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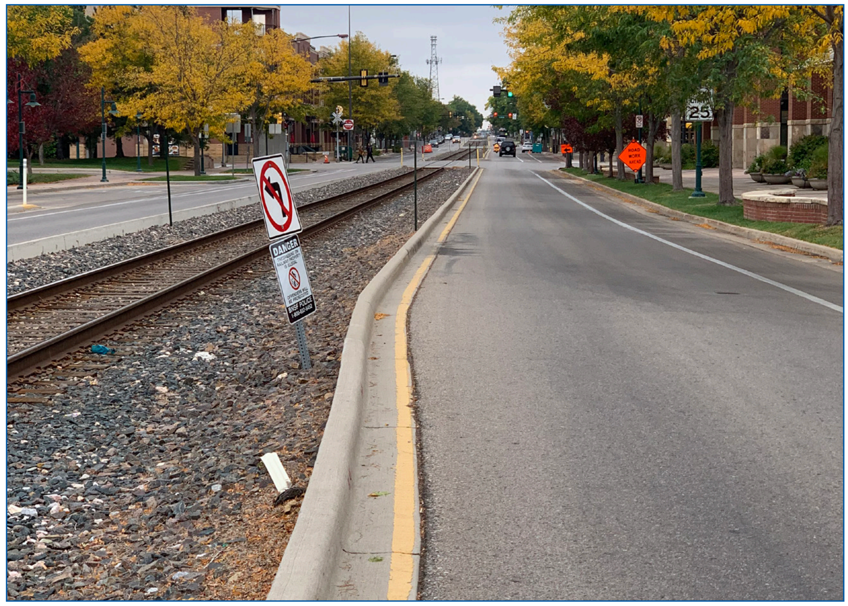
EFFECTIVENESS OF MITIGATION METHODS AND SIGNAGE IN REDUCING RAILWAY TRESPASSING EVENTS



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16. Abstract

Train-pedestrian conflicts result in a substantial number of serious and fatal injuries annually. Signs indicating safe and permissible behaviors near railroad rights-of-way are commonly relied upon to mitigate collisions. However, the effectiveness of these signs in preventing accidents depends on the clarity and interpretation of the sign. The objective of this study was to evaluate (1) the effectiveness of sign messaging strategies and designs, and (2) the effects of context and risk-taking on crossing decisions. A survey study (N=1,011) was conducted. Findings reveal that action-conveying and emotionally motivated signs are more effective in discouraging railroad crossing in high-risk situations compared with information-only signs. However, decisions to cross are primarily influenced by the presence of a train and the crossing gates' status, followed by sign type. MaxDiff analysis show that yellow signs with black symbols and square-shaped signs are perceived as the clearest in conveying safety information, compared with black on white, red on white, and circular signs. Individuals who cross railroad tracks as pedestrians more frequently exhibit higher risk-taking tendencies, while there is no relationship between driving across railroad tracks and risk-taking. These results can contribute to a deeper understanding of how different sign designs and messaging can enhance pedestrian safety and decision-making.

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Effectiveness of Mitigation Methods and Signage in Reducing Railway Trespassing Events

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Disclaimer

ABSTRACT

Train-pedestrian conflicts result in a substantial number of serious and fatal injuries annually. Signs indicating safe and permissible behaviors near railroad rights-of-way are commonly relied upon to mitigate collisions. However, the effectiveness of these signs in preventing accidents depends on the clarity and interpretation of the sign. The objective of this study was to evaluate (1) the effectiveness of sign messaging strategies and designs, and (2) the effects of context and risk-taking on crossing decisions. A survey study (N=1,011) was conducted. Findings reveal that action-conveying and emotionally motivated signs are more effective in discouraging railroad crossing in high-risk situations compared with information-only signs. However, decisions to cross are primarily influenced by the presence of a train and the crossing gates' status, followed by sign type. MaxDiff analysis show that yellow signs with black symbols and square-shaped signs are perceived as the clearest in conveying safety information, compared with black on white, red on white, and circular signs. Individuals who cross railroad tracks as pedestrians more frequently exhibit higher risk-taking tendencies, while there is no relationship between driving across railroad tracks and risk-taking. These results can contribute to a deeper understanding of how different sign designs and messaging can enhance pedestrian safety and decision-making.

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EXECUTIVE SUMMARY

This report investigates the impact of different sign messaging strategies and designs on pedestrian behavior at railroad crossings. Given that train-pedestrian collisions are a leading cause of rail-related fatalities globally, the study aims to evaluate the effectiveness of various sign types in preventing unsafe crossings. The research specifically explores how different messaging strategies (information-only, action-conveying, and emotionally motivated signs) and designs (various shape and color combinations) affect pedestrians' decision-making in various contexts, as well as the influence of individual risk-taking tendencies.

Three types of messaging strategies were evaluated: information only, action conveying, and emotionally motivated. These were selected based on an extensive literature review of signs currently deployed across the United States. The information only simply informed pedestrians of the presence of railroad tracks (e.g., "railroad crossing"). The action conveying further suggested the action that the pedestrian should take (e.g., "do not cross"). The emotionally motivated sign leveraged the pathos persuasive technique (e.g., "approximately every four hours, someone is struck at a highway rail grade crossing in the United States").

There were six unique sign design combinations evaluated: shape (circle or square) by color (black on yellow, black on white, and red on white). These were also selected based on an extensive literature review, with an emphasis on permissible sign designs as outlined in the Manual of Uniform Traffic Control Devices (MUTCD).

The study employed a survey methodology, collecting data from 1,011 participants across the United States who were recruited via a paid survey panel. The survey design included questions on participants' demographics, crossing behavior as both pedestrians and drivers, and their likelihood of crossing under different scenarios involving distinct sign types and contextual factors, such as the presence of a train or the status of crossing gates. Participants were also asked to evaluate the clarity and effectiveness of different sign designs using a MaxDiff analysis, which compared the perceived importance of various combinations of shapes and colors. Additionally, a risk-taking propensity score was calculated for each participant using an adapted version of the Domain-Specific Risk-Taking (DOSPERT) scale.

The results reveal that action-conveying signs (such as "Stop, Railroad Crossing" or "Do Not Cross") and emotionally motivated signs are generally more effective in discouraging pedestrian crossings in high-risk situations compared with information-only signs. Action-conveying signs were found to be particularly impactful when a train was present, while emotionally motivated signs elicited stronger responses when warning lights were flashing or gates were down. Conversely, information-only signs led to a higher likelihood of crossing when no train was present. The findings also show that participants' crossing decisions are primarily influenced by situational factors, such as the presence of a train or the status of crossing gates, over the type of signage.

The MaxDiff analysis of sign design effectiveness highlighted that black symbols on yellow backgrounds were perceived as the most effective in conveying safety information, while signs with black on white or red on white backgrounds were rated less favorably. The study further found that square-shaped signs were slightly more effective than circular ones. These results suggest that high-contrast colors and recognizable shapes play a crucial role in enhancing the visibility and interpretability of safety signs, supporting quicker and more accurate decision-making by pedestrians.

The discussion emphasizes that while action-conveying and emotionally motivated signs significantly influence pedestrian behavior, their effectiveness is context-dependent. For instance, these signs are more effective in scenarios where a train is present or crossing gates are down, but less so when no immediate risk is apparent. The study also reveals that individuals who frequently cross railroad tracks as pedestrians exhibit higher risk-taking tendencies, particularly younger adults and males. This suggests a need for targeted interventions that address the specific behaviors and perceptions of high-risk groups.

In conclusion, the report highlights the importance of using clear and directive signage, particularly action-conveying and emotionally motivated signs, to enhance pedestrian safety at railroad crossings. Recommendations for policymakers include prioritizing these types of signs in high-risk areas, conducting further research on optimizing sign placement and design, and implementing public education campaigns that target high-risk populations. The findings underscore the need for a multi-faceted approach to reducing train-pedestrian collisions, combining effective signage with broader safety measures and public awareness efforts.

Report Highlights:

- Survey study (N=1011) on sign messaging and design for pedestrian-rail crossings
- Action-conveying and emotionally motivated signs as more effective than information signs
- Square and black on yellow signs perceived as most effective in conveying safety
- Pedestrians who frequently cross railroad tracks exhibit higher risk-taking tendencies
- Relationship between likelihood to walk across tracks and risk-taking propensity

1. INTRODUCTION

There are more than 400 fatalities and a similar number of injuries annually in the U.S. due to trespassing railroad rights of way, for which most are preventable (FRA, 2021). Train-pedestrian collisions are the leading cause of rail-related deaths worldwide (Lobb, 2006). Compared with all types of rail crossing accidents and all types of pedestrian collisions, train-pedestrian collisions have the highest likelihood to result in fatalities and severe injuries (Lobb, 2006; Freeman and Rakotonirainy, 2015). Although trespassing along private railroad property outside of designated pedestrian crossings is illegal, many pedestrians believe trespassing to be safe and legal (Silla and Luoma, 2009). Moreover, pedestrians tend to illegally and/or unsafely cross tracks to take shortcuts or for purposes related to recreational activities (e.g., jogging, hunting, fishing, taking pictures) (Lobb et al., 2001; Silla and Luoma, 2009; FRA, 2021).

A distinction is often made between events where individuals intend to be hit by a train (i.e., suicides) and events where individuals are unintentionally struck by a train while illegally and/or unsafely crossing (i.e., accidents). Havarneanu et al. (2015) performed a meta-analysis on 139 publications to compare countermeasures aimed at reducing railway trespass and suicide and their effectiveness. The literature indicates that since train-pedestrian collisions are events with the same severe consequences, regardless of intent, the measures aimed at reducing accidents can also work for suicide, and vice versa (Radbo et al., 2005; Havarneanu et al., 2015).

Previous studies have investigated methods to mitigate the number of fatalities resulting from train-pedestrian collisions and improve safety at railroad crossings (Lobb et al., 2003; daSilva, 2013; Metaxatos and Sriraj, 2015; Freeman and Rakotonirainy, 2015; Larue et al., 2021). Mitigations have included active protection, improved warning and educational systems, signage, improved quality of the surfaces, and maintenance of the crossings (McPherson and Daff, 2005). Silla and Luoma (2009) found that fencing was the most effective in reducing the number of trespassers, followed closely by landscaping; both provided greater than a 90% reduction while prohibitive signs resulted in a 30% reduction. Control devices, such as passive signs, pavement markings, active bells, gates, flashing lights, and improved lateral clearance have also been explored (Keramatia et al., 2021; Easa et al., 2017). In general, adding one or more of these control devices to a crossing that already has one of these devices can reduce the likelihood of a crash occurring from 0.14% up to 0.25% (Keramatia et al., 2021). In a driving simulator study, Ma and Yan (2021) observed that improved signage and crossings with flashing lights together improved driver perception and performance.

In a study by Lobb et al. (2001), educational and environmental interventions were introduced to influence pedestrians to use an overpass rather than crossing the tracks illegally. The environmental interventions that limited the pedestrians' ability to cross the tracks were found to be more effective than the educational factors, and although the behavior had changed, the perception of the associated risk had not (Lobb et al., 2001). In another study by Lobb et al. (2003), high school boys were subjected to interventions in the forms of communication and education regarding unsafe crossing. Punishment and rewards were associated with unsafe and safe behavior, respectively, and these were mostly enforced. The punishments and rewards were found to be more effective than the education and communication countermeasures (Lobb, et al., 2003).

