 21).

	Condition		*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	18.00	3.52	19.00	6.00	16
		Enhanced Card	16.07	4.32	18.00	8.00	15
	One Week Delay						
		Control Card	18.64	3.56	21.00	5.25	14
		Enhanced Card	16.20	6.00	18.50	8.25	10
Older Participants							
	No Delay						
		Control Card	17.75	4.97	20.50	6.00	16
		Enhanced Card	18.93	2.66	21.00	4.00	15
	One Week Delay						
		Control Card	16.77	4.07	18.00	9.00	13
		Enhanced Card	17.73	3.41	18.00	4.50	15

Table A 30. Attitude toward the behavior recommended by the FYA tip card (min. possible score: 3, max: 21).

	Condition		*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	19.38	2.06	21.00	3.25	16
		Enhanced Card	17.53	3.27	18.00	6.00	15
	One Week Delay						
		Control Card	18.71	3.00	20.50	3.75	14
		Enhanced Card	17.10	5.90	20.00	6.00	10
Older Participants							
	No Delay						
		Control Card	18.56	3.41	21.00	4.50	16
		Enhanced Card	19.80	2.11	21.00	2.00	15
	One Week Delay						
		Control Card	17.31	3.25	18.00	7.00	13
		Enhanced Card	17.47	2.90	18.00	3.00	15

Table A 31. Attitude toward the behavior recommended by the RRFB tip card (min. possible score: 3, max: 21).

	Condition		*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	20.33	0.89	21.00	1.25	12
		Enhanced Card	19.87	1.92	21.00	2.00	15
	One Week Delay						
		Control Card	19.23	3.03	21.00	2.00	13
		Enhanced Card	19.30	3.16	21.00	1.00	10
Older Participants							
	No Delay						
		Control Card	19.56	1.97	21.00	2.25	16
		Enhanced Card	19.33	1.72	20.00	3.00	15
	One Week Delay						
		Control Card	18.57	3.39	19.50	2.75	14
		Enhanced Card	18.80	3.47	21.00	3.00	15

Table A 32. Behavioral intent towards the FYA tip card (min. possible score: 2, max: 14).

	Condition		*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	12.56	2.94	13.50	2.00	16
		Enhanced Card	11.67	2.64	12.00	3.50	15
	One Week Delay						
		Control Card	11.71	3.07	12.50	2.75	14
		Enhanced Card	10.60	3.78	12.00	3.50	10
Older Participants							
	No Delay						
		Control Card	12.31	1.92	12.00	2.00	16
		Enhanced Card	12.87	1.68	14.00	2.00	15
	One Week Delay						
		Control Card	10.92	2.50	12.00	5.00	13
		Enhanced Card	11.67	2.23	12.00	3.00	15

Table A 33. Behavioral intent towards the RRFB tip card (min. possible score: 2, max: 14).

	Condition		*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	11.17	3.30	12.00	2.50	12
		Enhanced Card	12.87	1.73	14.00	2.00	15
	One Week Delay						
		Control Card	12.38	2.33	13.00	2.00	13
		Enhanced Card	13.40	1.35	14.00	0.00	10
Older Participants							
	No Delay						
		Control Card	12.31	2.94	13.00	2.00	16
		Enhanced Card	12.27	1.94	13.00	3.00	15
	One Week Delay						
		Control Card	12.36	1.69	12.00	2.00	14
		Enhanced Card	11.73	1.49	12.00	1.00	15

Table A 34. Self-efficacy with the FYA tip card with age group breats (min. possible score: 3, max: 21).

	Condition		*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	12.38	2.87	13.00	2.00	16
		Enhanced Card	12.60	1.88	13.00	2.00	15
	One Week Delay						
		Control Card	12.29	2.81	13.00	2.00	14
		Enhanced Card	12.30	3.02	13.00	1.75	10
Older Participants							
	No Delay						
		Control Card	12.62	1.41	12.50	2.25	16
		Enhanced Card	13.87	0.52	14.00	0.00	15
	One Week Delay						
		Control Card	12.15	1.95	12.00	2.00	13
		Enhanced Card	12.67	1.59	13.00	2.00	15

Table A 35. Self-efficacy with the RRFB tip card (min. possible score: 3, max: 21).

Condition			*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	12.25	3.33	13.00	2.00	12
		Enhanced Card	13.73	0.70	14.00	0.00	15
	One Week Delay						
		Control Card	12.77	1.54	13.00	2.00	13
		Enhanced Card	13.50	0.85	14.00	0.75	10
Older Participants							
	No Delay						
		Control Card	12.56	2.99	14.00	2.00	16
		Enhanced Card	13.47	0.83	14.00	1.00	15
	One Week Delay						
		Control Card	13.00	1.04	13.00	2.00	14
		Enhanced Card	12.67	1.80	13.00	2.00	15

Social Sharing

Table A 36. Social sharing scores for the FYA tip card (min. possible score: 0, max: 14).

	Condition		*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	11.31	2.41	11.50	4.00	16
		Enhanced Card	8.80	2.78	9.00	4.00	15
	One Week Delay						
		Control Card	10.50	3.86	11.00	6.25	14
		Enhanced Card	9.30	4.83	10.50	4.50	10
Older Participants							
	No Delay						
		Control Card	10.94	3.80	12.00	4.25	16
		Enhanced Card	11.00	2.39	12.00	4.50	15
	One Week Delay						
		Control Card	9.92	3.40	11.00	3.00	13
		Enhanced Card	8.93	4.35	9.00	4.50	15

Table A 37. Social sharing scores for the RRFB tip card (min. possible score: 0, max: 14).

Condition			*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	11.00	2.09	11.00	2.00	12
		Enhanced Card	10.07	3.77	10.00	4.00	15
	One Week Delay						
		Control Card	10.92	2.90	11.00	4.00	13
		Enhanced Card	9.50	4.14	10.00	7.00	10
Older Participants							
	No Delay						
		Control Card	11.06	2.21	11.50	2.00	16
		Enhanced Card	8.93	4.06	10.00	6.50	15
	One Week Delay						
		Control Card	9.14	3.35	10.00	6.00	14
		Enhanced Card	9.67	3.75	10.00	3.50	15

Experimental Data

Speed and Accuracy by Delay Period and Tip Card Condition

Table A 38. Accuracy in responding by delay period and card version for the FYA tip card.

Condition			*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	0.76	0.05	0.75	0.01	16
		Enhanced Card	0.78	0.06	0.75	0.09	15
	One Week Delay						
		Control Card	0.77	0.04	0.75	0.03	15
		Enhanced Card	0.77	0.09	0.75	0.06	14
Older Participants							
	No Delay						
		Control Card	0.77	0.08	0.74	0.07	16
		Enhanced Card	0.76	0.05	0.74	0.04	14
	One Week Delay						
		Control Card	0.76	0.09	0.74	0.11	16
		Enhanced Card	0.75	0.05	0.75	0.02	15

Table A 39. Accuracy in responding by delay period and card version for the RRFB tip card.

Condition			*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	0.89	0.17	0.94	0.09	13
		Enhanced Card	0.82	0.22	0.94	0.20	15
	One Week Delay						
		Control Card	0.85	0.17	0.94	0.19	14
		Enhanced Card	0.89	0.11	0.94	0.18	14
Older Participants							
	No Delay						
		Control Card	0.95	0.04	0.98	0.06	13
		Enhanced Card	0.90	0.11	0.94	0.10	16
	One Week Delay						
		Control Card	0.88	0.15	0.93	0.07	14
		Enhanced Card	0.87	0.14	0.92	0.13	15

Speed in Responding

Table A 40. Speed in responding by delay period and card version for the FYA tip card (measured in seconds).

