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Complementary and competitive framing of driverless cars: framing effects, attitude volatility, or attitude resistance?

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Abstract

This study answers two research questions regarding framing theory. First, what happens when frames are challenged? Second, how resistant are the opinions that initial frames induce? 1,006 participants completed an online experiment where they were randomly assigned to first view a blog post with either complementary or competitive framing on driverless cars. Participants also viewed a blog post that challenged the stance of the first blog post. Results revealed that complementary frames polarized opinions, while competitive frames neutralized framing effects. Competitive frames induced more resistant opinions than complementary frames did. Attitude and support were susceptible to new, antagonistic information. This study concludes that framing effects are ephemeral and easily challenged by different information.

Media coverage of controversial issues from technology trends like driverless cars to political issues like elections are often multi-faceted, showing both complementary and competing frames of such issues. The framing literature has extensively examined how exposure to a single frame can shape attitudes (Cacciatore, Scheufele, & Iyengar, 2016), without considerations for how simultaneous exposure to two or more frames might shape attitudes (e.g., Borah, 2011). Even fewer studies have explored how exposure to different, competing information would alter attitudes (de Vreese, 2012). To realistically reflect the contemporary media environment, it is important to examine the effects of complementary and competing frames on public opinion. According to de Vreese (2012), an important question in framing studies require an answer: what happens when frames are challenged?

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This study aims to answer the question by examining how complementary and competitive frames might shape opinions. Considering the abundance of information online, exposing participants to two emphases frames simultaneously emulates a more realistic situation compared with exposing participants to only one frame. Another major question in framing research pertains to: how durable are framing effects? (Baden & Lecheler, 2012). Although most studies attempt to answer this question by testing how long framing effects persist in a longitudinal sense (e.g., Chong & Druckman, 2012; Lecheler & de Vreese, 2011), this study interprets this question as whether framing effects can persist in the face of different information. To answer this question, this study exposes participants to a second stimulus that presents different information to participants to explore how opinions will change when challenged. Specifically, applying framing theory and cognitive dissonance theory, this study examines framing effects and the durability of these effects caused by the different types of frames on attitudes toward driverless cars and support for driverless cars. Further, as the theory of cognitive dissonance (Festinger, 1957) posits that individuals with formed opinions might ignore different information that contradicts their current beliefs, this may make framing effects very durable. Alternatively, individuals might ignore existing beliefs in the face of different information, hence making framing effects ephemeral.

This study uses the context of driverless cars in Singapore to examine framing effects. Policymakers and scientists have forecasted that the widespread use of driverless vehicles can reduce traffic accidents by eliminating human error (Miles, 2018) and alleviating traffic congestion (Autonomous Vehicles, 2019). Further, driverless vehicles are more efficient in fuel consumption which helps to protect the environment (Worland, 2016). However, driverless cars may also eliminate delivery jobs and fail to react spontaneously to unexpected events (Miles, 2018). The presence of supportive and opposing arguments for driverless cars makes it a suitable context for framing studies.

It is also timely to examine the different strategies to communicate about driverless cars to the Singapore public. From year 2022, three areas in Singapore will be ready to include driverless vehicles as a daily commuting option (Lim, 2017). In 10–15 years, the Singapore government expects self-driving technology to be ready for widespread application (Cheah, 2017). Hence, this study will provide insights on the best practices that stakeholders can employ to communicate about driverless cars to the public.

Studying both attitude and support allows this study to evaluate the degree to which framing can shape opinions. According to the hierarchy of effects, there are three categories of behavior in increasing levels of involvement (Chen & Yang, 2008). The first category with the lowest level of involvement is the cognitive phase, where individuals gain awareness and knowledge of an issue. The second category with a moderate level of involvement is the affective phase, where individuals decide if they like or dislike a product or an issue. The third category with the highest level of involvement is the conative phase, where individuals have a desire to perform a behavior or to carry out an actual behavior. Attitude and support belong to different phases and indicate different levels of involvement.

An attitude is an evaluation of an issue (Eagly & Chaiken, 1993) that motivates behavior (Fazio, 1990). Attitudes are either positive or negative (Ajzen, 1991), representing overall like or dislike of an issue. On the other hand, support requires considerations beyond whether individuals like or dislike an issue as support contains behavioral elements (Dreyer, Polis, & Jenkins, 2017). Attitudes are classified under the affective

phase, which represents a moderate level of involvement; support is categorized under the conative phase (Palda, 1966). Overall, support indicates a higher level of involvement than attitudes, as seen by how attitudes are considered a precursor of support (Prayag, Hosany, Nunkoo, & Alders, 2013). Hence, even if framing effects can shape attitudes, these effects might not be strong enough to shift support. Indeed, scholars have called for future studies to delineate attitude and support when examining framing effects (Detenber, Ho, Ong, & Lim, 2018). Nonetheless, some scholars argue that support is a type of attitudinal outcome, as individuals can support an issue without acting on it (e.g., Whitmarsh, 2009). Hence, another objective of this study is to compare whether framing affects attitudes and support differently.

Complementary and Competitive Framing

Framing refers to selecting some aspects of an issue and making these aspects more salient in society (Entman, 1993). Framing is a communication technique that occurs naturally—when informing the public about an issue, communicators often need to present selected aspects of an issue or highlight certain aspects over others. Frames highlight the essence of an issue (Gamson & Modigliani, 1989) and guide individuals' orientations and conceptualizations of an issue (Chong & Druckman, 2007).