McPherson and Daff conducted a literature review (2005) and reported that the major contributing factors to pedestrian deaths at rail crossings were lack of awareness, entrapment, risk-taking, and deliberate collision activities. Further causes of train-pedestrian collisions, according to Read et al. (2016), include complication of the rail crossing system. Decision-making at rail crossings is not as straightforward as it may first appear, and there are many options, strategies, and influencing factors to be considered. It is questionable whether existing design processes cope with the complexity of rail crossing systems (Read et al., 2016). Similarly, Bazire and Tijus (2009) concluded that road sign decision-making is a significant factor contributing to the causes of roadway accidents.

Signage is often used as a solution for reducing railroad right of way trespassing or conveying unsafe crossing behaviors due to signs being considered practical and feasible (Sumwalt, 2019). However, signs may be more effective for attentive pedestrians and less so for those who are distracted while approaching a crossing (Larue et al., 2021). Further, the content and location of these signs often vary substantially and could benefit from road user validation of their intended meaning. Bazire and Tijus (2009) reported a significant deviation between legal and interpreted meanings of road signs, where in some cases no participants were able to accurately interpret a road sign meaning. As a result, behavior deviations occur when there is this mismatch between intended meaning and interpreted meaning, and simplification of the sign could reduce ambiguities, facilitate cognitive processing, and improve decision-making speed (Bazire and Tijus, 2009).

Although prior research has extensively studied the issue of train-pedestrian collisions and proposed numerous countermeasures, there remains a gap in the literature that specifically focuses on the efficacy of various sign messaging strategies at pedestrian-railroad crossings. Further, the role of context and risk-taking propensity in pedestrians' decision-making process at these crossings is not yet fully understood. Existing studies have examined interventions ranging from environmental modifications to education and communication programs. While these interventions have been found effective to varying degrees, the influence of sign messaging, which is a cost-effective and easily implementable solution, warrants more in-depth examination. Moreover, the interpretation and comprehension of these signs by pedestrians, particularly under different contexts and individual risk-taking propensities, are areas that remain underexplored.

This study, therefore, presents a unique contribution to the field by specifically focusing on the effectiveness of different sign messaging strategies at pedestrian-railroad crossings. We also explore how context (e.g., presence or absence of a train, the position of the crossing gate) and an individual's risk-taking propensity can influence their decision to cross railroad tracks. In doing so, our research complements the existing body of literature and addresses a critical gap by investigating not only the effectiveness of sign messaging strategies but also the role of context and individual differences in risk-taking. This detailed exploration will add to the understanding of how best to mitigate train-pedestrian collisions and enhance safety at railroad crossings.

As such, this study focuses on the use of signage to clarify safety instructions to pedestrians at rail crossings. Pedestrians rely on signage to provide indications of what they can do and what situations are safe. As stated previously, signage is not always well understood by pedestrians and some signs may be more communicative than others (Bazire and Tijus, 2009). The objective of this study is to evaluate (1) the effectiveness of sign messaging strategies and designs at pedestrian-railroad crossings, and (2) the effects of context and risk-taking propensity on decisions to cross railroad tracks.

2. METHODOLOGY

A survey study was conducted to evaluate opinions and perceptions regarding railroad-pedestrian crossings. The study received Institutional Review Board (IRB) approval and informed consent was obtained from each respondent.

2.1 Participants

All the participants lived in the United States and quota sampling was used to balance participant gender and geographic location to reasonably match U.S. census data. Participants were recruited using a paid survey panel through the Qualtrics platform, where Qualtrics performed the recruitment through its network to best match our quota sampling request. Each participant received a payment of $6 for their time and effort.

There were 1,011 participants included in this analysis. Participants ranged from 18 to 80 years old (Mean = 45.6, SD = 17.6). Specifically, there were 164 (16.2%) between 18–24 years old, 422 (41.7%) between 25–49 years old, 228 (22.6%) between 50–64 years old, and 195 (19.3%) respondents 65 and over. There were 492 (48.7%) females, 504 (49.8%) males, 10 (1%) non-binaries, and 5 (0.5%) preferred not to answer. Participants were dispersed across the U.S., with 243 (24.0%) living in the west, 221 (21.9%) living in the Midwest, 366 (36.2%) living in the south, and 179 (17.7%) living in the northeast.

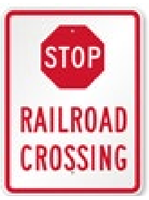
To gauge the representativeness of our sample, we compared these distributions with the U.S. Census Bureau's estimates for 2021 (US Census Bureau, 2021). In the U.S. population, approximately 9.1% are aged 18–24, 32.7% are within the 25–49 age bracket, 19.2% are between 50–64 years old, and 16.8% are aged 65 and over. As per the gender distribution, the U.S. population is comprised of approximately 50.5% females and 49.5% males. Our participant age distribution, while not an exact match, reflects a similar trend to the U.S. population with a larger representation of the 25–49 age group. The gender distribution in our study closely aligns with that of the U.S. population. However, given that our study used random sampling and only included participants 18 years and older, a perfect match with the national demographics was not expected nor achieved. Nevertheless, our sample provided a reasonable representation of the U.S. population, which supports the generalizability of our findings.

2.2 Survey Design

The survey was developed and administered through the online Qualtrics survey platform. Data collection occurred from December 2022 through January 2023. The survey took 10.7 minutes on average to complete, calculated from the 1,011 fully completed responses.

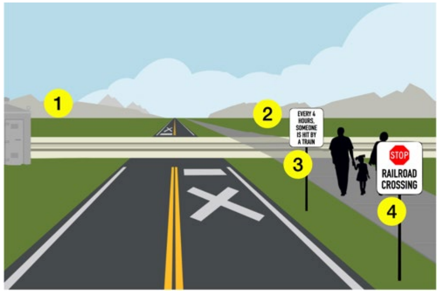
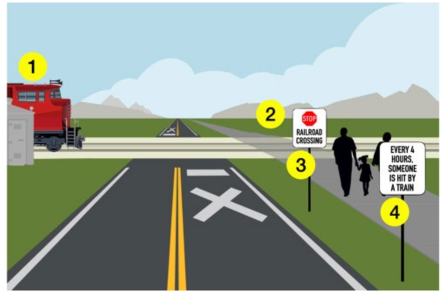
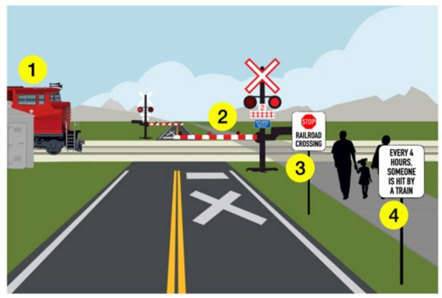
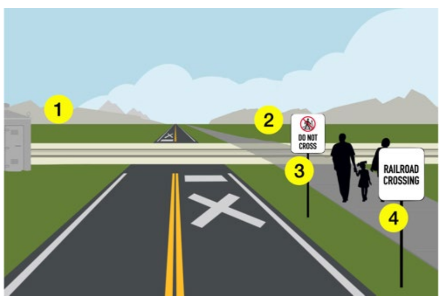
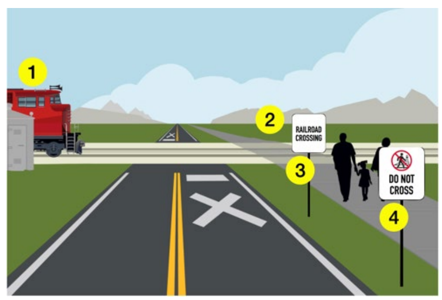
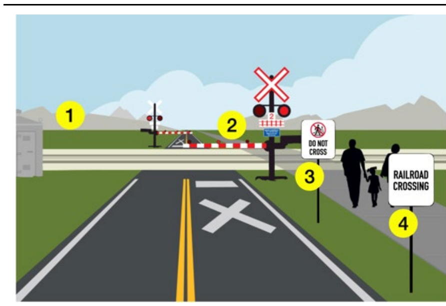
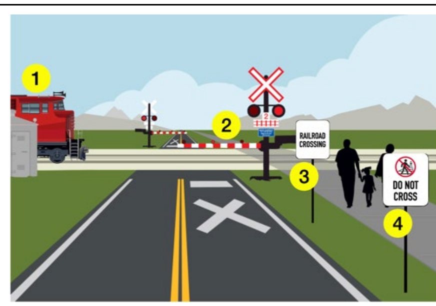
The survey began with basic demographic queries, followed by questions about the participants' frequency of crossing railroad tracks both as pedestrians and drivers. Subsequently, participants were exposed to six distinct types of signs (see Table 2.1): two that provided information only, two that were action conveying, and two that were emotionally motivated. The latter category, unlike the former two, utilized text-based messages for emotional appeal. These included the phrases, "Approximately every four hours, someone is struck at a highway-rail grade crossing in the United States" and "Never stop on tracks. Always expect a train." Whereas the information-only signs cued users of the presence of railroad tracks, and the action-conveying signs contained brief statements of "Stop, Railroad Crossing" and "Do Not Cross." These signs were selected for inclusion based on a review of the literature related to current and commonly used signs. For each sign, participants were asked how likely they would be to cross railroad tracks as a pedestrian under four different conditions: (1) with a train present, (2) with no train present, (3) with the crossing gate down, and (4) with warning lights flashing. This was designed to measure the potential influence of different sign types and messages on participants' behavior in various crossing situations. While the information-only and action-conveying signs were straightforward and visually oriented, the emotionally motivated signs relied on the strength of their textual content to impact respondents. In real-world applications, the emotional content would need to be carefully adapted to ensure quick comprehension and readability at a distance.

Table 2.1 Railroad crossing signage based on messaging strategies

Sign	Messaging Strategy
	Information only
	Information only
	Conveying action
	Conveying action
	Emotionally motivated
	Emotionally motivated

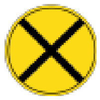
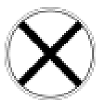
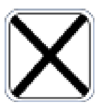
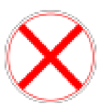
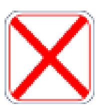
Participants were then shown eight images representing various train-pedestrian crossing scenarios, as shown in Table 2.2. The order that they were shown these images was randomized across participants. For each scene, participants were asked: (1) as a pedestrian, how likely are you to cross the railroad tracks for this scenario? (2) which item first most clearly communicates to you whether you should cross the railroad tracks? and (3) which item second most clearly communicates to you whether you should cross the railroad tracks? Each scenario included two railroad crossing signs: four scenarios compared an action-conveying sign versus information-only sign, and four scenarios compared an action-conveying sign versus emotionally motivated sign. Within each messaging strategy, participants were shown a scenario with (1) no train, (2) a train, (3) crossing gate down, and (4) a train with crossing gate down. The yellow circles with numbers visible in Table 2.2 were used as cues to indicate the various conditions, i.e., (1) train condition, (2) crossing gate condition, (3) sign closer to tracks, and (4) sign farther from tracks. In the survey, participants were asked to select which of these first and second most clearly influenced their decision to cross, where they were given the number and a brief description of the condition (e.g., "#1 – no train present"). The objective of these questions was to contextualize the signage and compare the messaging strategies against each other.