Condition			*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	1.55	0.68	1.64	0.98	16
		Enhanced Card	1.54	1.02	1.11	1.01	15
	One Week Delay						
		Control Card	1.65	0.68	1.57	0.87	15
		Enhanced Card	2.19	0.84	2.18	1.33	14
Older Participants							
	No Delay						
		Control Card	1.78	0.69	1.62	0.99	16
		Enhanced Card	1.48	0.41	1.50	0.77	14
	One Week Delay						
		Control Card	2.17	1.53	1.64	0.55	16
		Enhanced Card	1.51	0.35	1.62	0.58	15

Table A 41. Speed in responding by delay period and card version for the RRFB tip card (measured in seconds).

Condition			*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	1.62	0.22	1.59	0.41	13
		Enhanced Card	1.46	0.31	1.42	0.56	15
	One Week Delay						
		Control Card	1.60	0.42	1.55	0.41	14
		Enhanced Card	1.71	0.34	1.63	0.34	14
Older Participants							
	No Delay						
		Control Card	2.04	0.34	2.08	0.49	13
		Enhanced Card	1.84	0.38	1.85	0.40	16
	One Week Delay						
		Control Card	1.89	0.52	1.63	0.49	14
		Enhanced Card	1.63	0.34	1.58	0.37	15

Speed and Accuracy by Previous Experience

Table A 42. Accuracy by previous experience with the tip card and the device presented in the task.

Condition			*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	FYA Presented in Task						
		No Experience	0.79	0.08	0.75	0.04	13
		Saw Control Card	0.77	0.04	0.75	0.03	31
		Saw Enhanced Card	0.78	0.07	0.75	0.06	29
	RRFB Presented in Task						
		No Experience	0.89	0.13	0.93	0.10	12
		Saw Control Card	0.87	0.17	0.94	0.16	27
		Saw Enhanced Card	0.86	0.18	0.94	0.19	29
Older Participants							
	FYA Presented in Task						
		No Experience	0.77	0.06	0.75	0.05	13
		Saw Control Card	0.77	0.09	0.74	0.08	32
		Saw Enhanced Card	0.75	0.05	0.75	0.01	29
	RRFB Presented in Task						
		No Experience	0.82	0.16	0.84	0.21	14
		Saw Control Card	0.91	0.11	0.95	0.08	27
		Saw Enhanced Card	0.89	0.12	0.94	0.11	31

Table A 43. Accuracy in responding by delay period and card version for the RRFB tip card.

Condition			*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	0.89	0.17	0.94	0.09	13
		Enhanced Card	0.82	0.22	0.94	0.20	15
	One Week Delay						
		Control Card	0.85	0.17	0.94	0.19	14
		Enhanced Card	0.89	0.11	0.94	0.18	14
Older Participants							
	No Delay						
		Control Card	0.95	0.04	0.98	0.06	13
		Enhanced Card	0.90	0.11	0.94	0.10	16
	One Week Delay						
		Control Card	0.88	0.15	0.93	0.07	14
		Enhanced Card	0.87	0.14	0.92	0.13	15

Table A 44. Speed by previous experience with the tip card and the device presented in the task (measured in seconds).

Condition			*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	FYA Presented in Task						
		No Experience	1.67	0.80	1.27	1.50	13
		Saw Control Card	1.60	0.67	1.59	0.92	31
		Saw Enhanced Card	1.86	0.98	1.73	1.59	29
	RRFB Presented in Task						
		No Experience	1.70	0.51	1.50	0.98	12
		Saw Control Card	1.61	0.33	1.59	0.43	27
		Saw Enhanced Card	1.58	0.35	1.59	0.54	29
Older Participants							
	FYA Presented in Task						
		No Experience	1.81	0.73	1.84	1.10	13
		Saw Control Card	1.98	1.18	1.64	0.81	32
		Saw Enhanced Card	1.50	0.37	1.51	0.70	29
	RRFB Presented in Task						
		No Experience	1.90	0.48	1.85	0.24	14
		Saw Control Card	1.96	0.44	1.87	0.54	27
		Saw Enhanced Card	1.74	0.37	1.63	0.46	31

Table A 45. Speed in responding by delay period and card version for the FYA tip card (measured in seconds).

Condition			*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	1.55	0.68	1.64	0.98	16
		Enhanced Card	1.54	1.02	1.11	1.01	15
	One Week Delay						
		Control Card	1.65	0.68	1.57	0.87	15
		Enhanced Card	2.19	0.84	2.18	1.33	14
Older Participants							
	No Delay						
		Control Card	1.78	0.69	1.62	0.99	16
		Enhanced Card	1.48	0.41	1.50	0.77	14
	One Week Delay						
		Control Card	2.17	1.53	1.64	0.55	16
		Enhanced Card	1.51	0.35	1.62	0.58	15

Table A 46. Speed in responding by delay period and card version for the RRFB tip card (measured in seconds).

Condition			*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	No Delay						
		Control Card	1.62	0.22	1.59	0.41	13
		Enhanced Card	1.46	0.31	1.42	0.56	15
	One Week Delay						
		Control Card	1.60	0.42	1.55	0.41	14
		Enhanced Card	1.71	0.34	1.63	0.34	14
Older Participants							
	No Delay						
		Control Card	2.04	0.34	2.08	0.49	13
		Enhanced Card	1.84	0.38	1.85	0.40	16
	One Week Delay						
		Control Card	1.89	0.52	1.63	0.49	14
		Enhanced Card	1.63	0.34	1.58	0.37	15

Table A 47. Speed (seconds) and accuracy (proportion correct) in responding by stimulus format for the flashing trials.

	Variable		*M*	*SD*	*Mdn*	*IQR*	*N*
Middle-Aged Participants							
	Speed						
		Photo	1.93	1.05	1.63	1.12	141
		Sketchup	1.84	0.89	1.70	0.71	141
	Accuracy						
		Photo	0.70	0.24	0.63	0.46	141
		Sketchup	0.69	0.22	0.63	0.43	141
Older Participants							
	Speed						
		Photo	2.07	1.13	1.86	0.82	146
		Sketchup	2.01	1.02	1.83	0.87	146
	Accuracy						
		Photo	0.72	0.24	0.75	0.46	146
		Sketchup	0.68	0.22	0.63	0.42	146

Task 2c

Tip card reading times

Table A 48. Tip card reading times (seconds) by card and age group.

Age Group	Card	*M*	*SD*	*Mdn*	*IQR*	*N*
Middle	FYA	90.24	31.48	101.9	51.78	16
Middle	RA	88.45	33.77	95.89	47.49	12
Middle	RoR	81.34	34.67	85.65	53.78	13
Middle	RRFB	73.06	30.42	61.72	48.38	17
Older	FYA	89.53	28.09	88.93	52.04	12
Older	RA	87.7	22.68	89.16	33.93	12
Older	RoR	87.05	30.63	83.64	60.42	13
Older	RRFB	102.09	20.52	112.77	27.11	13

Table A 49. Participants' evaluations of how effectively the FYA device (as opposed to a standard left-turn arrow) allowed them to navigate the left-hand turns in the simulator by age group (possible values: 0 [there is no difference] through 10 [extremely well]).

Age Group	*M*	*SD*	*Mdn*	*IQR*	*N*
Middle	6.00	3.37	7.00	3.00	16
Older	6.86	3.46	8.00	3.25	14

Table A 50. Participants' evaluations of how effectively the device let them know when to turn by age group (possible values: 0 [not effective at all] through 10 [most effective]).

Age Group	Device	*M*	*SD*	*Mdn*	*IQR*	*N*
Middle	FYA	7.25	2.57	8.00	2.50	16
Middle	ROR	8.64	2.06	10.00	2.00	14
Older	FYA	6.86	2.91	8.00	2.50	14
Older	ROR	6.80	3.99	9.00	6.00	15

Table A 51. Things mentioned by participants when asked about their knowledge on the FYA device and if the purpose of the FYA device is clear.