Each frame comprises a frame emphasis and a frame direction. A frame emphasis refers to the aspect of an issue being discussed or highlighted (Detenber et al., 2018). Frame direction refers to the stance toward the issue that the frame adopts. Frame directions can be positive or negative, with positive frame being supportive of an issue and negative frames being antagonistic of an issue. Framing studies that exposed participants to a single frame revealed that positive frames improved attitude and support for an issue, whereas negative frames worsened attitude and support for an issue (Lecheler & de Vreese, 2011). These findings suggest that exposure to a single frame can successfully sway opinion of an issue.

However, to reflect reality, framing studies should examine how simultaneous exposure to more than one frame might shape attitude and support (Nisbet, Hart, Myers, & Ellithorpe, 2013), especially in the age of the Internet. Most people turn to online sources as their first and main information source (Ho, Leong, Looi, & Chuah, 2019). Without the space restrictions that used to constrain traditional media sources (Wilding, Fray, Molitorisz, & McKewon, 2018), online sources can simultaneously expose individuals to multiple frames. Unfortunately, relatively few studies have explored how simultaneous exposure to multiple frames shapes attitudes (Borah, 2011; Chong & Druckman, 2007).

When there is more than one frame in a single exposure, frames can be either complementary or competing (Wise & Brewer, 2010). Complementary frames have different frame emphases but have the same frame direction. That is, complementary frames involve using two or more aspects of an issue to present only reasons to support or reasons to oppose an issue (Wise & Brewer, 2010). On the other hand, competitive frames can have the same or different frame emphases, but the frames have different frame directions (Wise & Brewer, 2010). Competitive frames present one or more aspects of an issue, and one frame might be positive, whereas the other is negative. When viewing competitive frames, individuals view reasons to both support and oppose an issue.

Overall, complementary frames unanimously promote one issue stance, whereas competitive frames present both pros and cons of an issue.

A few studies have simultaneously examined the framing effects of complementary and competitive frames. The findings in these studies are consistent. Complementary frames polarize attitudes and support, whereas competitive frames neutralize attitude and support (Wise & Brewer, 2010). For example, Detenber et al. (2018) found that complementary frames that emphasize anticlimate action resulted in unfavorable public attitudes toward proenvironmental behaviors and green energy technologies, compared with competitive frames. Similarly, Aklin and Urpelainen (2013) demonstrated that the effects of the original frames on public support for clean energy policy can be undermined by counter frames. These findings suggest that complementary frames enhance the strength of framing effects of single frames by having an additive effect. On the contrary, competitive frames challenge each other and cancel out each other's framing effects to produce relatively neutral evaluations of an issue, especially when the frames have comparable argument strengths (Borah, 2011).

H1: Complementary pro frames will produce more favorable attitudes toward driverless cars than competitive frames.

H2: Complementary anti frames will produce less favorable attitudes toward driverless cars than competitive frames.

RQ1: How will the effects of complementary and competitive frames differ in terms of attitude and support?

Lasting or Ephemeral Framing Effects

In the face of different information, how resistant are the opinions that initial frames induce? Past frames can make individuals react to new frames in different ways. Scholars have found that individuals tend to be dismissive of different information that does not align with their prior beliefs (Ribeiro, Calais, Almeida, & Meira, 2017), even viewing the different information to be biased (Druckman & Bolsen, 2011). If past frames shape individuals' beliefs, then exposure to different frames should not bring about significant changes in attitudes and support. That is, opinions formed through exposure to past frames should be resistant in face of different frames. However, another possibility is that different frames will "overwrite" the effects of past frames, as the former exert their own framing effects. If so, attitudes and support will shift according to the direction of the new frame. In this case, framing effects are volatile and easily challenged by different information.

Given that the Internet has spurred the era of information overload (Berghel, 1997), it is unlikely that individuals will only view one article about an issue. Hence, it is vital to understand how opinions change after exposure to different frames. Furthermore, the digital media landscape has also created ideological echo chambers, in which people can either be passively exposed to value-congruent information or actively select information that confirm their prior beliefs (Dylko et al., 2017; Spohr, 2017). The information shown on people's social media accounts or results from search engines are often based on their prior behaviors or preferences (DeVito, 2016; Dylko et al., 2017). Such self-segregating online news use can be a way for people to align their cognitions.

According to the cognitive dissonance theory (Festinger, 1957), individuals seek to keep their opinions, knowledge, attitudes, and behaviors consistent. Such elements are examples of cognitions. Festinger (1957) proposed that an individual possessing any two inconsistent cognitions will experience dissonance, which is associated with psychological discomfort. The presence of dissonance thus motivates the individual to relieve the discomfort by minimizing inconsistency or achieving consistency between the cognitions. Festinger (1957) suggests that as the magnitude of the dissonance increases, individuals will face greater psychological discomfort, which provides them greater motivation to reduce the dissonance.

There are few framing studies that explicitly tested for the effects of cognitive dissonance. Prunty and Apple (2013) found that individuals were more receptive of messages framed in a manner that was in line with their prior beliefs. Another study by Dardis et al. (2008) found that individuals were receptive of differing information and would adjust their opinions according to the new information only if the new information did not contradict their core beliefs and values. These studies suggest that earlier framing effects might shape opinions to a certain degree, and these opinions might be resistant to different information that challenges individuals' core beliefs. That is, earlier framing effects can be very durable, especially if earlier frames help to shape individuals' core beliefs.