Table 2.2 Railroad crossing signage within context

Scene Without Train	Scene With Train	Messaging Strategy
		Emotionally motivated vs. Conveying action *Crossing arms: no*
		Emotionally motivated vs. Conveying action *Crossing arms: yes*
		Information only vs. Conveying action *Crossing arms: no*
		Information only vs. Conveying action *Crossing arms: yes*

Next, MaxDiff (or best-worst scaling) questions were used to compare various sign designs rather than messaging strategies. There were six sign designs shown to compare perceived significance: shape (circle versus square) and color (black on yellow, black on white, and red on white), as seen in Table 2.3. For these questions, there were a series of five questions that each asked, “When approaching a train crossing as a pedestrian, please choose the signs below that most and least clearly communicate whether it is safe to cross at the train crossing.” Then four of the signs were displayed, and participants selected the sign among the options that most clearly communicated whether it was safe, and then the sign among the options that least clearly indicated whether it was safe. With the six sign designs, four signs were displayed within each question; and in five questions, participants were provided the opportunity to compare all of the signs against each other. As a result, the MaxDiff analysis yielded a rank ordering of the signs, from first to last, for how well the signs conveyed safety relative to each other for each participant.

Table 2.3 Combinations of colors and shapes for railroad crossing signage

Sign Design	**Shape**	**Color**
	Circle	Black on yellow
	Square	Black on yellow
	Circle	Black on white
	Square	Black on white
	Circle	Red on white
	Square	Red on white

Lastly, the Domain-Specific Risk-Taking (DOSPERT) scale (Blais and Weber, 2006) was adapted and used to measure each respondents' risk-taking propensity. There were 10 questions that captured risk taking and risk perception across recreational and health/safety domains. This scale yielded a risk-taking score for each participant.

2.3 Data Cleaning and Analysis

Initial data cleaning was conducted as part of Qualtrics' paid survey panel service; hence it is unknown to the research team how many total responses were collected to obtain the 1,011 completed responses included in this analysis. In this initial data cleaning, Qualtrics removed incomplete survey responses and performed a speed check, where participants who completed the survey in one-half the median completion time were removed.

Statistical analysis was conducted using R (version 4.2.2) and SPSS (version 28.0.1.0). Significance was assessed using a Bonferroni correction on $\alpha = 0.05$. Statistical tests were used to evaluate the likelihood to walk across railroad tracks for various signs and the effects of risk-taking propensity on likelihood to cross. Specifically, t-tests and analysis of variance (ANOVA) were used to understand differences in demographics on risk-taking scores. Linear regression was used to explore the relationship between walking and driving across railroad tracks on risk-taking. Risk-taking scores were also the dependent variable in t-tests comparing groups that were unlikely and likely to cross under various scenarios. Lastly, t-tests were used to evaluate differences in MaxDiff utility of sign designs based on frequency of walking across railroad tracks and risk-taking profiles.

2.3.1 Dependent Variables

Risk-Taking Score. A total risk-taking score was computed for each participant based on the DOSPERT questions. There were 10 questions that used a 5-point Likert scale, asking how likely they were to engage in each activity, ranging from 1 (very unlikely) to 5 (very likely). The sum of their responses across the 10 questions were used to compute their total risk-taking score, which could range from 10 (least risky) to 50 (most risky).

Sign Utility. A utility score was computed for each sign design for each participant, which demonstrates the relative importance of each sign. This utility score is common for MaxDiff analysis (Furlan and Turner, 2014), and was computed by subtracting the number of times a sign was chosen as least important from the number of times it was chosen as most important. A more positive utility score indicates a sign more clearly communicating if it is safe, and a more negative utility score indicates a sign less clearly communicating if it is safe.

2.3.2 Independent Variables

Sign Messaging Strategy. The messaging strategy pertained to the sentiment associated with the content displayed on the sign. There were three types of messaging strategies investigated: information only, action conveying, and emotionally motivated.

Sign Design. This explored the effect of shape (circle versus square) and color (black on yellow, black on white, and red on white), hence there were six levels of sign design.

Context. Participants' perceptions of each sign were assessed across four different contexts: train, no train, crossing gates down, and flashing warning lights.

Likelihood to Cross. Each participant was asked how likely they would be to cross, as a pedestrian, the railroad tracks under various contexts for the different signs. This was asked on a 5-point Likert scale, from very unlikely to very likely. This was then coded as a binary variable for statistical analysis: likely (very likely or somewhat likely) and unlikely (very unlikely and somewhat unlikely). Neutral responses were removed for statistical tests.

Frequency of Crossing as a Pedestrian. The survey asked participants how frequently they walked across railroad tracks in their real life. Responses were coded into binary groups: often (more than once a week, once a week, or once a month) and not often (a few times a year, rarely, never).

Frequency of Crossing as a Driver. Similarly, the survey also asked about how frequently they drove across railroad tracks. These were also coded into the same binary categories: often (more than once a week, once a week, or once a month) and not often (a few times a year, rarely, never).

Risk-Taking Groups. The average score across the 10 DOSPERT risk questions was computed for each participant, which could range from 1 to 5. Scores greater than 3 were coded as "risk seeking" and scores less than 3 were coded as "risk adverse." Respondents with an average risk score of 3 (N = 42) were removed for this analysis.

Demographics. Participant age and gender were also included in analysis.

3. RESULTS

3.1 Summary of Exposure to Railroad Crossings

The survey investigated how frequently participants crossed railroad tracks both as pedestrians and as drivers, as seen in Table 3.1. The findings revealed that 37.6% (380 participants) reported crossing railroad tracks at least once a month as pedestrians, while a larger proportion, 62.4% (631 participants), did not. In contrast, a higher percentage of participants crossed railroad tracks as drivers, with 73.8% (746 participants) doing so at least monthly, and only 26.2% (265 participants) not engaging in this behavior. In summary, the participants were more likely to cross railroad tracks while driving than as pedestrians.

Table 3.1 Participant frequencies of railroad crossing

Railroad Crossing Behavior	Count	%
Walk Across Railroad Tracks		
At least once a month	380	37.6%
Never/Rarely	631	62.4%
Drive Across Railroad Tracks		
At least once a month	746	73.8%
Never/Rarely	265	26.2%

3.2 Summary of Risk-Taking Scores

A total risk-taking score was computed for each participant, which could range from 10 (risk averse) to 50 (risk seeking). The average score across all participants was 22.60 (SD = 10.33). In this study, males demonstrated a higher overall risk-taking propensity compared with females, with mean risk-taking scores of 25.32 (SD = 10.27) and 19.61 (SD = 9.46), respectively: $t(963.52) = 9.109$, $p < .001$. Additionally, an ANOVA indicated that age group had a significant effect on risk-taking score, $F(3, 981) = 60.3$, $p < .001$, where younger age groups exhibited greater risk-taking propensity than older adults: 18–24 y.o. (Mean = 26.58, SD = 8.78), 25–49 y.o. (Mean = 25.81, SD = 10.66), 50–64 y.o. (Mean = 19.16, SD = 8.82), and 65+ y.o. (Mean = 16.56, SD = 7.86). These findings suggest that males and younger adults are generally more inclined to take risks.

3.2.1 Comparison of Railroad Crossing Frequency and Risk Score

A linear regression model was used to predict risk-taking scores based on frequency of crossing railroad tracks as a pedestrian (at least monthly, "often" vs. rarely, "not often") and frequency of crossing railroad tracks as a driver (at least monthly, "often" vs. rarely, "not often"). Age, as a continuous variable, and gender (female, male, non-binary) were also included to control for demographics. The results, presented in Table 3.2, indicate that gender, age, and frequency of walking across railroad tracks were significant predictors of risk-taking scores. Specifically, males were associated with an expected risk-taking score of 3.16 (β) points higher than females While there was no significant difference in risk-taking between female and non-binary, it is important to note that there were only 10 non-binary respondents. Also, as expected from the ANOVA discussed above, age was associated with a decrease in expected risk-taking score of 0.16 (β) points for each year increase in age.

Individuals who walked across railroad tracks often (i.e., at least monthly) had significantly higher risk-taking scores (β = 4.50) compared with those who did not. However, the frequency of driving across railroad tracks was not a significant predictor of risk-taking score. This suggests that individuals who regularly cross railway tracks as pedestrians are more likely to engage in risky behaviors. However, the lack of difference in driving frequency could be due to drivers perceiving the risk of crossing railroad tracks as similar to other risky driving behaviors or a general lack of awareness of the dangers associated with crossing railroad tracks.

Table 3.2 Linear regression predicting total risk score

Variable	Coeff.	SE	t	p
(Intercept)	26.74	1.156	23.124	< .001
Age	-0.165	0.018	-9.072	< .001
Male *(vs. Female)*	3.16	0.610	5.182	< .001
Non-Binary *(vs. Female)*	2.53	2.918	0.868	ns
Walk Across Tracks Often *(vs. Not Often)*	4.50	0.657	6.851	< .001
Drive Across Tracks Often *(vs. Not Often)*	0.06	0.681	0.093	ns

Note: $R^2 = 0.227$ (N = 982, $p < .001$)

3.3 Perceptions of Sign Messaging Strategies

The survey evaluated the effectiveness of six distinct signs: two information-only signs, two action-conveying signs, and two emotionally motivated signs. Participants were asked to rate their likelihood of crossing the railroad tracks as a pedestrian under four different conditions, with (1) a train present, (2) no train present, (3) crossing gate down, and (4) warning lights flashing.

The results indicated that information-only signs resulted in the highest likelihood of participants crossing the railroad when no train was present (73.7% and 72.5%). For action-conveying signs, this likelihood decreased (65.6% and 33.9%), and it was further reduced for emotionally motivated signs (55.7% and 57.7%).

When a train was present, action-conveying signs were the most effective at dissuading participants from crossing, with 79.6% unlikely to cross in one instance. Emotionally motivated signs also exhibited a high percentage of participants unlikely to cross (77.5% and 77.3%), while information-only signs yielded slightly lower percentages (72.0% and 70.0%).

Likewise, when the crossing gate was down or warning lights were flashing, both action-conveying and emotionally motivated signs were more effective at discouraging track crossing compared with information-only signs. Overall, action-conveying and emotionally motivated signs demonstrated a greater impact on participants' behavior in high-risk situations, such as the presence of a train or activated warning systems. The results are illustrated in Figure 3.1.