Age Group	The purpose of the device is clear	When you see a green arrow, turn left	When you see a red arrow, stop	When you see a yellow arrow, prepare to stop	When you see a yellow arrow, complete your left turn	When you see a flashing yellow arrow, turn left if there is a safe gap in traffic (pedestrians and vehicles)
Middle	69%	0%	0%	0%	0%	73%
Older	71%	0%	0%	7%	8%	62%

Table A 52. Things mentioned by participants when asked about their knowledge on the ROR device and if the purpose of the ROR device is clear.

Age Group	The purpose of the device is clear	When you see a red arrow or red circle, stop vehicle before the crosswalk	When you see a ROR sign, stop and wait for green before turning right	When you see a red circle/arrow, turn when there is a safe gap in traffic and no pedestrians are in the crosswalk
Middle	83%	0%	50%	0%
Older	87%	2%	67%	0%

Table A 53. Participants' answers regarding whether or not the device can help them navigate an intersection more safely.

Age Group	Device	Yes	No	I don't know
Middle	FYA	73%	20%	13%
Older	FYA	69%	8%	23%
Middle	ROR	86%	0%	14%
Older	ROR	87%	13%	0%

Table A 54. Percentage of participants who mentioned pros or cons when asked about the pros and cons of the device they saw.

Age Group	Device	Mentioned Pros	Mentioned Cons
Middle	FYA	67%	60%
Older	FYA	69%	62%
Middle	ROR	57%	43%
Older	ROR	67%	47%

Table A 55. Percentage of participants who made a negative or positive comment regarding the device they saw when asked about any additional feedback they may have regarding the device.

Age Group	Device	Made Positive Comments	Made Negative Comments
Middle	FYA	64%	36%
Older	FYA	62%	31%
Middle	ROR	43%	7%
Older	ROR	14%	0%

Wait Time

Table A 56. Wait time (s) by intersection and tip card.

Tip Card	Int. #	Turn Type	No Turn on Red Sign	*M*	*SD*	*Mdn*	*IQR*	*N*
FYA	1	FYA	N/A	4.47	3.64	3.48	6.05	31
FYA	2	ROR	No	10.67	4.81	10.87	8.65	29
FYA	3	FYA	N/A	3.35	2.83	2.90	2.99	31
FYA	4	ROR	Yes	10.41	5.61	9.27	6.29	31
ROR	1	FYA	N/A	3.53	3.41	2.40	5.53	30
ROR	2	ROR	No	7.26	4.26	6.77	3.57	29
ROR	3	FYA	N/A	4.43	3.47	3.96	4.64	30
ROR	4	ROR	Yes	10.79	5.41	9.04	7.14	30

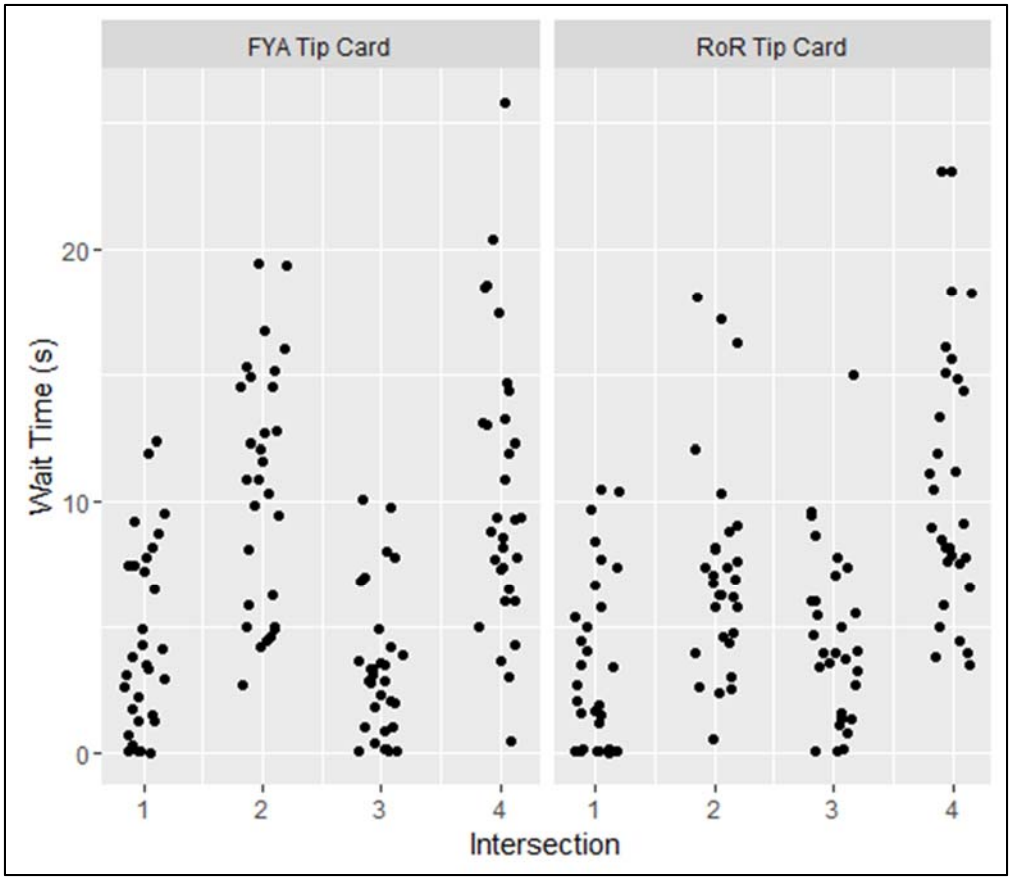

Figure A 1. Dot plot of wait time by intersection and tip card. Each point represents a single participant's wait time.

Table A 57. Wait time (s) by intersection and age.

Age Group	Int. #	Turn Type	No Turn on Red Sign	*M*	*SD*	*Mdn*	*IQR*	*N*
Middle	1	FYA	N/A	4.08	3.38	3.30	6.10	30
Middle	2	ROR	No	9.87	5.11	9.43	9.54	30
Middle	3	FYA	N/A	4.29	2.80	3.93	2.97	30
Middle	4	ROR	Yes	8.67	3.35	8.35	4.02	30
Older	1	FYA	N/A	3.94	3.72	3.37	5.84	31
Older	2	ROR	No	7.99	4.37	6.82	5.05	28
Older	3	FYA	N/A	3.48	3.51	2.68	3.67	31
Older	4	ROR	Yes	12.46	6.45	11.93	10.38	31

Distance to Oncoming Vehicle

Table A 58. Distance (ft) at which participants turned in front of the oncoming vehicle by tip card.

Tip Card	Int. #	Turn Type	No Turn on Red Sign	*M*	*SD*	*Mdn*	*IQR*	*N*
FYA	1	FYA	N/A	89.83	N/A	89.83	0.00	1
ROR	1	FYA	N/A	58.36	23.52	58.36	16.63	2

Table A 59. Distance (ft) at which participants turned in front of the oncoming vehicle by age group.

Age Group	Int. #	Turn Type	No Turn on Red Sign	*M*	*SD*	*Mdn*	*IQR*	*N*
Middle	1	FYA	N/A	41.73	N/A	41.73	0.00	1
Older	1	FYA	N/A	82.41	10.49	82.41	7.42	2

Timing of Right-Hand Turns

Table A 60. Percentage of participants who waited for the signal to turn green before making a right-hand turn by tip card and no-turn-on-red sign presence.

Tip Card	No Turn on Red Sign	Total # Turns	% Turns Made After Light Turned Green
FYA	No	29	55%
FYA	Yes	31	97%
ROR	No	29	24%
ROR	Yes	30	100%

Table A 61. Percentage of participants who waited for the signal to turn green before making a right-hand turn by age group and no-turn-on-red sign presence.