Yet, if the different information introduces new frames of thought that individuals did not previously consider, they may ignore existing beliefs and may change their opinion. Studies have shown that attitudes are less stable and less well-established for newer technologies than conventional technologies, suggesting that attitudes for novel, unfamiliar technologies might be sensitive to changes (Feindt & Poortvliet, 2020; van Giesen, Fischer, & van Trip, 2018). Extending this notion to this study, individuals may not hold stable attitudes toward a novel technology like driverless cars, and as such, different information could change their attitudes toward driverless cars. As mere exposure to frames in the media have been shown to shape attitudes, even after accounting for individuals' differences in motivated attention to news (Shehata, 2014), further investigations about whether attitudes may change in the face of different information are warranted. This study posits:

H3: After initial exposure to complementary frames, participants' attitudes toward driverless cars will change when they are exposed to a different frame that challenges the original frames.

Unlike complementary frames, the framing effects of competitive frames are weaker (Detenber et al., 2018), and therefore, the induced attitude among individuals is also likely to be weaker or that the individuals may not have an opinion (undecided). Competitive frames proactively present individuals with reasons to support *and* oppose an issue. In other words, after viewing competitive frames, individuals form their opinions while considering both pros and cons to an issue and are aware of the presence of conflicting opinions. To form an opinion, individuals may already have attempted to reduce their dissonance (Compton & Pfau, 2005). Therefore, even though competitive frames are expected to initially induce relatively neutral or undecided opinions, these opinions are likely to be less volatile.

H4: After initial exposure to competitive frames, participants' attitudes toward driverless cars will change when they are exposed to a different frame that either supports or opposes driverless cars.

Context of Study: Driverless Cars in Singapore

As a city-state with an estimated population size of 5.7 million people (Department of Statistics Singapore, 2020), Singapore's car ownership rate is roughly 11%, with nearly one million vehicles on Singapore's roads (BBC News, 2017). The total vehicle population in Singapore has shrunk over the years, and majority of the residents rely on public transport for their daily commute (BBC News, 2017). In 2019, a report by KPMG ranked Singapore top in Asia and second in the world in its readiness to adopt driverless vehicles (Abdullah, 2019). The western part of Singapore has become an expanded testing ground for autonomous vehicles (Abdullah, 2019). As a country that has the third highest population density in the world, driverless vehicles could reduce the numbers of private vehicle owners and by doing so reduce congestion and air pollution (Lago & Trueman, 2019). Implementation of driverless vehicles could reduce the cost of transportation and improve access for sectors of the community such as the elderly and the disabled (Smart Nation Singapore, 2020).

However, public acceptance of driverless cars can be eroded by potential accidents that involve the vehicles. Media coverage of driverless cars is an important factor that can shape public perception (Ho, Leow, & Leung, 2020). A content analysis of Singapore's most widely read newspaper outlet, *The Straits Times*, revealed that safety, economic, and personal data usage were the most salient frames that shaped the discussion of driverless cars (see Supplementary Appendix SC). As these predominant frames also highlighted supportive and opposing arguments, this study used the prosafety (S+), antisafety (S−), proeconomy (E+), antieconomy (E−), prodata usage (D+), and antidata usage (D−) frames in the stimulus design. The findings from this study may be generalizable to other major cities in the world that are planning to adopt driverless cars.

Method

Upon obtaining ethical approval from the University's Institutional Review Board, Qualtrics, a research company, was hired to disseminate the online experiment to their online panel between August and October 2018. Participants who passed both attention check questions and completed the experiment were awarded points that could be exchanged for gifts. This study recruited 1,006 Singaporeans and Permanent Residents aged 21 years and above, attaining a response rate of 37.5%.

Sample

Among the 1,006 participants, 50.0% were males and 50.0% were females. The median age of the sample was 41.0 ($M = 41.6$, SD = 12.8). The median household income bracket was S$6,000—S$6,999 and the median education level attained was a Bachelor's degree or equivalent. In terms of ethnic distribution, 88.2% were Chinese, 5.9% were Malay, 3.8% were Indian, and 2.1% were of other ethnicities.

Experimental Design and Procedure

There were three components to the experiment. Participants had to complete all three components for their responses to be valid and included for analysis. Upon successful completion of the study, participants were redirected to a debrief screen that explained to them the real purpose of the study. For the first component, participants were randomly assigned to one of six framing conditions (framing: S + E+ vs. S− E− vs. S + S− vs. E + E− vs. S + E− vs. S− E+). This was a between-subjects design, in which in each condition, participants viewed a blog post that used one of the framing conditions in the driverless cars context. Participants then indicated their attitude and level of support for driverless cars. After which, participants answered an attention check question, asking which frames the blog post discussed ("*Which of the following issues does this blog post discuss?*"). We excluded participants who did not answer the attention check question correctly in the data analysis. Eventually, each condition had between 166 and 169 valid responses.

For the second component, all participants had to complete a series of riddles that served as a distraction from the main framing task. This distraction serves to increase external validity of the experiment as individuals often become distracted from their main online task. All participants viewed a second blog post that either supported or opposed driverless cars. Participants in the competitive framing conditions viewed a second blog post that challenged the stance of the first blog post they viewed. We divided participants in each competitive framing conditions into two subconditions: one subcondition viewed a supportive second blog post, the other viewed an unsupportive second blog post. Altogether, there were 10 conditions in the second part of the experiment (framing: S + E+/D− vs. S−E−/D+ vs. S + S−D+ vs. S + S−/D− vs. E + E−/D+ vs. E + E−/D− vs. S + E−/D+ vs. S + E−/D− vs. S−E+/D+ vs. S−E+/D−). Participants then reported their final attitude and support for driverless cars and answered a second attention check question about which frame the blog post discussed. We removed participants who provided inaccurate answers to the attention check question from the analysis. The complementary framing conditions (S + E+/D− and S−E−/D+) had 167 and 168 participants respectively; each of the competitive framing conditions (S + S−/D+ vs. S + S−D− vs. E + E−/D+ vs. E + E−/D− vs. S + E−/D+ vs. S + E−/D− vs. S−E+/D+ vs. S−E+/D−) had 83–85 participants. Supplementary Appendix SB presents the participant distribution in the experiment.