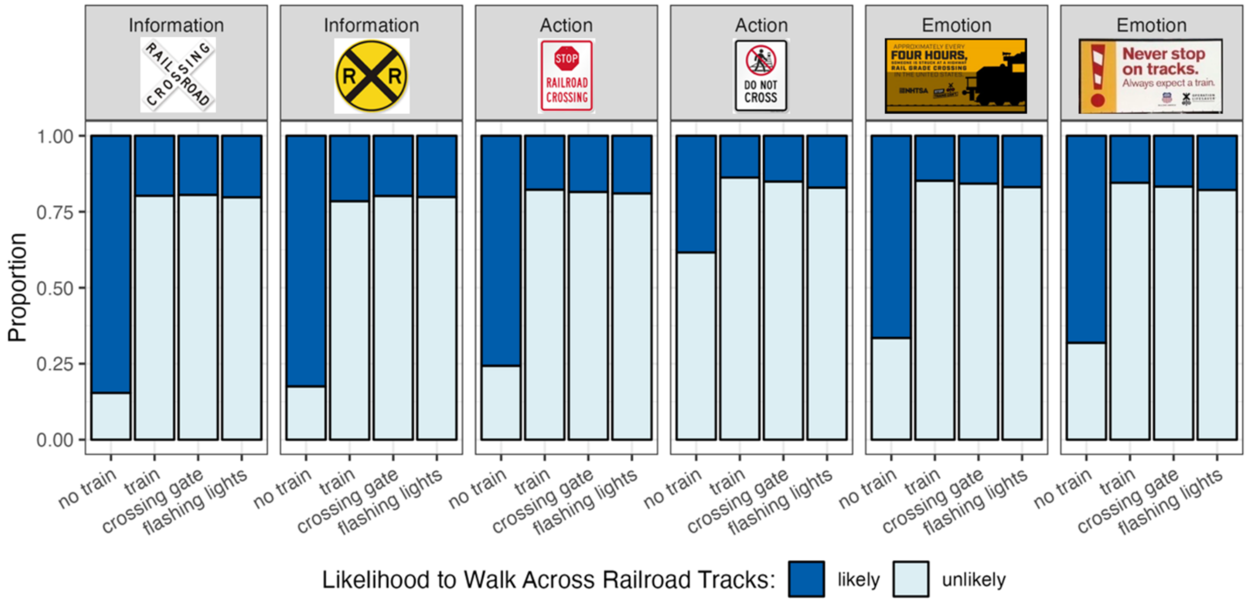


Figure 3.1 Likelihood to walk across railroad tracks by sign type

3.3.1 Perceptions Based on Risk Score

The likelihood of walking across railroad tracks for each of these signs was also compared to the risk-taking scores. For this, t-tests were performed to compare risk-taking scores between likely and unlikely crossers, and a Bonferroni correction was applied for multiple comparisons. These results are summarized in Table 3.3.

The analysis revealed that for all six signs, there was a significant difference in risk-taking scores between likely and unlikely crossers when a train is present, crossing gate is down, or warning lights are flashing. Specifically, individuals who reported they were likely to cross railroad tracks also had higher risk-taking tendencies regardless of the sign type (information, action, or emotional). There was no significant difference in risk-taking scores between likely and unlikely crossers when no train is present for both information-only signs, the “stop” action-conveying sign, and one of the emotionally motivated signs. This suggests that the presence of a train has a greater influence on risk-taking behavior than the type of sign messaging. For the “do not cross” (action) sign and the “never stop on tracks, always expect a train” (emotion) sign, there were significant differences in risk-taking scores between likely and unlikely crossers when no train is present. Respondents likely to cross exhibited higher risk-taking scores, which implies that these two signs may have a stronger impact on risk-taking behavior in the absence of a train compared with the other signs.

Table 3.3 Risk-taking scores for likely versus unlikely to walk across tracks by sign

Sign	Train Present	No Train	Crossing Gate	Flashing Lights
	$\mu_{unlikely} = 20.22$ $\mu_{likely} = 30.31$ $t(217.6) = 9.87$, $p < .001$	$\mu_{unlikely} = 24.10$ $\mu_{likely} = 22.18$ ns	$\mu_{unlikely} = 19.92$ $\mu_{likely} = 31.22$ $t(201.8) = 10.64$, $p < .001$	$\mu_{unlikely} = 19.72$ $\mu_{likely} = 31.65$ $t(225.3) = 12.52$, $p < .001$
	$\mu_{unlikely} = 19.61$ $\mu_{likely} = 31.54$ $t(234.7) = 12.37$, $p < .001$	$\mu_{unlikely} = 22.74$ $\mu_{likely} = 22.33$ ns	$\mu_{unlikely} = 19.83$ $\mu_{likely} = 31.11$ $t(211.8) = 11.22$, $p < .001$	$\mu_{unlikely} = 19.44$ $\mu_{likely} = 32.03$ $t(214.6) = 12.84$, $p < .001$
	$\mu_{unlikely} = 19.96$ $\mu_{likely} = 32.86$ $t(192.0) = 12.62$, $p < .001$	$\mu_{unlikely} = 21.91$ $\mu_{likely} = 22.54$ ns	$\mu_{unlikely} = 19.58$ $\mu_{likely} = 33.30$ $t(197.6) = 13.96$, $p < .001$	$\mu_{unlikely} = 19.55$ $\mu_{likely} = 32.84$ $t(212.8) = 14.11$, $p < .001$
	$\mu_{unlikely} = 19.82$ $\mu_{likely} = 36.13$ $t(147.2) = 16.01$, $p < .001$	$\mu_{unlikely} = 19.77$ $\mu_{likely} = 26.00$ $t(515.2) = 8.25$, $p < .001$	$\mu_{unlikely} = 19.71$ $\mu_{likely} = 35.35$ $t(161.6) = 15.81$, $p < .001$	$\mu_{unlikely} = 19.43$ $\mu_{likely} = 34.79$ $t(191.0) = 16.88$, $p < .001$
	$\mu_{unlikely} = 19.87$ $\mu_{likely} = 35.67$ $t(158.2) = 15.23$, $p < .001$	$\mu_{unlikely} = 21.64$ $\mu_{likely} = 22.99$ ns	$\mu_{unlikely} = 19.79$ $\mu_{likely} = 34.20$ $t(165.1) = 13.81$, $p < .001$	$\mu_{unlikely} = 19.61$ $\mu_{likely} = 34.87$ $t(185.8) = 16.43$, $p < .001$
	$\mu_{unlikely} = 20.01$ $\mu_{likely} = 33.56$ $t(162.7) = 12.38$, $p < .001$	$\mu_{unlikely} = 20.86$ $\mu_{likely} = 23.06$ $t(651.9) = 3.11$, $p = .0019$	$\mu_{unlikely} = 19.75$ $\mu_{likely} = 33.68$ $t(175.0) = 13.51$, $p < .001$	$\mu_{unlikely} = 19.66$ $\mu_{likely} = 33.56$ $t(194.4) = 14.48$, $p < .001$

Note: Sign 1 & 2 = information; Sign 3 & 4 = action; Sign 5 & 6 = emotional
Note: Bonferroni correction for 24 comparisons = .05/24 = .002

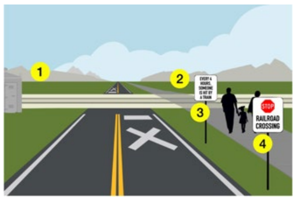
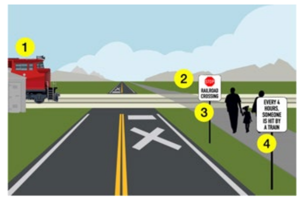
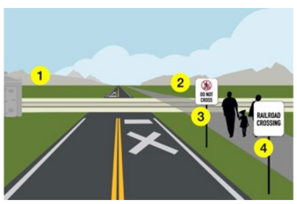
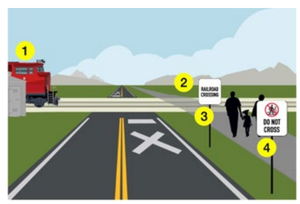
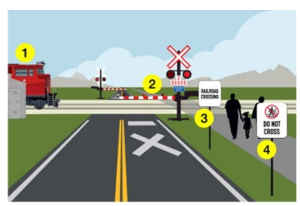
3.4 Perceptions of Signs by Context

Participants were presented with eight images of different scenarios, and for each they were asked about their likelihood of crossing and the first and second most important factors in their decision regarding whether it was safe to cross. The scenarios compared action-conveying signs with information-only and emotionally motivated signs. Results, which are presented in Table 3.4, revealed that the presence of a train and crossing gate played a crucial role in pedestrian decision-making, while action-conveying signs appeared to be more effective in communicating the risk compared with emotionally motivated and information-only signs.

When a train was present, participants were more likely to prioritize the train's presence as the primary factor in their decision to cross. In these scenarios, action-conveying signs, such as "Stop, Railroad Crossing" or "Do Not Cross," served as the second most important factor for participants. The presence of a train combined with action-conveying signs effectively communicated the risks associated with crossing the railroad tracks, leading pedestrians to make safer decisions.

On the other hand, when a train was absent, participants focused more on crossing gate status (down or absent) as the primary factor in their decision-making process. In these cases, action-conveying signs still played an essential role as the secondary factor in influencing pedestrian decisions. This demonstrates that even without a train present, action-conveying signs were more effective in guiding pedestrian behavior compared with emotionally motivated or information-only signs.

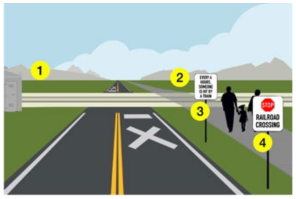
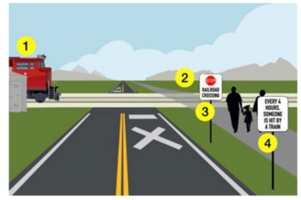
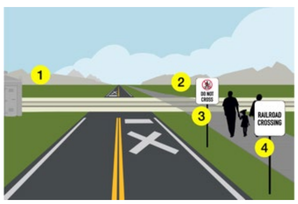
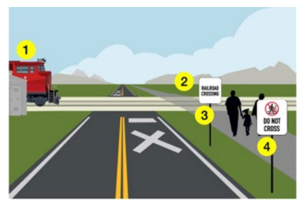
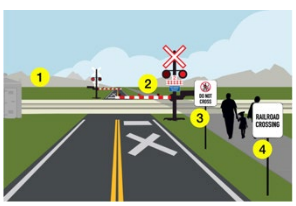
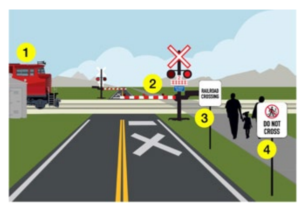
Table 3.4 Factors within context that most clearly communicates if it is safe to cross

Crossing Gate	Scene without Train		Scene with Train	
Sign Types: Action vs. Emotion				
No		1st: No train present 2nd: No crossing gate down		1st: Train present 2nd: Action conveying sign
Yes		1st: Crossing gate down 2nd: Action conveying sign		1st: Train present 2nd: Crossing gate down
Sign Types: Action vs. Information				
No		1st: No crossing gate down 2nd: Action conveying sign		1st: Train present 2nd: Action conveying sign
Yes		1st: Crossbar Down 2nd: Action conveying sign		1st: Train present 2nd: Action conveying sign

3.4.1 Comparison Based on Risk Score

We then conducted several t-tests, with Bonferroni correction, to analyze participants' likelihood to walk across railroad tracks in those scenarios in regard to their risk-taking tendencies. These comparisons are summarized in Table 3.5. There was a significant difference in risk-taking scores between the likely and unlikely to cross groups for seven of the eight comparisons. In all cases, higher risk-taking scores were observed for the likely to cross group, compared with the unlikely to cross group. The only scenario with no difference was the case with no train, no crossing gates, an action-conveying sign, and an emotionally motivated sign.