Age Group	No Turn on Red Sign	Total # Turns	% Turns Made After Light Turned Green
Middle	No	30	50%
Middle	Yes	30	100%
Older	No	28	29%
Older	Yes	31	97%

Appendix B – Qualtrics Survey Questions

MTurk Tip Card - for Task 2b – CONDITIONALIZED

Note: The survey questions below include a data descriptor (in parentheses) not visible to participants

Participant Number *(participant_number)*:

Condition *(condition_code)*
- ❍ NONE (1)
- ❍ FYA (2)
- ❍ RRFB (3)

What is your gender? *(gender)*
- ❍ Male (4)
- ❍ Female (5)

What is your date of birth? (MM/DD/YYYY) *(year_born)*

Do you currently wear corrective glasses or contacts? *(glasses_contacts)*
- ❍ Yes (1)
- ❍ No (2)

Are you color blind? *(color_blind)*
- ❍ Yes (1)
- ❍ No (2)
- ❍ I don't know (3)

Do you currently hold a valid driver's license? *(valid_license)*
- ❍ Yes (1)
- ❍ No (2)

How often do you drive in a week? *(often_drive)*

- ❍ Not at all (6)
- ❍ 1 time a week (1)
- ❍ 2-4 times a week (2)
- ❍ 5-10 times a week (4)
- ❍ 11+ times a week (5)

On average, how many miles do you drive per week? *(miles_drive)*

Here are a number of personality traits that may or may not apply to you. Please select a number next to each statement to indicate the extent to which you agree or disagree with that statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other. *(TIPI)*

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Extraverted, enthusiastic. (1)	❍	❍	❍	❍	❍	❍	❍
Critical, quarrelsome. (2)	❍	❍	❍	❍	❍	❍	❍
Dependable, self-disciplined. (3)	❍	❍	❍	❍	❍	❍	❍
Anxious, easily upset. (4)	❍	❍	❍	❍	❍	❍	❍
Open to new experiences, complex. (5)	❍	❍	❍	❍	❍	❍	❍
Reserved, quiet. (6)	❍	❍	❍	❍	❍	❍	❍
Sympathetic, warm. (7)	❍	❍	❍	❍	❍	❍	❍
Disorganized, careless. (8)	❍	❍	❍	❍	❍	❍	❍
Calm, emotionally stable. (9)	❍	❍	❍	❍	❍	❍	❍
Conventional, uncreative. (10)	❍	❍	❍	❍	❍	❍	❍

For the next items, answer the question below by clicking the button close to the word that best reflects your feelings. If you don't think either word reflects your feelings, click a button somewhere in the middle area between the two words. How would you describe your feelings about the tip card you read? *(feelings)*

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Dislike:Like (1)	❍	❍	❍	❍	❍	❍	❍
Negative:Positive (2)	❍	❍	❍	❍	❍	❍	❍
Unfavorable:Favorable (3)	❍	❍	❍	❍	❍	❍	❍

My taking the actions recommended by the tip card would be*: (attitudeb1)*

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Bad:Good (1)	❍	❍	❍	❍	❍	❍	❍
Pleasant:Unpleasant (2)	❍	❍	❍	❍	❍	❍	❍

My feelings about taking the actions recommended by the tip card are: *(attitudeb2)*

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Negative:Positive (1)	❍	❍	❍	❍	❍	❍	❍

Please indicate the extent to which you agree or disagree with each of the following statements: *(M _attitude)*

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I am able to take the actions recommended in the tip card. (1)	❍	❍	❍	❍	❍	❍	❍
Whether I take the actions recommended in the tip card, is completely up to me. (2)	❍	❍	❍	❍	❍	❍	❍
It would be easy for me to take the actions recommended the tip card. (3)	❍	❍	❍	❍	❍	❍	❍
I intend to take the actions recommended in tip card as soon as possible. (4)	❍	❍	❍	❍	❍	❍	❍
I intend to take the actions recommended in tip card whenever possible. (5)	❍	❍	❍	❍	❍	❍	❍

Please answer the following questions related to the tip card you previously saw: *(SUS_p1)*

	Strongly agree (5)	Somewhat agree (4)	Neither agree nor disagree (3)	Somewhat disagree (2)	Strongly disagree (1)
I think that I would use tip cards like this frequently. (17)	❍	❍	❍	❍	❍
I found this tip card unnecessarily complex. (2)	❍	❍	❍	❍	❍
I thought the tip card was easy to use. (3)	❍	❍	❍	❍	❍
I think that I would need assistance to be able to understand this tip card. (4)	❍	❍	❍	❍	❍
I found the features of this tip card to be useful. (5)	❍	❍	❍	❍	❍
I had difficulty seeing important details in the pictures. (18)	❍	❍	❍	❍	❍
I thought there were inconsistencies in this tip card (19)	❍	❍	❍	❍	❍

Please answer the following questions related to the tip card you previously saw: *(SUS_p2)*

	Strongly agree (5)	Somewhat agree (4)	Neither agree nor disagree (3)	Somewhat disagree (2)	Strongly disagree (1)
I imagine that most people would be able to learn from this tip card very quickly. (8)	❍	❍	❍	❍	❍
I found the tip card cumbersome to use. (9)	❍	❍	❍	❍	❍
I found the print on the tip card large enough to read easily. (3)	❍	❍	❍	❍	❍
I felt very confident that I understood this tip card. (10)	❍	❍	❍	❍	❍
I felt like I needed to reference other sources of information to understand this tip card. (11)	❍	❍	❍	❍	❍

Please answer the following questions related to the tip card you previously saw: *(SUS_p3)*

	Strongly agree (5)	Somewhat agree (4)	Neither agree nor disagree (3)	Somewhat disagree (2)	Strongly disagree (1)
The tip card is just what I would expect for one created for individuals my age. (12)	❍	❍	❍	❍	❍
At times, I felt confused about where information was on the tip card. (13)	❍	❍	❍	❍	❍
It was easy to find the information I needed. (3)	❍	❍	❍	❍	❍
The organization of information on the tip card is clear. (14)	❍	❍	❍	❍	❍

Thinking about your experience using this tip card, how much do you agree or disagree with the following statements? *(experien_1)*

	Strongly agree (5)	Somewhat agree (4)	Neither agree nor disagree (3)	Somewhat disagree (2)	Strongly disagree (1)
My attention was focused. (1)	❍	❍	❍	❍	❍
I concentrated fully. (2)	❍	❍	❍	❍	❍
It meant a lot to me. (3)	❍	❍	❍	❍	❍
It was rewarding. (4)	❍	❍	❍	❍	❍
It was useful. (5)	❍	❍	❍	❍	❍

Thinking about your experience using this tip card, how much do you agree or disagree with the following statements? *(experien_2)*

	Strongly agree (5)	Somewhat agree (4)	Neither agree nor disagree (3)	Somewhat disagree (2)	Strongly disagree (1)
It was worthwhile. (1)	❍	❍	❍	❍	❍
I found myself relating this information to ideas I've had before. (2)	❍	❍	❍	❍	❍
I tried to relate the information that was presented to my own experiences. (3)	❍	❍	❍	❍	❍
I thought about how the information presented related to other things I know. (4)	❍	❍	❍	❍	❍
I found myself making connections between the information presented and information I read or heard about elsewhere. (5)	❍	❍	❍	❍	❍

In this section, there are two questions related to sharing information. *(social_sha)*

	0 (1)	1 (2)	2 (3)	3 (4)	4 (5)	5 (6)	6 (7)	7 (8)
How interested are you in sharing the information described in the tip card with FRIENDS? (1)	❍	❍	❍	❍	❍	❍	❍	❍
How interested are you in sharing the information described in the tip card with FAMILY MEMBERS? (2)	❍	❍	❍	❍	❍	❍	❍	❍