Stimuli: Blog Posts

Each participant first viewed a blog post comprising two frames on driverless cars. The frame emphases selected for this study were safety and economic frames. The second blog post comprised only one frame on driverless cars. The frame emphasis selected for this blog post was on the use of personal data. These three frames were selected as they are salient frames in the discussion of driverless cars. These issues also have salient arguments that supported or opposed the development of driverless cars. Using frames salient in society further increased the ecological validity of the study. All the frames used the same number of words. Supplementary Appendix SA explains the pretest procedure and the exact wordings for each frame.

Measures

We created composite variables after ensuring high internal consistency among items.

Attitude towards driverless cars. Participants answered five 5-point semantic differential scale items measuring attitude toward driverless cars before the start of the experiment and after viewing each blog post. Participants answered if they thought that driverless cars were bad/good, foolish/wise, unpleasant/pleasant, useless/useful, dangerous/safe (adapted from Payre, Cestac, & Delhomme, 2014). Higher scores indicate more positive evaluations of driverless cars ($M = 3.31$, $SD = 0.92$, *Cronbach's* $\alpha = .95$).

Support for driverless cars. Participants answered three 5-point Likert scale items measuring their support for driverless cars. The three items are, "I support the use of driverless cars," "I support government funding for the development of driverless cars," and "I prefer driverless cars over cars that require a human driver." The items were adapted from Haboucha, Ishaq, and Shiftan (2017). A higher score reflects greater support for driverless cars ($M = 3.24$, $SD = 0.98$, *Cronbach's* $\alpha = .88$).

Manipulation check: tone of blog post. Participants indicated if they felt the overall tone of the blog post was very negative, negative, neutral, positive, or very positive toward driverless cars. This item was adapted from Ferguson and Gallagher (2007). A higher score indicates that the blog post adopted a more positive tone toward driverless cars.

Manipulation check: strength of argument. Participants indicated the perceived strength of each frame using a single 5-point Likert scale item ("*What was the strength of the argument in the blog post with regard to,... [insert frame that participant viewed]*"). Altogether, participants answered three items, measuring the argument strength of the three frames they viewed. We created this item for this study.

Results

To test the hypotheses and research questions, SPSS version 25 was used to conduct a series of one-way Analysis of Covariance (ANCOVA) tests, Analysis of Variance (ANOVA) tests, and generalized linear models. Argument strength was added as a control variable to the analyses to ensure that the findings can be attributed to framing effects, rather than different argument strengths.

Manipulation Checks

Initial attitudes and support. An ANOVA analysis was conducted to test if initial attitudes and support differed significantly across groups. Results revealed that attitudes ($F\,[5, 1{,}000] = 0.77$, $p > .05$, $\eta p^2 = 0.07$) and support ($F\,[5, 1{,}000] = 1.01$, $p > .05$, $\eta p^2 = 0.07$) did not significantly differ across groups. Hence, differences in attitudes and support after viewing the blog posts can be attributed to the frames, rather than differences in initial opinions.

Tone of blog post. For the first blog post, participants perceived a significant difference in the tone of the blog post across framing conditions (F [5, 1,000] = 10.5, $p < .001$). Post hoc Tukey HSD tests revealed that the tone of prodriverless cars complementary frames was significantly more positive ($M = 4.18$, $SD = 0.71$) than that of antidriverless cars complementary frames ($M = 2.23$, $SD = 0.91$) and all four competitive frames (S + S−: $M = 3.13$, $SD = 0.88$; E + E−: $M = 2.98$, $SD = 0.90$; S + E−: $M = 3.42$, SD = 0.88; S−E+: $M = 3.18$, $SD = 0.86$). Further, the tone of antidriverless cars complementary frames was significantly more negative than that of all four competitive frames. Participants also perceived that the tone of the positive and negative second blog post were significantly different (F [1, 1,002] = 640.6, $p < .001$). Participants indicated that the D+ frame ($M = 3.66$, $SD = 0.82$) was more positive in tone than the D− frame ($M = 2.34$, $SD = 0.84$).

Argument strength. Argument strengths across the four frames in the first blog post were similar (S+: $M = 3.44$, $SD = 0.97$; S−: $M = 3.52$, $SD = 0.97$; E+: $M = 3.41$, $SD = 1.03$; E−: $M = 3.64$, $SD = 0.97$). For the second blog post, the positive frame had a weaker argument strength ($M = 3.13$, SD = 0.99) than the negative frame ($M = 3.79$, $SD = 0.92$). This difference was significant t (1,004) = 10.8, $p < .01$. Due to the differences, argument strength was added as a control variable in the analyses.