Table 3.5 Risk-taking scores for likely versus unlikely to walk across tracks by context

Crossing Gate	Scene without Train		Scene with Train	
Sign Types: Action vs. Emotion				
No		$\mu_{unlikely} = 22.37$ $\mu_{likely} = 22.55$ ns		$\mu_{unlikely} = 20.45$ $\mu_{likely} = 35.57$ $t(116.0) = 12.66$, $p < .001$
Yes		$\mu_{unlikely} = 20.22$ $\mu_{likely} = 31.27$ $t(168.2) = 9.76$, $p < .001$		$\mu_{unlikely} = 20.30$ $\mu_{likely} = 35.94$ $t(108.0) = 12.80$, $p < .001$
Sign Types: Action vs. Information				
No		$\mu_{unlikely} = 20.88$ $\mu_{likely} = 23.18$ $t(835.5) = 3.36$, $p = .0008$		$\mu_{unlikely} = 20.11$ $\mu_{likely} = 34.37$ $t(135.5) = 12.83$, $p < .001$
Yes		$\mu_{unlikely} = 20.15$ $\mu_{likely} = 31.06$ $t(184.4) = 10.52$, $p < .001$		$\mu_{unlikely} = 20.34$ $\mu_{likely} = 35.11$ $t(114.5) = 11.79$, $p < .001$

Note: Bonferroni correction for 8 comparisons = .05/8 = .006

3.5 MaxDiff of Sign Design Effectiveness

The study employed a MaxDiff analysis to examine the perceived significance of various railroad crossing sign designs, focusing on shape (circle vs. square) and color (black on yellow, black on white, and red on white). Participants were shown four of the six sign designs at a time, and asked to select two signs: one that most clearly and one that least clearly communicates whether it is safe to cross at the railroad crossing if they were approaching as a pedestrian. This was repeated across five questions, such that they were able to compare all six sign designs against each other and generate a rank order of the sign designs based on their ability to communicate safety relative to one another. The objective was to understand the effectiveness of the different signage designs in conveying safety information to pedestrians at railroad crossings. The overall rankings generated by this analysis are as follows, from most effective to least: (1) Circle, black on yellow; (2) Square, black on yellow; (3) Square, red on white; (4) Circle, red on white; (5) Square, black on white; and (6) Circle, black on white.

More specifically, the average utility scores across all participants for each sign design is provided in Figure 3.2. This shows the relative importance of each sign compared with the others around the mean. The signs with the black symbol on white background had strongly negative utility scores, indicating their significantly lower effect on communicating safety. While the yellow signs had the largest average utility scores for communicating safety.

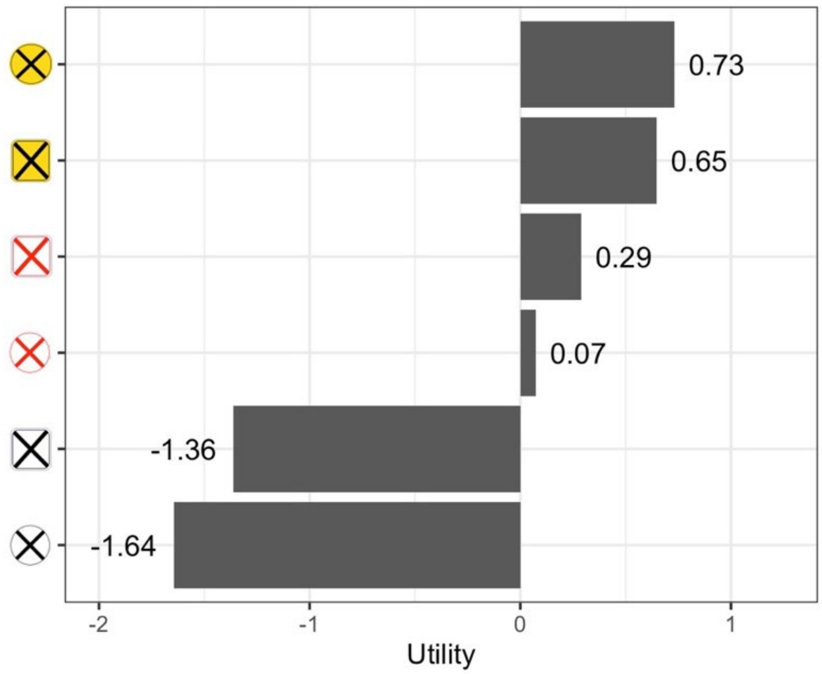


Figure 3.2 Average utility scores for each sign

A repeated measures ANOVA, appropriately accounting for the multiple observations per participant, revealed a significant effect of shape ($F(1,5052) = 9.57$, $p = .002$) and color ($F(2, 5052) = 869.72$, $p < .001$) on sign utility. A Tukey HSD post-hoc test showed a significant difference between each color contrast ($p < .0001$), with means 0.690 (black on yellow), 0.182 (red on white), and -1.50 (black on white). Similarly, Tukey HSD post-hoc indicated a significant difference between shape contrasts ($p = .002$), with means -0.141 (square) and -0.280 (circle).

3.5.1 Utility of Sign Based on Risk Score

Lastly, t-tests with Bonferroni correction were conducted to compare utility scores for each sign based on frequency of walking across railroad tracks and risk-taking scores. Similar to the analyses above, the frequency of walking across tracks was grouped into often (i.e., at least monthly) and not often (i.e., rarely/never). A binary categorization was coded for the risk-taking score, where the average across the risk questions was computed for each respondent, and then scores greater than 3 were “risk-seeking” and scores less than 3 were “risk-adverse.”

There was no significant difference in utility scores between risk-seeking and risk-adverse respondents across all six signs. Similarly, there was no significant difference in utility scores between respondents that crossed railroad tracks as pedestrians often versus not often. This means that the relative importance of each sign to users does not significantly differ based on the frequency of walking across tracks or their risk-taking tendencies.

4. DISCUSSION

Pedestrian-railroad crossings play a critical role in ensuring the safety of road users as they navigate the transportation infrastructure. However, the effectiveness of these crossings in preventing accidents and fatalities often depends on the clarity and impact of the sign present at these locations. To gain insight into the opinions and perceptions regarding pedestrian-railroad crossings in the United States, we conducted a survey study with 1,011 participants.

Our findings revealed that action-conveying and emotionally motivated signs were more effective in dissuading railroad crossing in high-risk situations, such as when a train was present, when crossing gates were down, or when warning lights were flashing. Bazire and Tijus (2009) similarly found that the context in which a sign appears significantly impacts a road user's interpretation of the sign. One possible explanation for this increased effectiveness is that action-conveying signs provide clear instructions on the desired behavior, reducing ambiguity and prompting individuals to take appropriate precautions (Wogalter et al., 1999). These signs can facilitate faster decision-making by offering explicit directives, such as "Stop" or "Do Not Cross," allowing pedestrians to quickly understand the expected action without having to interpret more abstract information.

In addition to providing clear instructions, emotionally motivated signs are designed to elicit a stronger emotional response, often by invoking fear or empathy. Research has shown that fear appeals can be effective in changing attitudes and behaviors, particularly when they are perceived as relevant and personally threatening (Witte, 1992). Emotionally motivated signs can heighten risk perception by making the dangers associated with crossing railroad tracks more salient, thus leading to increased compliance with safety measures.

Note that participants' decisions were primarily influenced by the presence of a train and crossing gate status. However, action-conveying signs consistently proved to be more effective in communicating risk and guiding pedestrian behavior compared with emotionally motivated and information-only signs, regardless of whether a train was present. These findings emphasize the importance of incorporating action-conveying signs in railroad crossing signage design to enhance public safety and promote safer decision-making by pedestrians.

In addition to sign design effectiveness, our study discovered that black symbols on a yellow background were most successful in conveying safety information to users. Several factors contribute to the efficacy of these signs, including high contrast, visibility, association with caution, and universality, all of which are supported by existing research. High contrast between black symbols and a yellow background enhances readability and comprehension from a distance while helping the sign stand out against its surroundings (Laughery and Wogalter, 2006; Wogalter et al., 1999). This high contrast ensures that the sign captures pedestrians' attention and can be easily understood, even in complex or cluttered environments.

Yellow is a highly visible hue, particularly in low light conditions such as dawn or dusk (Hu et al., 2020). This increased visibility aids in sign recognition and comprehension, ensuring that pedestrians can quickly identify and react to the safety information being conveyed. Yellow is commonly associated with caution, warnings, or alerts (Hu et al., 2020; Wogalter et al., 1999). This association helps pedestrians more swiftly recognize the sign's purpose and respond accordingly, promoting safer behavior in potentially hazardous situations. This universality makes the color more easily recognizable and familiar to pedestrians, regardless of their cultural background, thus enhancing the effectiveness of the signs.

We also found that individuals who frequently cross railroad tracks as pedestrians exhibit higher risk-taking scores compared with those who do not engage in this behavior, which was similarly observed by Larue et al. (2018). This is also consistent with previous research showing that individuals who engage in risky behaviors tend to exhibit higher risk-taking propensities (Dahlen and White, 2006; Larue et al., 2019; Hasanzadeh et al., 2020). Interestingly, this pattern was not observed for individuals who frequently cross railroad tracks as drivers. This disparity could be attributed to the variations in perceived risk between pedestrians and drivers at railroad crossings, or a general lack of awareness regarding the hazards of crossing railroad tracks while driving (Tey et al., 2012; Larue et al., 2019). Factors such as the presence of additional safety features in vehicles and the relatively passive nature of driving compared with walking may contribute to this disparity, leading to a reduced perception of risk for drivers compared with pedestrians. Further research is required to comprehensively understand this distinction and devise targeted interventions accordingly.

The study's findings corroborate previous research, indicating that younger adults and males exhibit higher risk-taking propensities at pedestrian-railroad crossings (Darvell et al., 2015; Read et al., 2021). Several factors may contribute to this observation, including differences in risk perception, sensation-seeking tendencies, and the influence of social norms and peer pressure (Davey et al., 2008; Darvell et al., 2015; Read et al., 2021). Younger individuals, particularly adolescents and young adults, may have an underdeveloped capacity to accurately assess and perceive risks (Steinberg, 2008). This cognitive limitation stems from the ongoing development of the prefrontal cortex, a brain region responsible for decision-making, impulse control, and risk evaluation (Giedd et al., 1999). Consequently, younger pedestrians might underestimate the dangers associated with crossing railroad tracks or overestimate their ability to navigate such situations safely.