Describe the appearance of the signal on the tip card you saw. *(appearance_signal)*

What was the name of the traffic sign or signal in the tip card you read*? (atten_chec)*

- ❍ Rectangular rapid flashing beacon (1)
- ❍ Flashing yellow arrow (2)
- ❍ Right turn on red arrow (3)
- ❍ School crossing sign (4)
- ❍ Speed zone ahead (5)

In the space provided below, please tell us what purpose the Flashing Yellow Arrow serves for our roadways. *(purpose_FYA)*

In the space provided below, please tell us what drivers should do when they see a Flashing Yellow Arrow (FYA). *(action_FYA)*

Timing *(fya_free_recall_time)*

First Click (1)
Last Click (2)
Page Submit (3)
Click Count (4)

Which of the following is a picture of the Flashing Yellow Arrow (FYA)? *(FYA_MC_Q1)*

- ❍ Image 1 (1)
- ❍ Image 2 (2)
- ❍ Image 3 (3)

The primary purpose of the Flashing Yellow Arrow (FYA) is to: *(FYA_MC_Q2)*

- ❍ Alert drivers that they can make a left turn when there is no oncoming traffic (9)
- ❍ Alert drivers that oncoming cars will be stopping at the intersections (10)
- ❍ Alert drivers that they can make a right turn when there is no crossing traffic (12)
- ❍ Alert drivers that they cannot make a left turn at that intersection (13)

When you see a solid yellow arrow, it means that you should: *(FYA_MC_Q3)*

- ❍ Make a left turn when there is no oncoming traffic (8)
- ❍ Make a right turn if there is no crossing traffic (9)
- ❍ Make a left turn if there are no crossing pedestrians (10)
- ❍ Finish making your left turn or be prepared to stop (7)

When you see a flashing yellow arrow, it means you should: *(FYA_MC_Q4)*

- ❍ Be ready to make a left turn provided there is a safe gap in vehicle and pedestrian traffic (8)
- ❍ Be ready to make a right turn provided there is a safe gap in vehicle and pedestrian traffic (9)
- ❍ Prepare to stop and wait for the signal to change (10)
- ❍ Prepare to yield to pedestrians who are crossing the street (11)

When you see a flashing yellow arrow, you can: *(FYA_MC_Q5)*

- ❍ Make a right turn when there is a safe gap in vehicle and pedestrian traffic (8)
- ❍ Make a left turn provided there is a safe gap in vehicle and pedestrian traffic (10)
- ❍ Make a left turn provided there are no pedestrians in the street (6)
- ❍ Make a left turn provided there are no oncoming vehicles (11)

In the space provided below, please tell us what purpose the Rectangular Rapid Flashing Beacon (RRFB) serves for our roadways. *(purpose_RRFB)*

In the space provided below, please tell us what drivers should do when they see a Rectangular Rapid Flashing Beacon (RRFB). *(action_RRFB)*

Timing *(RRFB_free_recall_tim)*

First Click (1)
Last Click (2)
Page Submit (3)
Click Count (4)

Which of the following is a picture of the Rectangular Rapid Flashing Beacon? *(RRFB_MC_Q1)*

- ❍ Image 1 (1)
- ❍ Image 2 (2)
- ❍ Image 3 (3)

The primary purpose of the RRFB is to: *(RRFB_MC_Q2)*

- ❍ Alert drivers to dangerous road conditions (1)
- ❍ Alert drivers to pedestrians crossing at a crosswalk (4)
- ❍ Alert drivers to a blind curve (6)
- ❍ Alert drivers to the presence of oncoming traffic (8)

When you see an RRFB without its lights flashing, you should: *(RRFB_MC_Q3)*

- ❍ Be alert for the presence of pedestrians (4)
- ❍ Proceed past the crosswalk as normal (5)
- ❍ Be alert for turning cars (6)
- ❍ Yield to pedestrians and allow them to finish crossing the street (7)

When you see an RRFB with its lights flashing, you should: *(RRFB_MC_Q4)*

- ❍ Be alert for the presence of pedestrians (4)
- ❍ Proceed past the crosswalk as normal (3)
- ❍ Be alert for turning cars (5)
- ❍ Yield to pedestrians and allow them to finish crossing the street (7)

When the RRFB has flashing lights, you can proceed through the crosswalk: *(RRFB_MC_Q5)*

- ❍ Normally, as you have the right of way (4)
- ❍ Only when the crosswalk is clear of pedestrians (5)
- ❍ When the opposing traffic begins to move (6)
- ❍ When pedestrians are clear from your lane of traffic, but are still in the crosswalk (7)

PANAS Scale (Positive and Negative Affect Schedule)

Right now I am feeling... *(emo_1)*

	0 (1)	1 (2)	2 (3)	3 (4)	4 (5)	5 (6)	6 (7)	7 (8)
Elated (1)	❍	❍	❍	❍	❍	❍	❍	❍
Afraid (2)	❍	❍	❍	❍	❍	❍	❍	❍
Annoyed (3)	❍	❍	❍	❍	❍	❍	❍	❍
Ashamed (4)	❍	❍	❍	❍	❍	❍	❍	❍
Happy (5)	❍	❍	❍	❍	❍	❍	❍	❍
Dreary (6)	❍	❍	❍	❍	❍	❍	❍	❍
Cheerful (7)	❍	❍	❍	❍	❍	❍	❍	❍
Aggravated (8)	❍	❍	❍	❍	❍	❍	❍	❍
Dismal (9)	❍	❍	❍	❍	❍	❍	❍	❍
Tense (10)	❍	❍	❍	❍	❍	❍	❍	❍

Right now I am feeling... *(emo_2)*

	0 (1)	1 (2)	2 (3)	3 (4)	4 (5)	5 (6)	6 (7)	7 (8)
Upset (1)	❍	❍	❍	❍	❍	❍	❍	❍
Calm (2)	❍	❍	❍	❍	❍	❍	❍	❍
Proud (3)	❍	❍	❍	❍	❍	❍	❍	❍
Scared (4)	❍	❍	❍	❍	❍	❍	❍	❍
Joyful (6)	❍	❍	❍	❍	❍	❍	❍	❍
Satisfied (7)	❍	❍	❍	❍	❍	❍	❍	❍
Sad (8)	❍	❍	❍	❍	❍	❍	❍	❍

Right now I am feeling... *(emo_3)*

	0 (1)	1 (2)	2 (3)	3 (4)	4 (5)	5 (6)	6 (7)	7 (8)
Regretful (1)	❍	❍	❍	❍	❍	❍	❍	❍
Irritated (2)	❍	❍	❍	❍	❍	❍	❍	❍
Pleasant (3)	❍	❍	❍	❍	❍	❍	❍	❍
Fearful (4)	❍	❍	❍	❍	❍	❍	❍	❍
Angry (5)	❍	❍	❍	❍	❍	❍	❍	❍
Guilty (6)	❍	❍	❍	❍	❍	❍	❍	❍
Confident (7)	❍	❍	❍	❍	❍	❍	❍	❍

Attitude toward the Behavior

For the next items, answer the question below by clicking the button close to the word that best reflects your feelings. If you don't think either word reflects your feelings, click a button somewhere in the middle area between the two words. How would you describe your feelings about the tip card you just read? *(feelings)*

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Dislike:Like (1)	❍	❍	❍	❍	❍	❍	❍
Negative:Positive (2)	❍	❍	❍	❍	❍	❍	❍
Unfavorable:Favorable (3)	❍	❍	❍	❍	❍	❍	❍