Complementary Versus Competitive Frames

After controlling for the strength of arguments in the blog post, there was a significant framing effect on attitudes (F [5, 1,005] = 14.8, $p < .001$, $\eta p^2 = 0.07$) and support (F [5, 1,005] = 5.5, $p < .001$, $\eta p^2 = 0.03$) for driverless cars. Simple comparison of adjusted means suggest that participants exposed to the complementary proframes had the most favorable attitude toward driverless cars and were most supportive of driverless cars (Attitude: $M_{S+E+} = 3.61$; Support: $M_{S+E+} = 3.38$). On the other hand, participants exposed to the complementary antiframes had the least favorable attitudes toward driverless cars and were least supportive of driverless cars (Attitude: $M_{S-E-} = 3.10$; Support: $M_{S-E-} = 3.13$). The competitive frames induced relatively neutral attitudes toward driverless cars ($M_{S+S-} = 3.33$; $M_{E+E-} = 3.42$; $M_{S+E-} = 3.44$; $M_{S-E+} = 3.15$). Similarly, competitive frames induced relatively neutral support for driverless cars ($M_{S+S-} = 3.36$; $M_{E+E-} = 3.32$; $M_{S+E-} = 3.25$; $M_{S-E+} = 3.15$). However, the S−E+ frame induced the least favorable attitude and least support among the competitive frames, almost similar to that of the anticomplementary frame. Figures 1 and 2 present the mean scores of attitudes and support for driverless cars across the six frame types.

Closer inspection through post hoc comparisons with Bonferroni adjustments revealed that complementary proframes induced significantly more favorable attitudes than complementary antiframes ($p < .001$) and two of the competitive frames conditions. Specifically, the S + S− ($p < .01$) and S−E+ ($p < .001$) conditions induced significantly less favorable attitudes than the S + E+ condition. Complementary proframes did not induce attitudes that were significantly more favorable than the E + E− and S + E− conditions ($p > .05$). Complementary antiframes induced significantly less favorable attitudes than the S + S− ($p < .01$), E + E− ($p < .001$), and S + E− ($p < .001$) conditions. However, complementary antiframes did not induce

Figure 1.
Simple comparison of adjusted means for attitudes toward driverless cars across the six frames typologies with 95% CIs (N = 1,006). Note. *Numbers on the y-axis are partially displayed.*

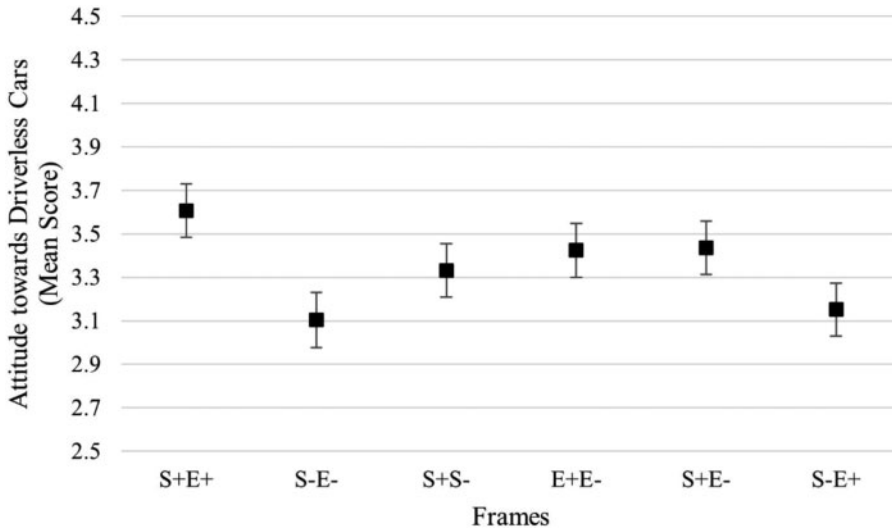
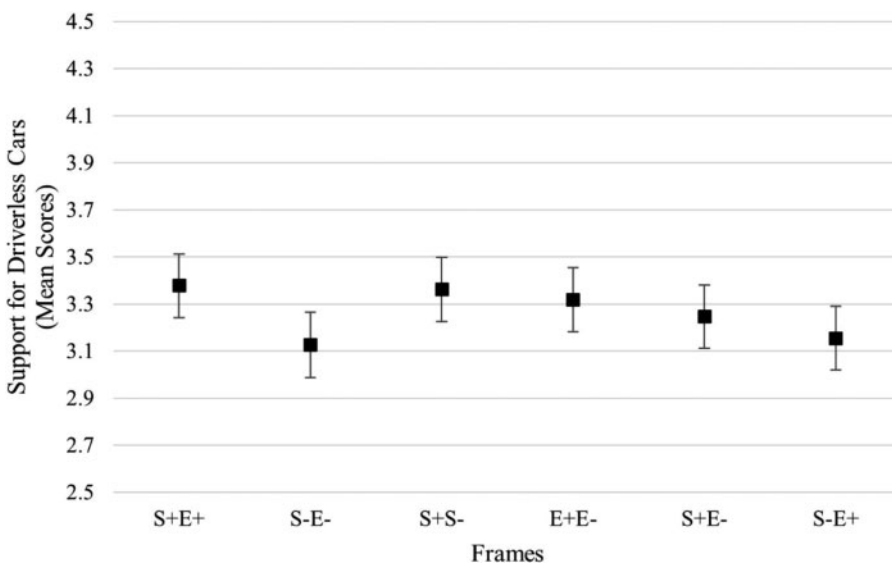


Figure 2.
Simple comparison of adjusted means for support for driverless cars across the six frames typologies with 95% CIs (N = 1,006). Note. *Numbers on the y-axis are partially displayed.*



attitudes that were significantly less favorable than the S−E+ condition ($p > .05$). Hence, the results partially supported *H1* and *H2*.

To answer *H3*, we also compared support for driverless cars across the framing conditions. Framing effects were less distinct for the support outcome. Post hoc comparisons with Bonferroni adjustments revealed that complementary proframes induced significantly more support than complementary antiframes ($p < .001$). However, complementary proframes did not induce significantly different levels of support from all four competitive frames ($p > .05$). Complementary antiframes induced significantly less favorable attitudes than all other conditions (S+S−: $p < .01$; E+E−: $p < .01$; S+E−: $p < .05$), except the S−E+ condition ($p > .05$). Hence, answering *H3*, the results suggest that support was less susceptible to framing effects than attitudes.