Similarly, males have been found to display higher risk-taking tendencies compared with females in numerous domains, including driving behavior, substance use, and gambling (Byrnes et al., 1999; Weber et al., 2002). One contributing factor to this gender difference is sensation-seeking behavior, with males generally exhibiting a stronger preference for novel, exciting, and potentially risky experiences (Zuckerman, 1994). Additionally, males may perceive the risks associated with railroad crossings differently than females, feeling more in control of the situation or downplaying potential dangers (Weber et al., 2002). Moreover, social factors, such as peer pressure and social norms, also play a significant role in shaping risk-taking behavior among younger individuals and males. Conformity to peer group expectations and the desire to project an image of fearlessness or bravado may encourage risk-taking at railroad crossings (Gardner and Steinberg, 2005).

The current study presents several limitations that warrant consideration. First, the use of quota sampling, although it provided a balanced sample in terms of gender and geographic location, may not accurately represent the entire U.S. population regarding other demographic factors such as ethnicity, education, and socioeconomic status. This limitation may affect the generalizability of the findings. Future research could employ more comprehensive sampling methods, such as stratified random sampling, to ensure better representation of the U.S. population. Second, the study focused on three types of sign messaging strategies and six sign designs, which may not encompass the full range of signage possibilities that could be utilized at pedestrian-railroad crossings. Future research could expand the range of sign messaging strategies and designs to allow for a more comprehensive evaluation of potential solutions for improving safety. Moreover, the two emotionally motivated signs contained dense textual information compared with the other signs, and this disparity in message content could influence sign effectiveness, such as too slowly communicating critical information in some contexts. Finally, the self-reported nature of a survey may not accurately reflect real-life situations and the actual behavior of individuals at railroad crossings, as participants may respond differently when faced with an actual crossing scenario. Conducting experimental or naturalistic field studies that involve observing participants' real-life behavior at pedestrian-railroad crossings could provide a better understanding of the effectiveness of different sign messaging strategies and designs.

5. CONCLUSIONS

This study provides valuable insights into the effectiveness of various sign messaging strategies and designs at pedestrian-railroad crossings. Our findings emphasize the importance of using action-conveying and emotionally motivated signs to enhance pedestrian safety and decision-making. By considering the specific needs of high-risk populations, such as younger individuals and males, targeted interventions can be developed to address the unique challenges they face when navigating railroad rights of way.

Implications of this research for policy and practice include revising signage guidelines to prioritize the use of action-conveying and emotionally motivated signs, allocating resources for targeted education and awareness campaigns, conducting comprehensive safety assessments, monitoring and evaluating interventions, and encouraging cross-sector collaboration. By integrating these evidence-based strategies into policy and practice, transportation authorities, policymakers, and local communities can work together to improve safety at pedestrian-railroad crossings and reduce the incidence of accidents and fatalities.

Ultimately, the results of this study underscore the need for a multifaceted approach to enhancing pedestrian safety at railroad crossings. This approach should incorporate not only effective sign design and messaging strategies, but also a broader focus on understanding and addressing the underlying factors that contribute to risky behavior and decision-making among pedestrians. Through ongoing research, collaboration, and the implementation of evidence-based policies and interventions, we can continue to advance our understanding of pedestrian safety at railroad crossings and make strides toward creating a safer transportation infrastructure for all.

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APPENDIX: SURVEY

Colorado State University

Survey Intro

This survey is about your perceptions regarding pedestrian crossings at train tracks. The survey should take approximately 15 minutes to complete.

Your participation is completely voluntary and you may withdraw from the survey at any point. Survey responses will be confidential and data from this research will be reported only in the aggregate. Your responses will be anonymous.

Thank you very much for your time and participation.

Demographics

To begin, we would like to ask a few questions about you.

What is your age?

What is your gender?

- Male
- Female
- Non-binary / third gender
- Prefer not to answer

What is the zip code of your current residence?

What region do you live in the US?

- Northeast
- Midwest
- South

- West

Default Question Block

In this section, we want to learn about your perceptions about train track crossing.

How often do you walk across train tracks?

- More than once a week
- Once a week
- Once a month
- A few times a year
- Rarely
- Never

How often do you drive across train tracks?

- More than once a week
- Once a week
- Once a month
- A few times a year

○ Rarely

○ Never

For the next question group, refer to the following image:

When walking toward a train crossing, how likely are you to cross the train tracks with this sign displayed and ...

	Very unlikely	Somewhat unlikely	Neutral	Somewhat likely	Very likely
... with a train present?	○	○	○	○	○
... with no train present?	○	○	○	○	○
... with the crossing arms down?	○	○	○	○	○
... with the warning lights flashing?	○	○	○	○	○

For the next question group, refer to the following image:

When walking toward a train crossing, how likely are you to cross the train tracks with this sign displayed and ...

	Very unlikely	Somewhat unlikely	Neutral	Somewhat likely	Very likely
... with a train present?	○	○	○	○	○
... with no train present?	○	○	○	○	○
... with the crossing arms down?	○	○	○	○	○
... with the warning lights flashing?	○	○	○	○	○

For the next question group, refer to the following image:

When walking toward a train crossing, how likely are you to cross the train tracks with this sign displayed and ...

	Very unlikely	Somewhat unlikely	Neutral	Somewhat likely	Very likely
... with a train present?	○	○	○	○	○
... with no train present?	○	○	○	○	○
... with the crossing arms down?	○	○	○	○	○
... with the warning lights flashing?	○	○	○	○	○

For the next question group, refer to the following image:

When walking toward a train crossing, how likely are you to cross the train tracks with this sign displayed and ...

	Very unlikely	Somewhat unlikely	Neutral	Somewhat likely	Very likely
... with a train present?	○	○	○	○	○
... with no train present?	○	○	○	○	○
... with the crossing arms down?	○	○	○	○	○
... with the warning lights flashing?	○	○	○	○	○

For the next question group, refer to the following image:

When walking toward a train crossing, how likely are you to cross the train tracks with this sign displayed and ...

	Very unlikely	Somewhat unlikely	Neutral	Somewhat likely	Very likely
... with a train present?	◯	◯	◯	◯	◯
... with no train present?	◯	◯	◯	◯	◯
... with the crossing arms down?	◯	◯	◯	◯	◯
... with the warning lights flashing?	◯	◯	◯	◯	◯

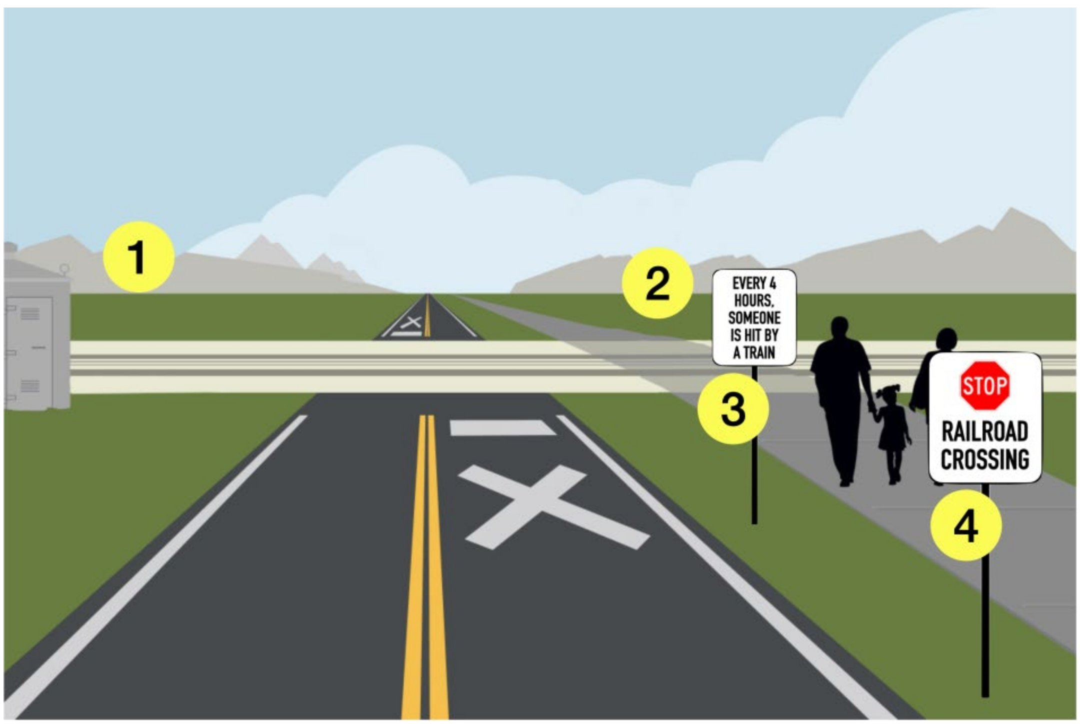
For the next question group, refer to the following image:

When walking toward a train crossing, how likely are you to cross the train tracks with this sign displayed and ...

	Very unlikely	Somewhat unlikely	Neutral	Somewhat likely	Very likely
... with a train present?	◯	◯	◯	◯	◯
... with no train present?	◯	◯	◯	◯	◯

	Very unlikely	Somewhat unlikely	Neutral	Somewhat likely	Very likely
... with the crossing arms down?	◯	◯	◯	◯	◯
... with the warning lights flashing?	◯	◯	◯	◯	◯

For the next question group, please refer to the following image:



As a pedestrian, how likely are you to cross the train tracks for this scenario?

- Very unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Very likely

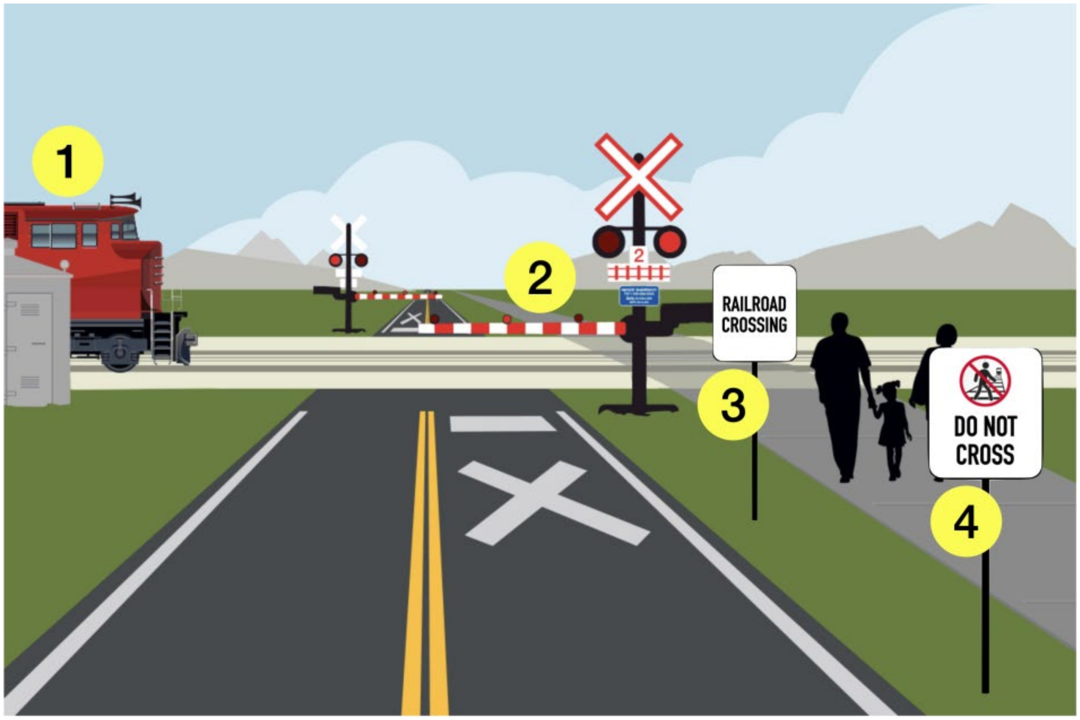
Which item FIRST most clearly communicates to you whether you should cross the train tracks?