My taking the actions recommended by the tip card would be: *(attitudeb1)*

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Bad:Good (1)	❍	❍	❍	❍	❍	❍	❍
Pleasant:Unpleasant (2)	❍	❍	❍	❍	❍	❍	❍

My feelings about taking the actions recommended by the tip card are: *(attitudeb2)*

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Negative:Positive (1)	❍	❍	❍	❍	❍	❍	❍

Please indicate the extent to which you agree or disagree with each of the following statements: *(m_attitude)*

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I am able to take the actions recommended in the tip card. (1)	❍	❍	❍	❍	❍	❍	❍
Whether I take the actions recommended in the tip card, is completely up to me. (2)	❍	❍	❍	❍	❍	❍	❍
It would be easy for me to take the actions recommended the tip card. (3)	❍	❍	❍	❍	❍	❍	❍
I intend to take the actions recommended in tip card as soon as possible. (4)	❍	❍	❍	❍	❍	❍	❍
I intend to take the actions recommended in tip card whenever possible. (5)	❍	❍	❍	❍	❍	❍	❍

System Usability Survey
Please answer the following questions related to the tip card you previously saw: *(SUS_P1)*

	Strongly agree (5)	Somewhat agree (4)	Neither agree nor disagree (3)	Somewhat disagree (2)	Strongly disagree (1)
I think that I would use tip cards like this frequently. (17)	❍	❍	❍	❍	❍
I found this tip card unnecessarily complex. (2)	❍	❍	❍	❍	❍
I thought the tip card was easy to use. (3)	❍	❍	❍	❍	❍
I think that I would need assistance to be able to understand this tip card. (4)	❍	❍	❍	❍	❍
I found the features of this tip card to be useful. (5)	❍	❍	❍	❍	❍
I had difficulty seeing important details in the pictures. (18)	❍	❍	❍	❍	❍
I thought there were inconsistencies in this tip card (19)	❍	❍	❍	❍	❍

Please answer the following questions related to the tip card you previously saw: *(SUS_p2)*

	Strongly agree (5)	Somewhat agree (4)	Neither agree nor disagree (3)	Somewhat disagree (2)	Strongly disagree (1)
I imagine that most people would be able to learn from this tip card very quickly. (8)	❍	❍	❍	❍	❍
I found the tip card cumbersome to use. (9)	❍	❍	❍	❍	❍
I found the print on the tip card large enough to read easily. (3)	❍	❍	❍	❍	❍
I felt very confident that I understood this tip card. (10)	❍	❍	❍	❍	❍
I needed to reference other sources of information to understand this tip card. (11)	❍	❍	❍	❍	❍

Please answer the following questions related to the tip card you previously saw: *(SUS_p3)*

	Strongly agree (5)	Somewhat agree (4)	Neither agree nor disagree (3)	Somewhat disagree (2)	Strongly disagree (1)
The tip card is just what I would expect for one created for individuals my age. (12)	❍	❍	❍	❍	❍
At times, I felt confused about where information was on the tip card. (13)	❍	❍	❍	❍	❍
It was easy to find the information I needed. (3)	❍	❍	❍	❍	❍
The organization of information on the tip card is clear. (14)	❍	❍	❍	❍	❍

Attention Scale

Thinking about your experience using this tip card, how much do you agree or disagree with the following statements? *(experien_1)*

	Strongly agree (5)	Somewhat agree (4)	Neither agree nor disagree (3)	Somewhat disagree (2)	Strongly disagree (1)
My attention was focused. (1)	❍	❍	❍	❍	❍
I concentrated fully. (2)	❍	❍	❍	❍	❍
It meant a lot to me. (3)	❍	❍	❍	❍	❍
It was rewarding. (4)	❍	❍	❍	❍	❍
It was useful. (5)	❍	❍	❍	❍	❍

Elaboration Scale

Thinking about your experience using this tip card, how much do you agree or disagree with the following statements? *(experien_2)*

	Strongly agree (5)	Somewhat agree (4)	Neither agree nor disagree (3)	Somewhat disagree (2)	Strongly disagree (1)
It was worthwhile. (1)	❍	❍	❍	❍	❍
I found myself relating this information to ideas I've had before. (2)	❍	❍	❍	❍	❍
I tried to relate the information that was presented to my own experiences. (3)	❍	❍	❍	❍	❍
I thought about how the information presented related to other things I know. (4)	❍	❍	❍	❍	❍
I found myself making connections between the information presented and information I read or heard about elsewhere. (5)	❍	❍	❍	❍	❍

Social Sharing Questions

In this section, there are two questions related to sharing information. *(social_sha)*

	0 (1)	1 (2)	2 (3)	3 (4)	4 (5)	5 (6)	6 (7)	7 (8)
How interested are you in sharing the information described in the tip card with FRIENDS? (1)	❍	❍	❍	❍	❍	❍	❍	❍
How interested are you in sharing the information described in the tip card with FAMILY MEMBERS? (2)	❍	❍	❍	❍	❍	❍	❍	❍

Attention Check question

What was the name of the traffic sign or signal in the tip card you read? *(atten_chec)*

- ❍ Rectangular rapid flashing beacon (1)
- ❍ Flashing yellow arrow (2)
- ❍ Right turn on red arrow (3)
- ❍ School crossing sign (4)
- ❍ Speed zone ahead (5)

Free Recall Prompts

In the space provided below, please tell us everything you can about the Rectangular Rapid Flashing Beacon (RRFB). We are interested to know what you remember about what the RRFB signal looks like, what it means, and how you are to respond when you see it. *(rrfb_free_recall)*

In the space provided below, please tell us everything you can about the Flashing Yellow Arrow (FYA). We are interested to know what you remember about what the FYA signal looks like, what it means, and how you are to respond when you see it. *(fya_free_recall)*

Multiple-Choice Questions

Which of the following is a picture of the Rectangular Rapid Flashing Beacon? *(RRFB_MC_Q1)*

- ❍ Image 1 (1)
- ❍ Image 2 (2)
- ❍ Image 3 (3)

The primary purpose of the RRFB is to: *(RRFB_MC_Q2)*

- ❍ Alert drivers to dangerous road conditions (1)
- ❍ Alert drivers to pedestrians crossing at a crosswalk (4)
- ❍ Alert drivers to a blind curve (6)
- ❍ Alert drivers to the presence of oncoming traffic (8)

When you see an RRFB without its lights flashing, you should: *(RRFB_MC_Q3)*

- ❍ Be alert for the presence of pedestrians (4)
- ❍ Proceed past the crosswalk as normal (5)
- ❍ Be alert for turning cars (6)
- ❍ Yield to pedestrians and allow them to finish crossing the street (7)

When you see an RRFB with its lights flashing, you should: *(RRFB_MC_Q4)*

- ❍ Be alert for the presence of pedestrians (4)
- ❍ Proceed past the crosswalk as normal (3)
- ❍ Be alert for turning cars (5)
- ❍ Yield to pedestrians and allow them to finish crossing the street (7)

When the RRFB has flashing lights, you can proceed through the crosswalk: *(RRFB_MC_Q5)*

- ❍ Normally, as you have the right of way (4)
- ❍ Only when the crosswalk is clear of pedestrians (5)
- ❍ When the opposing traffic begins to move (6)
- ❍ When pedestrians are clear from your lane of traffic, but are still in the crosswalk (7)

Which of the following is a picture of the Flashing Yellow Arrow (FYA)? *(FYA_MC_Q1)*

- ❍ Image 1 (1)
- ❍ Image 2 (2)
- ❍ Image 3 (3)

The primary purpose of the Flashing Yellow Arrow (FYA) is to: *(FYA_MC_Q2)*

- ❍ Alert drivers that they can make a left turn when there is no oncoming traffic (9)
- ❍ Alert drivers that oncoming cars will be stopping at the intersections (10)
- ❍ Alert drivers that they can make a right turn when there is no crossing traffic (12)
- ❍ Alert drivers that they cannot make a left turn at that intersection (13)