Test of Attitude Resistance

Repeated measures ANCOVAs were used to analyze how complementary and competitive frames protect attitudes and support from the framing effects of new information. Argument strength was included as a covariate to control for its effects. There was a significant interaction between time and framing condition for attitudes ($F[9, 995] = 22.1$, $p < .001$, $\eta p^2 = 0.17$) and support ($F[9, 995] = 7.03$, $p < .001$, $\eta p^2 = 0.06$).

Answering *H3*, participants first exposed to complementary proframes had significantly less favorable attitudes and lower levels of support after viewing a negative second blog post ($M_{S+E+} = 3.59$, $M_{D-} = 3.07$, $p < .001$). Similarly, participants first exposed to complementary antiframes had significantly more favorable attitudes and higher levels of support after viewing a positive second blog post ($M_{S-E-} = 3.10$, $M_{D-} = 2.94$, $p < .001$). Hence, the results suggest that after viewing complementary frames, attitudes can significantly change according to the direction of the different frame.

Answering *H4*, six of the eight competitive frames conditions also revealed significant changes ($p < .05$) in attitudes when participants viewed a second blog post ($M_{S+S-} = 3.36$, $M_{D+} = 3.62$; $M_{S+S-} = 3.15$, $M_{D-} = 2.94$; $M_{E+E-} = 3.24$, $M_{D-} = 2.86$; $M_{S+E-} = 3.32$, $M_{D-} = 2.97$; $M_{S-E+} = 3.23$, $M_{D+} = 3.45$; $M_{S-E+} = 2.99$, $M_{D-} = 2.81$). The two conditions that did not cause a significant change in attitudes both involved participants viewing the stimulus that was prodriverless cars ($M_{E+E-} = 3.48$, $M_{D+} = 3.45$; $M_{S+E-} = 3.63$, $M_{D+} = 3.59$). Answering *H4*, the findings suggest that attitudes are typically volatile, and are generally vulnerable to the most recent framing effects. Figure 3 presents the pairwise comparisons for attitudes after viewing the blog posts.

To further provide data to answer the research questions, a repeated measures ANCOVA with support as the behavioral outcome was conducted. A similar pattern for support and attitude was observed, although support was more resistant than attitude. Participants who first viewed complementary proframes significantly lowered their level of support when they viewed the second, negative post ($M_{S+E+} = 3.38$, $M_{D-} = 3.20$, $p < .001$). Similarly, participants who first viewed complementary antiframes significantly heightened their level of support when they viewed the second, positive post ($M_{S-E-} = 3.11$, $M_{D+} = 3.24$, $p < .001$). However, for competitive frames, support significantly shifted toward the direction of the second blog post for only three of the eight conditions. Conditions that successfully induced a shift ($p < .05$) in support involved exposing participants to a second blog post that was antagonistic of driverless cars ($M_{E+E-} =$

Figure 3.
*Comparisons of adjusted means for attitudes toward driverless cars across 10 sets of frames combinations, with 95% CIs (*N = *1,006).* Note. *Numbers on the y-axis are partially displayed. Black boxes denote significant differences (*p < *.05) between pairs of frames at time 1 and time 2 (e.g., S + E+/D−). Light gray boxes denote nonsignificant differences between pairs of frames at time 1 and time 2 (e.g., E + E−/D+).*

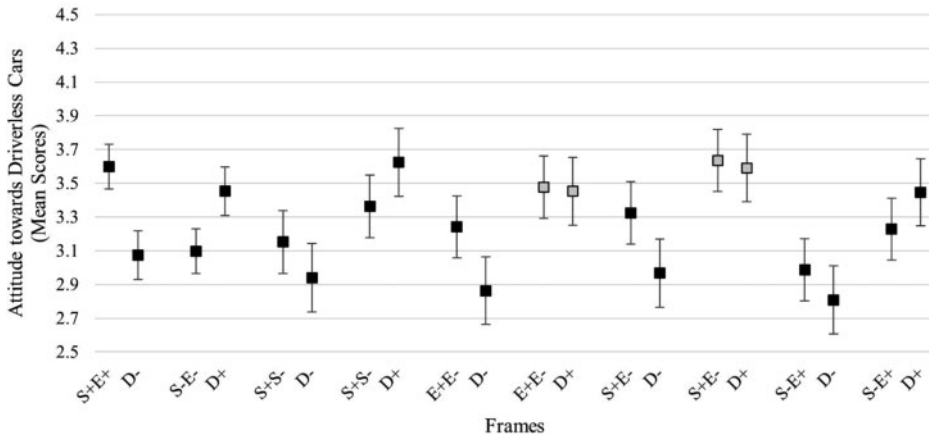
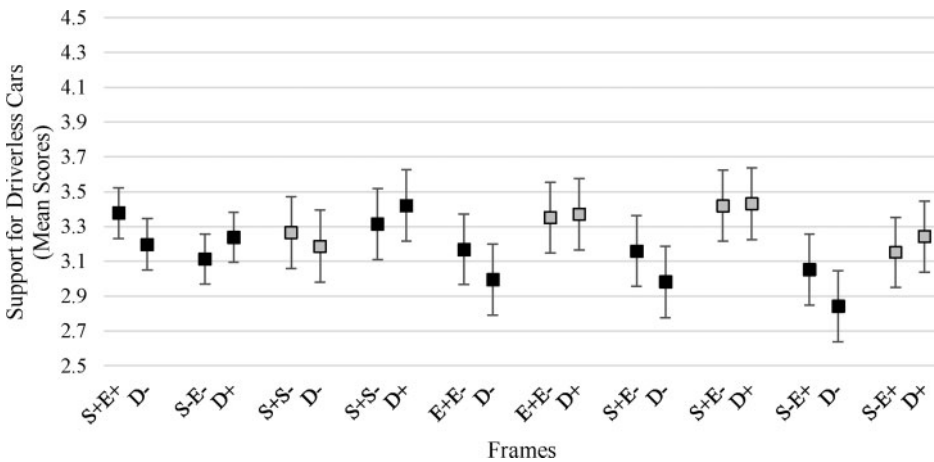