- #1 - Train not present
- #2 - No crossbar across path
- #3 - Sign "Every 4 hours, someone is hit by a train"
- #4 - Sign "Stop Railroad Crossing"

Which item SECOND most clearly communicates to you whether you should cross the train tracks?

- #1 - Train not present
- #2 - No crossbar across path
- #3 - Sign "Every 4 hours, someone is hit by a train"
- #4 - Sign "Stop Railroad Crossing"

For the next question group, please refer to the following image:



As a pedestrian, how likely are you to cross the train tracks for this scenario?

- ◯ Very unlikely
- ◯ Somewhat unlikely
- ◯ Neutral
- ◯ Somewhat likely
- ◯ Very likely

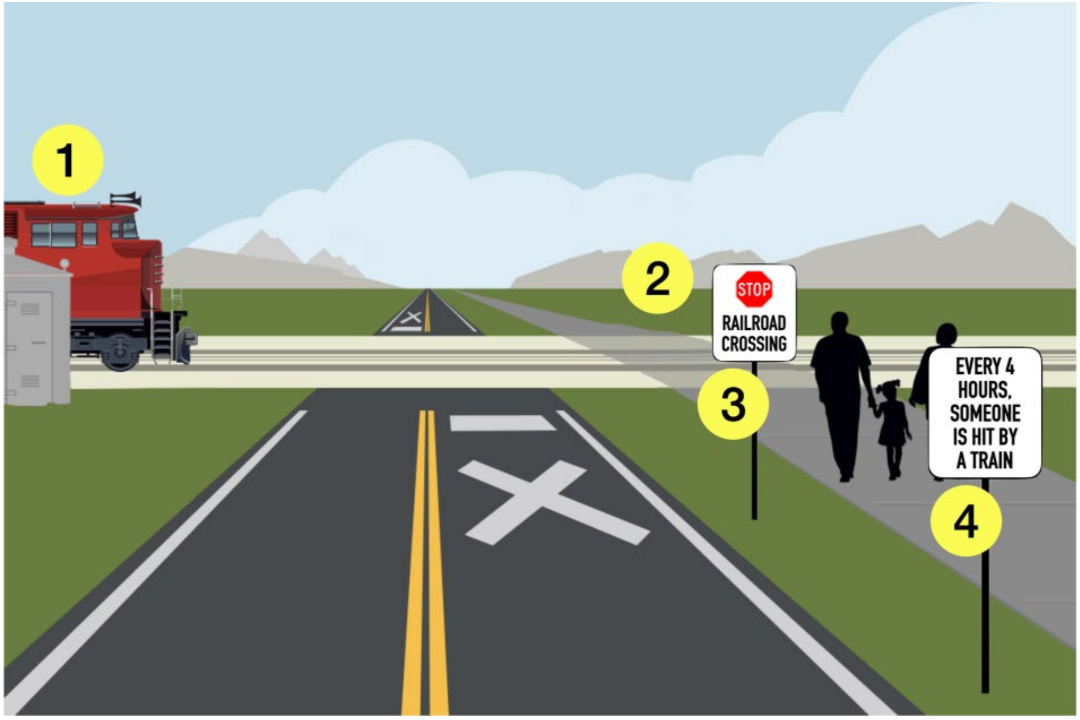
Which item FIRST most clearly communicates to you whether you should cross the train tracks?

- #1 - Train present/approaching
- #2 - Crossbar down
- #3 - Sign "Railroad Crossing"
- #4 - Sign "Do Not Cross"

Which item SECOND most clearly communicates to you whether you should cross the train tracks?

- #1 - Train present/approaching
- #2 - Crossbar down
- #3 - Sign "Railroad Crossing"
- #4 - Sign "Do Not Cross"

For the next question group, please refer to the following image:



As a pedestrian, how likely are you to cross the train tracks for this scenario?

- ○ Very unlikely
- ○ Somewhat unlikely
- ○ Neutral
- ○ Somewhat likely
- ○ Very likely

Which item FIRST most clearly communicates to you whether you should cross the train tracks?

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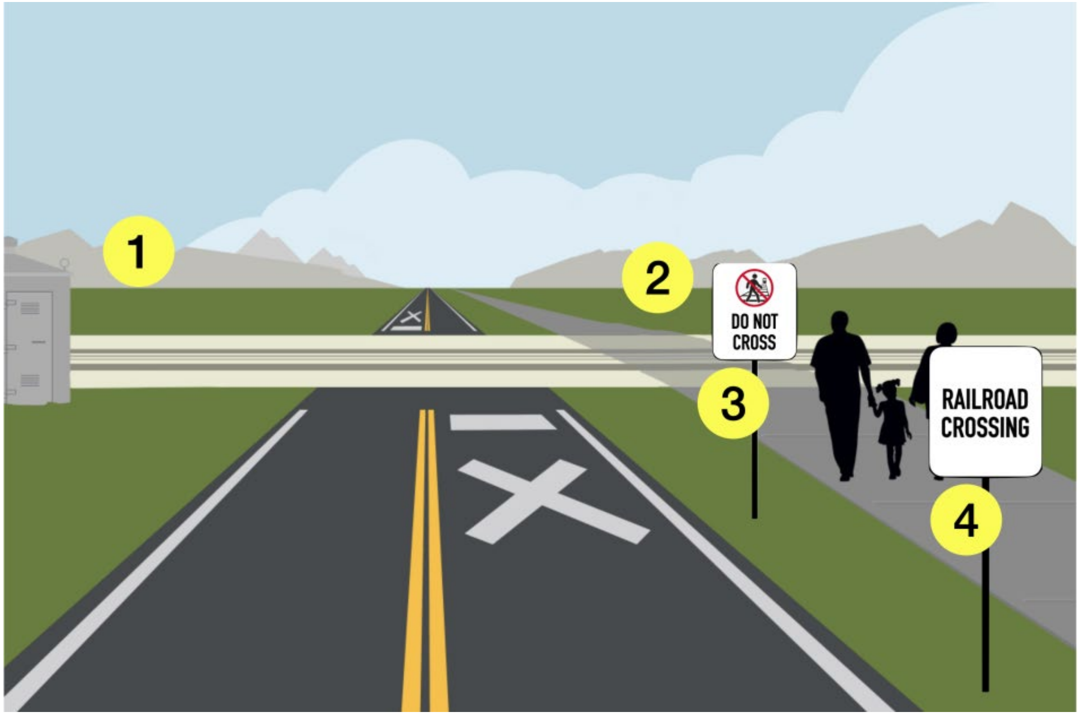

As a pedestrian, how likely are you to cross the train tracks for this scenario?

- ◯ Very unlikely
- ◯ Somewhat unlikely
- ◯ Neutral
- ◯ Somewhat likely
- ◯ Very likely

Which item FIRST most clearly communicates to you whether you should cross the train tracks?

- #1 - Train not present
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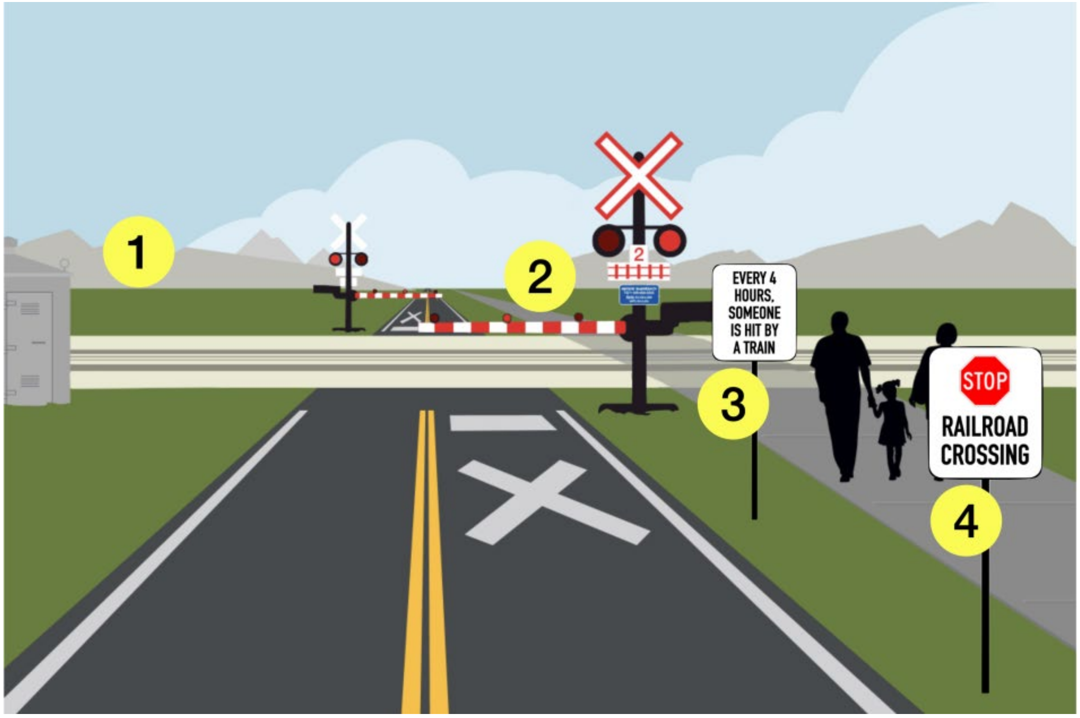

As a pedestrian, how likely are you to cross the train tracks for this scenario?

- Very unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Very likely

Which item FIRST most clearly communicates to you whether you should cross the train tracks?