When you see a solid yellow arrow, it means that you should: *(FYA_MC_Q3)*

- ❍ Make a left turn when there is no oncoming traffic (8)
- ❍ Make a right turn if there is no crossing traffic (9)
- ❍ Make a left turn if there are no crossing pedestrians (10)
- ❍ Finish making your left turn or be prepared to stop (7)

When you see a flashing yellow arrow, it means you should: *(FYA_MC_Q4)*

- ❍ Be ready to make a left turn provided there is a safe gap in vehicle and pedestrian traffic (8)
- ❍ Be ready to make a right turn provided there is a safe gap in vehicle and pedestrian traffic (9)
- ❍ Prepare to stop and wait for the signal to change (10)
- ❍ Prepare to yield to pedestrians who are crossing the street (11)

When you see a flashing yellow arrow, you can: *(FYA_MC_Q5)*

- ❍ Make a right turn when there is a safe gap in vehicle and pedestrian traffic (8)
- ❍ Make a left turn provided there is a safe gap in vehicle and pedestrian traffic (10)
- ❍ Make a left turn provided there are no pedestrians in the street (6)
- ❍ Make a left turn provided there are no oncoming vehicles (11)

Demographics

What is your gender? *(gender)*

- ❍ Male (4)
- ❍ Female (5)

What year were you born? (4 digits please, e.g., 1991) *(year_born)*

Do you currently wear corrective glasses or contacts? *(glasses_contacts)*

- ❍ Yes (1)
- ❍ No (2)

Are you color blind? *(color_blind)*

- ❍ Yes (1)
- ❍ No (2)
- ❍ I don't know (3)

What is your state of residence? (two letters only, e.g., FL for FLORIDA) *(state_of_residence)*

Do you currently hold a valid driver's license? *(valid_license)*

- ❍ Yes (1)
- ❍ No (2)

How often do you drive in a week? *(often_drive)*

- ❍ Not at all (6)
- ❍ 1 time a week (1)
- ❍ 2-4 times a week (2)
- ❍ 5-10 times a week (4)
- ❍ 11+ times a week (5)

On average, how many miles do you drive per week? *(miles_drive)*

TIPI Scale (Ten Item Personality Inventory)

Here are a number of personality traits that may or may not apply to you. Please select a number next to each statement to indicate the extent to which you agree or disagree with that statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.
TIPI Here are a number of personality traits that may or may not apply to you. Please select a number next to each statement to indicate the extent to which you agree or disagree with that statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other. *(TIPI)*

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Extraverted, enthusiastic. (1)	❍	❍	❍	❍	❍	❍	❍
Critical, quarrelsome. (2)	❍	❍	❍	❍	❍	❍	❍
Dependable, self-disciplined. (3)	❍	❍	❍	❍	❍	❍	❍
Anxious, easily upset. (4)	❍	❍	❍	❍	❍	❍	❍
Open to new experiences, complex. (5)	❍	❍	❍	❍	❍	❍	❍
Reserved, quiet. (6)	❍	❍	❍	❍	❍	❍	❍
Sympathetic, warm. (7)	❍	❍	❍	❍	❍	❍	❍
Disorganized, careless. (8)	❍	❍	❍	❍	❍	❍	❍
Calm, emotionally stable. (9)	❍	❍	❍	❍	❍	❍	❍
Conventional, uncreative. (10)	❍	❍	❍	❍	❍	❍	❍

Difficulties Prompt

Did you experience any difficulties viewing the tip cards (promotional image at the beginning)? *(difficulty_bool)*

- ❍ Yes (1)
- ❍ No (2)

If Yes Is Selected, Then Skip To:
Please describe these difficulties as...
If No Is Selected, Then Skip To End of Block

Please describe these difficulties as best as possible in the box below: *(feedback_open)*

Note: Participants who received the FYA card saw the FYA relevant questions, No-Turn-On-Red participants saw No-Turn-On-Red questions, and both groups saw the demographic questions and SSQ

FYA Relevant Questions

This section of questions relates to the Flashing Yellow Arrow sign traffic control device you saw in the simulator task.

Is the usage of the Flashing Yellow Arrow traffic control device you just experienced clear to you? Please describe what you know about this traffic control device based on your observation and understanding. *(Q1)*

Could this Flashing Yellow Arrow traffic control device help you navigate an intersection more safely? Please provide reasons to support your answer. *(Q2)*

Please rate how effectively this Flashing Yellow Arrow traffic control device allowed you to navigate a left turn compared to a standard left-turn arrow. *(Q3)*
10 being "extremely well", to 0 being "there is no difference".
Your rating: _____ Use the slider to select your rating

Describe how effectively this Flashing Yellow Arrow traffic control device let you know when to turn. Please also provide your rating out of 10*; (Q4)*
10 being "most effective" and 0 being "not effective at all".
Your rating: _____ Use the slider to select your rating

Describe the pros and cons of the Flashing Yellow Arrow traffic control device you just experienced in detail. *(Q5)*

Please provide any additional feedback you have for this Flashing Yellow Arrow traffic control device. *(Q6)*

No Turn On Red Relevant Questions
This section of questions relates to the No Turn On Red sign traffic control device you saw in the simulator task.

Is the usage of the No Turn On Red traffic control device you just experienced clear to you? Please describe what you know about this traffic control device based on your observation and understanding. *(Q1)*

Could this No Turn On Red traffic control device help you navigate an intersection more safely? Please provide reasons to support your answer. *(Q2)*

Please rate how effectively this No Turn On Red traffic control device allowed you to navigate a left turn compared to a standard left-turn arrow. *(Q3)*
10 being "extremely well", to 0 being "there is no difference".
Your rating: _____ Use the slider to select your rating

Describe how effectively this No Turn On Red traffic control device let you know when to turn. Please also provide your rating out of 10; *(Q4)*
10 being "most effective" and 0 being "not effective at all".
Your rating: _____ Use the slider to select your rating

Describe the pros and cons of the No Turn On Red traffic control device you just experienced in detail. *(Q5)*

Please provide any additional feedback you have for this No Turn On Red traffic control device. *(Q6)*

Demographic Questions

Are you color blind? *(Q1)*
Yes
No
I don't know

Do you currently hold a valid driver's license? *(Q2)*
Yes
No

Do you currently wear corrective glasses or contacts*? (Q3)*
Yes
No

Here are a number of personality traits that may or may not apply to you. Please select a number next to each statement to indicate the extent to which you agree or disagree with that statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.

	1	2	3	4	5	6	7
Extraverted, enthusiastic							
Critical, quarrelsome							
Dependable, self-disciplined.							
Anxious, easily upset.							
Open to new experiences, complex.							
Reserved, quiet.							
Sympathetic, warm.							
Disorganized, careless.							
Calm, emotionally stable.							
Conventional, uncreative.							