Figure 4.
*Comparisons of adjusted means for support for driverless cars across 10 sets of frames combinations, with 95% CIs (*N = *1,006).* Note. *Numbers on the y-axis are partially displayed. Black boxes denote significant differences (*p <*.05) between pairs of frames at time 1 and time 2 (e.g., S + E+/D−). Light gray boxes denote nonsignificant differences between pairs of frames time 1 and time 2 (e.g., S + S−/D−).*



3.17, $M_{D-} = 3.00$; $M_{S+E-} = 3.16$, $M_{D-} = 2.98$; $M_{S-E+} = 3.05$, $M_{D-} = 2.84$). Support for driverless cars were resistant (i.e., nonsignificant differences) in five of the eight competitive frames conditions ($M_{S+S-} = 3.31$, $M_{D+} = 3.42$; $M_{S+S-} = 3.27$, $M_{D-} = 3.19$; $M_{E+E-} = 3.35$, $M_{D+} = 3.37$; $M_{S+E-} = 3.42$, $M_{D+} = 3.43$; $M_{S-E+} = 3.15$, $M_{D+} = 3.24$). Answering *RQ1*, the results suggest that support is resistant and difficult to increase in the face of new positive information. However, support is generally volatile and easily declines in the face of new negative information. Figure 4 presents the pairwise comparisons for support after viewing the blog posts.

Discussion

This study aimed to achieve two research objectives. First, to test framing effects in a realistic situation by exposing participants to complementary or competitive frames pertaining to driverless cars. Such framing situations occur naturalistically and play different roles in shaping opinion over time. Second, this study aimed to test the limits of framing by examining how resistant framing effects are in the face of different competing information. With these objectives in mind, this study highlights three key findings. First, the findings attest to framing effects. Second, attitudes are volatile as different information can sway prior attitudes. Third, in the face of different competing information, support is more enduring than attitudes.

In the absence of different competing information, the findings revealed that complementary frames resulted in stronger attitudes and support. That is, complementary proframes induced the most favorable opinions of driverless cars, whereas complementary antiframes induced the least favorable opinions of driverless cars. Comparing opinions induced by complementary proframes and complementary antiframes, the findings from this study provide support for classic framing effects.

Further, a simple comparison of means revealed that competitive frames seemed to induce relatively neutral opinions, suggesting that positive frames tend to cancel out the framing effects of negative frames, and vice versa. Upon closer examination of the results, certain competitive framing conditions induced similar opinions as complementary frames.

Competitive frames comprise two or more frames using the same or different issue emphases. Previously, Detenber et al. (2018) found that opinions were similar regardless of whether competitive frames used the same or different issue emphasis. However, closer inspection of our findings seems to suggest that it is less about having one or two issue emphases, but more about the frame combinations.

Past framing studies found that many issues had frames that individuals valued above all other frames, labeled as chronically accessible frames (Cacciatore et al., 2016). Individuals are more influenced by arguments pertaining to these frames. A simple comparison of attitudes across the conditions revealed that all conditions with the antisafety frame (S + S−, S−E+, S−E−) induced less favorable attitudes toward driverless cars. This observation seems to suggest that in the context of driverless cars, safety messages have a stronger framing effect than economic messages. One major debate about driverless car that hinges on the use of artificial intelligence technologies lies in its limitation in making judgments at the intersections of human values, moral rights, ethics, and social norms (Cunneen, Mullins, & Murphy, 2019). Taking this to be a technological deficiency, critics highlighted that this may present new safety risks to users,

particularly in cases when traffic accidents are unavoidable (e.g., Lin, 2013). This could potentially explain why antisafety frames induced stronger framing effect than the other messages in this study.

When individuals viewed the antisafety and proeconomic frames, attitude and support were similar to that as when individuals viewed the complementary antiframes (Attitude: $M_{S-E+} = 3.15$; $M_{S-E-} = 3.10$; Support: $M_{S-E+} = 3.15$; $M_{S-E-} = 3.13$). It is plausible that the proeconomy frame backfired in the presence of the antisafety frame, as individuals might have perceived the blog post to justify a loss in safety for a gain in the economy. If individuals valued their safety more than a gain in the economy, they may feel that the post is appalling. This study suggests that the combination of issue emphases is more important than gauging whether the competitive frames have the same or different issue emphases.

The findings of this study showed that opinions are typically volatile. Attitudes are exceptionally susceptible to framing effects. Support was more resistant to framing effects than attitudes, but injection of different frames could still continuously alter support. Overall, this study found that it is overly simplistic to state that framing can motivate individuals to change their stance to match their prior attitudes to reduce cognitive dissonance. The results suggest that competitive frames did invoke individuals to change their attitude to reduce the undesirable state of dissonance, whereas complementary frames failed to invoke such behaviors.