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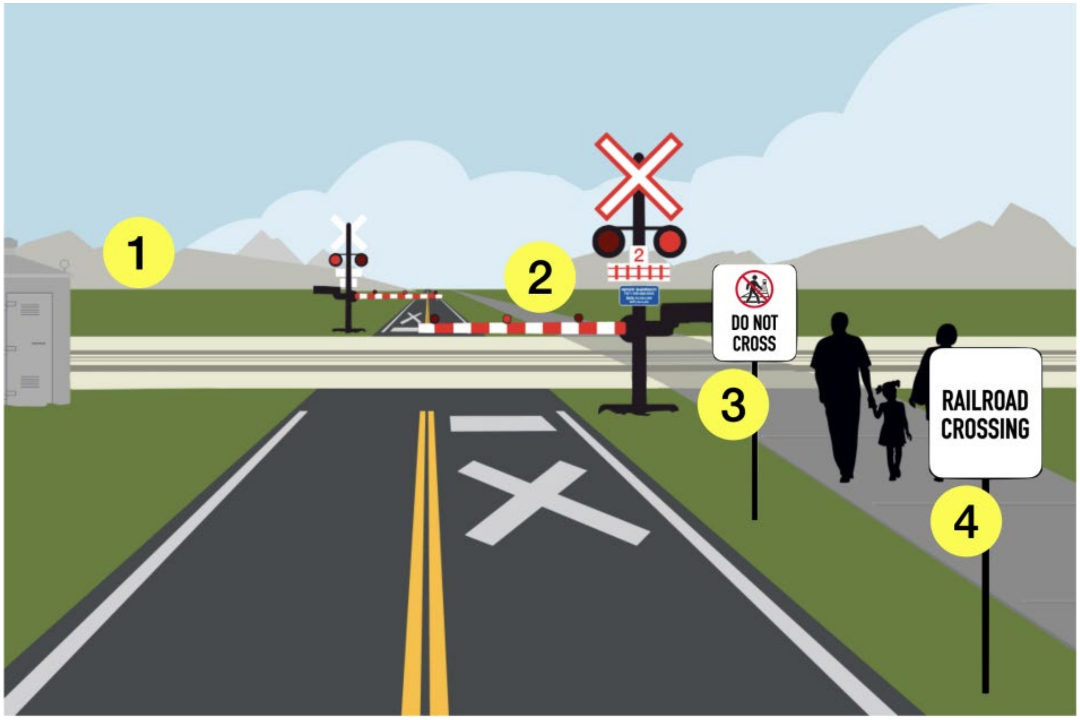

As a pedestrian, how likely are you to cross the train tracks for this scenario?

- Very unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Very likely

Which item FIRST most clearly communicates to you whether you should cross the train tracks?

- #1 - Train not present
- #2 - Crossbar down
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- #4 - Sign "Railroad Crossing"

Which item SECOND most clearly communicates to you whether you should cross the train tracks?

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- #4 - Sign "Railroad Crossing"

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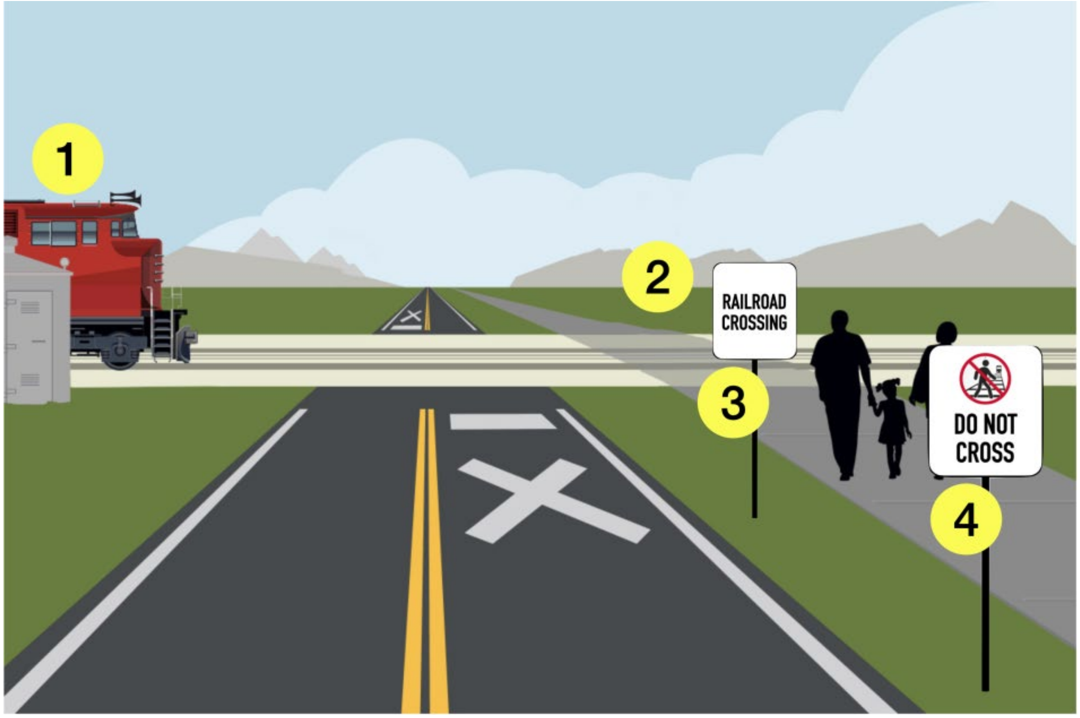

As a pedestrian, how likely are you to cross the train tracks for this scenario?

- ○ Very unlikely
- ○ Somewhat unlikely
- ○ Neutral
- ○ Somewhat likely
- ○ Very likely

Which item FIRST most clearly communicates to you whether you should cross the train tracks?

- #1 - Train present/approaching
- #2 - No crossbar across path
- #3 - Sign "Railroad Crossing"
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Which item SECOND most clearly communicates to you whether you should cross the train tracks?

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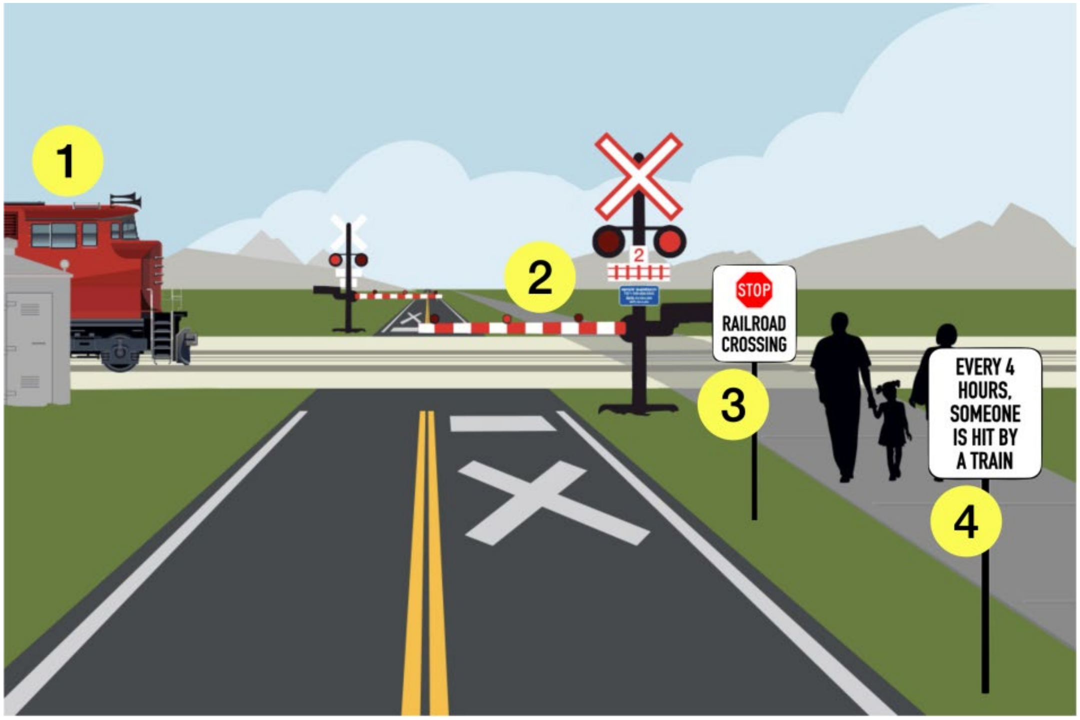

As a pedestrian, how likely are you to cross the train tracks for this scenario?

- Very unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Very likely

Which item FIRST most clearly communicates to you whether you should cross the train tracks?

- #1 - Train present/approaching
- #2 - Crossbar down
- #3 - Sign "Stop Railroad Crossing"
- #4 - Sign "Every 4 hours, someone is hit by a train"

Which item SECOND most clearly communicates to you whether you should cross the train tracks?

- #1 - Train present/approaching
- #2 - Crossbar down
- #3 - Sign "Stop Railroad Crossing"
- #4 - Sign "Every 4 hours, someone is hit by a train"

MaxDiffBlock

(1/5) When approaching a train crossing as a pedestrian, please choose the signs below that Most and Least Clearly communicate whether it is safe to cross at the train crossing.

Most Clearly Communicates		Least Clearly Communicates
◯	${e://Field/1.1_MAXDIFF}	◯
◯	${e://Field/1.2_MAXDIFF}	◯
◯	${e://Field/1.3_MAXDIFF}	◯
◯	${e://Field/1.4_MAXDIFF}	◯

(2/5) When approaching a train crossing as a pedestrian, please choose the signs below that Most and Least Clearly communicate whether it is safe to cross at the train crossing.

Most Clearly Communicates		Least Clearly Communicates
◯	${e://Field/2.1_MAXDIFF}	◯
◯	${e://Field/2.2_MAXDIFF}	◯
◯	${e://Field/2.3_MAXDIFF}	◯
◯	${e://Field/2.4_MAXDIFF}	◯

(3/5) When approaching a train crossing as a pedestrian, please choose the signs below that Most and Least Clearly communicate whether it is safe to cross at the train crossing.

Most Clearly Communicates		Least Clearly Communicates
○	${e://Field/3.1_MAXDIFF}	○
○	${e://Field/3.2_MAXDIFF}	○
○	${e://Field/3.3_MAXDIFF}	○
○	${e://Field/3.4_MAXDIFF}	○

(4/5) When approaching a train crossing as a pedestrian, please choose the signs below that Most and Least Clearly communicate whether it is safe to cross at the train crossing.

Most Clearly Communicates		Least Clearly Communicates
○	${e://Field/4.1_MAXDIFF}	○
○	${e://Field/4.2_MAXDIFF}	○
○	${e://Field/4.3_MAXDIFF}	○
○	${e://Field/4.4_MAXDIFF}	○

(5/5) When approaching a train crossing as a pedestrian, please choose the signs below that Most and Least Clearly communicate whether it is safe to cross at the train crossing.

Most Clearly Communicates		Least Clearly Communicates
○	${e://Field/5.1_MAXDIFF}	○
○	${e://Field/5.2_MAXDIFF}	○
○	${e://Field/5.3_MAXDIFF}	○
○	${e://Field/5.4_MAXDIFF}	○

Risk Taking

Next, we want to ask some questions about your personality.

For each of the following statements, please indicate your likelihood of engaging in each activity or behavior.

	Very unlikely	Somewhat unlikely	Neutral	Somewhat unlikely	Very likely
Going camping in the wilderness.	○	○	○	○	○
Going down a ski run that is beyond your ability.	○	○	○	○	○
Going whitewater rafting at high water in the spring.	○	○	○	○	○
Driving a car without wearing a seat belt.	○	○	○	○	○

	Very unlikely	Somewhat unlikely	Neutral	Somewhat unlikely	Very likely
Taking a skydiving class.	○	○	○	○	○
Riding a motorcycle without a helmet.	○	○	○	○	○
Bungee jumping off a tall bridge.	○	○	○	○	○
Piloting a small plane.	○	○	○	○	○
Walking home alone at night in an unsafe area of town.	○	○	○	○	○
Leaving your young children alone at home while running an errand.	○	○	○	○	○