How often do you drive in a week? *(Q5)*
Not at all
1 time a week
2-4 times a week
5-10 times a week
11+ times a week

On average, how many miles do you drive per week? *(Q6)*

What is your date of birth? (MM/DD/YYYY*) (Q7)*

What is your gender? *(Q8)*
Male
Female

Sim Sickness Questionnaire (SSQ)
For each symptom, please circle the rating that applies to you RIGHT NOW. Please complete even if you have no symptoms

	RATING			
	none	slight	moderate	severe
General Discomfort				
Fatigue				
Headache				
Eye strain				
Difficulty focusing				
Salivation increased				
Sweating				
Nausea				
Difficulty Concentrating				
"Fullness of the head"				
Dizziness with Eyes Open				
Dizziness with Eyes Closed				
Vertigo				
Stomach awareness				
Burping				

Other Simulator Sickness symptoms: *(Q1)*

Have you eaten prior to entry into the simulator? *(Q2)*
Yes
No

If you've eaten, what time did you eat? *(Q3)*

Do you wear corrective lenses? *(Q4)*
Contacts
Glasses
No, I don't wear corrective lenses

Do you have any previous experiences of motion sickness? *(Q5)*
Yes
No

If so, when was the last time you felt motion sickness? *(Q6)*

Appendix C - User Comments Relevant to Safety

Table C 1. Safety-relevant interpretation errors discovered in open-responses for Task 2a-2c

Task	Misinterpretation	Signal Involved	Age of Respondent	Open-Response
2a	Assumed side of flashing light to have meaning	RRFB	71	In areas where there is a crosswalk, you would see the beacon and an image on a sign above it of a "walking person". There are two separate lights on the beacon. When the light on the left is on, it is alerting you to be aware someone may be attempting to cross the street in the crosswalk. When both lights are flashing it means STOP and let the person walk in the crosswalk. When the light on the right is on, it means you may then begin driving again.
2a	Assumed side of flashing light to have meaning	RRFB	25	It is a new sign that signals a pedestrian crosswalk consisting of 2 lights. When the left light is lit, prepare to stop, when both lights are lit, someone is crossing.
2a	Assumed side of flashing light to have meaning	RRFB	37	It is below the pedestrian crossing sign and above the diagonal arrow. There are two right next to each other. They are yellow and rectangular. If one is lit, it is a warning to prepare for a pedestrian. If both are lit and flashing, that means a pedestrian is crossing and you are not allowed to drive.
2a	Assumed side of flashing light to have meaning	RRFB	23	It is rectangular, and lights up on the left side when a pedestrian wants to cross the street. When you see it flash, you should stop so the pedestrian can cross.
2a	Assumed side of flashing light to have meaning	RRFB	67	It is situated below the pedestrian walk sign. It lights up the left side to warn that someone wants to cross the street and lights up both the right and left side when someone is walking in th costs walk.

2a	Assumed side of flashing light to have meaning	RRFB	54	It was confusing was my first thought. It confused me with the side by side layout and the differentiation by the black vs other colored background. It took me a while to understand the key implicated in the diagram. I eventually got the idea of it, but had to work at it kind of hard and that might be a deterent to some people. It referred to a rapid flashing beacon and that you should slow down and look for pedestrians ready to cross the street or in the cross walk and stop to let them pass.
2a	Assumed side of flashing light to have meaning	RRFB	29	It's a diamond-shaped sign that has to do with pedestrian crossings. If only the left light under the sign was on, the motorist was to expect a pedestrian to want to cross. If both lights were on, the motorist was supposed to stop for pedestrians, and if only the right light was on, the motorist could proceed like normal.
2a	Assumed side of flashing light to have meaning	RRFB	34	it's a small rectangle with 2 small lights when it's lit up you stop an let people cross if no one is in crosswalk you can go but what confuses me is that it doesn't really tell you if the lights are on do you stop ? is it one light go two lights stop ? it should be made more clear
2a	Assumed side of flashing light to have meaning	RRFB	53	Left means someone is waiting to cross, two lights mean people are in the crosswalk and right means its safe to cross the pedestrian walkway. It should use traffic signal colors, not left to right lights, it's too confusing.

2a	Assumed side of flashing light to have meaning	RRFB	70	RRFB is a rectangular sign with a black arrow pointing to the lower left side and has a pair of yellow lights. One flashes when a pedestrian is about to enter the crosswalk and both yellow lights flash when the pedestrian is in the crosswalk. The motorist should be alert prepared to stop when he sees the single light and completely stop prior to entering the crosswalk when both lights are flashing. In the later case he should remain stopped until the crosswalk is clear.
2a	Assumed side of flashing light to have meaning	RRFB	59	RRFBs have an arrow pointing to the crosswalk with flashing lights on the upper left and upper right of the rectangle with the arrow. When both lights are flashing, the vehicle should stop to let pedestrians cross. When the light to the inside (near the street) is flashing, there is a pedestrian wanting to cross. The driver should exercise caution. When the outside light is flashing, the driver should exercise caution but may pass through if there is not a pedestrian in the cross walk.
2a	Assumed side of flashing light to have meaning	RRFB	23	That is uses two lights underneath the pedestrian sign. Based on the combo of light depends on whether you should stop or not. Left light means be ready to stop, 2 lights means stop, and the right light means keep going.
2a	Assumed side of flashing light to have meaning	RRFB	36	The beacon is in the shape of a yellow rectangle with black outline and drawing. When the left light is illuminated, a driver is to slow down and prepare for someone to enter the crosswalk. When both lights are illuminated, a driver is to stop and let the pedestrian(s) complete their walk across the crosswalk. When the right light is illuminated, the driver is clear to proceed with driving as usual through the crosswalk.

2a	Assumed side of flashing light to have meaning	RRFB	79	The photos are too small; it's difficult to see what they would look like in real life. From what I could tell, when nothing is happening the light on the right is on (maybe green light, or a green frame around the light??). When you are going to need to stop, the light on the left (red? red frame?) either goes 'on' or flashes?? Not sure. Stop when both lights are flashing or when pedestrian is in crosswalk. The photo seems to show the lights 'on' -- I suppose there's no way to show them actually flashing. I really didn't think the photos were very good/explanatory. Room for improvement there.
2a	Assumed side of flashing light to have meaning	RRFB	33	The RRFB is a signal under the pedestrian walk sign that will alert you when a pedestrian wants to cross and when the pedestrian is crossing. It seems to work by showing one constant light if a pedestrian wants to cross, in which case you stop and let him or her cross or it shows two blinking lights, in which case the pedestrian is crossing now and you need to stop your car.
2a	Assumed side of flashing light to have meaning	RRFB	57	The RRFB was an addition below a Pedestrian Crossing sign. There were two lights above a downward pointing arrow. The arrow indicated where the crosswalk was located. When the left-most (streetside) light was lit or flashing, we are being told that a pedestrian is waiting to cross. When both lights are lit or flashing, they are crossing. We are supposed to stop appropriately to allow crossing.
2a	Assumed side of flashing light to have meaning	RRFB	36	The sign is a yellow diamond with two flashing lights below it.\\When the left light flashes, pedestrians want to cross I should be prepared to stop. When both lights are flashing, the pedestrians are crossing. When the lights are off and the road is free of pedestrians, I am free to drive through.

2a	Assumed side of flashing light to have meaning	RRFB	60	The sign warns if a pedestrian wants to use the crosswalk. One flashing light means prepare to stop and two means stop for pedestrian. The driver can proceed when the crosswalk is clear
2a	Assumed side of flashing light to have meaning	RRFB	85	Two rectangular lights; if left is flashing, use caution. If both are flashing, stop. If right is steady, ok to continue.
2b	Assumed side of flashing light to have meaning	RRFB	64	I believe the signal was located underneath the diamond shaped sign with a picture of a pedestrian located in the sign. The signal I think consisted of two rectangles which would light up while a pedestrian was in the crosswalk. The left light would blink when the pedestrian was directly in the crosswalk and the right light would blink when the pedestrian was either approaching or through the crosswalk.
2a	**Traffic control device detects objects**	RRFB	56	The RRFB is located below a sign for Pedestrian Crossing. Motorists should slow down and use caution when approaching the sign. When a pedestrian is at the sign or anywhere in the crossing lane, the rectangles will flash. This will notify motorists to stop. When the crossing lane is clear, the sign will not flash and it is safe to drive through.
2c	**Traffic control device detects objects**	FYA	88	pro: detects objects might not be aware of cons: Can develop a reliance in the device so you quit looking for your self
2c	**Traffic control device detects objects**	FYA	88	Yes the device will detect objects that you might have missed