Two reasonable speculations—inoculation theory and negativity bias—could potentially help to explain these findings. Inoculation theory is a tool to shield attitudes and behavioral intentions from future persuasive attacks (Dillingham & Ivanov, 2017). Inoculation theory suggests that a small dose of counterargument can immunize individuals from stronger arguments in the future (McGuire, 1964). Extending the inoculation theory into the framing context, competitive frames could have helped to inoculate individuals' opinions from different information, whereas complementary frames fail to induce an inoculation effect.

The finding that new negative frames can significantly alter both attitude and support, whereas new positive frames can only significantly shift attitude, suggests that negative frames can be more potent than positive frames. This could possibly be explained by a psychological phenomenon called negativity bias. Negativity bias is the notion that individuals pay more attention to negative events than positive events (Rozin & Royzman, 2001). Similarly, subjected to arguments with the same argument strength, individuals are likely to be more affected by the negative information than the positive information (Ito, Larsen, Smith, & Cacioppo, 1998). Extending this notion to this study, when confronted with conflicting information, individuals may be more affected by the negative information and err on the safe side. Individuals, in turn, adjust their attitudes rather than dismiss the negative information. Nonetheless, these are speculations that warrant further verifications.

This study conducted a simple comparison of the final attitudes and support across the conditions, as it attempts to find out which framing condition ultimately led to the most polarized opinions. The findings show that after exposure to two blog posts, initial exposure to competitive frames induced the most extreme attitudes. Initial exposure to complementary frames, on the other hand, induced relatively neutral attitudes and support. The most favorable attitudes were induced by the S + S−/D+ ($M = 3.62$) and S + E−/D+ ($M = 3.59$) conditions. The following conditions induced the most

negative attitudes toward driverless cars: S + E−/D− ($M = 2.97$), S + S−/D− ($M = 2.94$), E + E−/D− ($M = 2.86$), and S−E+/D− ($M = 2.81$). The complementary frames did not eventually induce extreme attitudes, but instead produced attitudes that were relatively neutral compared with the other framing conditions. The pattern was repeated for the support outcome variable with slight variations. Again, the complementary frames ultimately induced relatively neutral levels of support for driverless cars. Polarized levels of support were induced by initial exposure to competitive frames.

The findings from this study attested to traditional framing effects. However, these framing effects are not durable in the face of different information. Attitudes are volatile, readily shifting to align with different information. Support is more enduring than attitudes, except when the new information is antagonistic toward an issue. Taken together, it appears that framing effects on attitudes are typically ephemeral and easily challenged by different information. The abundance of information available in the contemporary media environment suggests that framing is unlikely to be effective in shaping long-term attitudes. Another contrasting scenario is also possible, where algorithms and selective exposure act to polarize opinions between fragmented audiences. Further, following the hierarchy of effects, framing effects might only be effective in shaping lower level outcomes that require less commitment. Framing effects are unlikely to significantly shape higher order outcomes such as behavioral intention and actual behavior. This study agrees with the claims that attitude and support should be examined in tandem, and that support is a more robust test of framing effects.

The stronger framing effects induced by safety messages also provide support that not all issue emphases exert the same influence on individuals, even after controlling for argument strength. Individuals are likely to perceive that certain aspects are more important than others in an issue. There is a possibility that certain frame emphases with weaker argument strengths might have stronger framing effects than other frame emphases with stronger argument strengths.

The findings from this study inform communication strategies. There is little value in trying to be the first to put out information about an issue. Instead, this study found that to reduce cognitive dissonance, individuals sway their opinions more often than they ignore differing information. Hence, it is more valuable to continuously provide small pieces of information to support a stance of an issue than to provide the public with one detailed write-up. Further, in the context of driverless cars, this study recommends stakeholders to emphasize safety considerations when discussing about driverless cars. Beyond the context of driverless cars, the findings emphasize the importance of knowing the issue emphases that are salient to different stakeholders. By highlighting arguments relevant to salient issue emphases, practitioners increase their chances of effective communication efforts.

Framing studies using experimental approach are often under scrutiny for not reflecting reality (Vliegenthart, 2012). This study attempted to overcome this potential limitation by using real frames and arguments available online to design our stimulus, making them more realistic. In addition, participants were exposed to more than one frame simultaneously and were presented new, competing information. This simulated realistic articles that often discuss more than one frame. Moreover, this study hosted the experiment online and designed the stimulus to look like blog posts. Hosting the stimulus online presents a more naturalistic environment for the participants compared with presenting the blog posts in the form of a paper stimulus in an experimental

setting. The more naturalistic environment allows greater generalizability of our findings to real-life settings.

Next, this study only used three issue emphases in the context of driverless cars. Although the selected three frames are salient in the discussion of driverless cars, many other frames exist. This study was unable to examine the complementary and competitive framing effects with all possible frame combinations (e.g., the data privacy frames could be used in stage 1 of the study and reserve either safety or economic frames in stage 2 of the study). Further, articles are not limited to two frames. Future studies can further develop this experiment by including more combinations of issue emphases and including more frames in a single stimulus. This study did not control for the influence of beliefs, prior attitude, or perceived familiarity regarding driverless cars on both public attitudes and support. As these factors may be potential confounds, future studies should include them as control variables in the analyses. Finally, issues around artificial intelligence technologies like driverless cars revealed human existential questions that may be more salient to people's core values and belief systems than other types of technological innovations. Hence, people's attitudes toward driverless cars may be relatively more stable compared with their attitudes toward other types of new unfamiliar technologies. Beyond what is examined in this study, future studies can compare complementary and competitive framing effects across various forms of technological innovations to further shed light on how frames can change attitudes under different circumstances.

Supplementary Data

Supplementary Data are available at *IJPOR* online.

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