

## Reflective Clothing is Attractive to Pedestrians

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### ABSTRACT

Motor vehicle crash fatalities involving pedestrians result in 1.8 deaths per 100,000 population annually in the US. Most of these fatalities are attributed to the pedestrian not being seen in time for the driver to avoid a collision, particularly under poor lighting conditions. Previous research shows that reflective clothing worn at night significantly increases a pedestrian's visual conspicuity to drivers, especially when worn on a part of the body that moves. The purpose of the present research was to examine pedestrians' willingness to pay an additional dollar amount for clothing providing increased conspicuity at night. Two studies were conducted with sample sizes of  $n = 340$  and  $325$ , respectively, comprised of university students and non-students. Findings from these two studies suggest that over 49 percent of respondents would be willing to pay an additional amount (\$33 versus \$30) for a sweat shirt or jacket, and over 60 percent would pay the same additional amount for athletic shoes. These findings suggest that a relatively large segment of the population are interested in and would be willing to spend more for clothing with reflective material. In both studies, significantly more women than men selected the reflective material option. Respondents spending more time outdoors at dusk or at night walking, running or jogging professed a significantly greater willingness to purchase the reflective clothing than respondents reporting spending less time outdoors at dusk or after dark. Implications for product marketing and future research are discussed.

### INTRODUCTION

Public road crashes are a major safety issue, accounting for 28 percent of all deaths due to injury in the U.S. (Martinez, 2000). Approximately half of all motor vehicle crash fatalities involve pedestrians, resulting in 1.8 deaths per 100,000 population annually (Langham and Moberly, 2003). One of the primary causes of public road crashes involving pedestrians is lack of conspicuity (Shinar, 1978; Owens and Sivak, 1993, 1996). Under conditions of poor visibility such as at night, pedestrians are not seen in enough time to avoid a crash (Langham et al., 2003). Relatively more pedestrian accidents occur at night than at any other time of day, when controlling for public road exposure and vehicle flow (Goodwin and Hutchinson, 1977). Increasing pedestrian conspicuity to enable vehicle drivers to see them is one important method for increasing public road safety (Greatrix and Smithies, 1999; Lesley, 1995).

Conspicuity is defined by Lesley (1995) as the extent to which an object "stands out from its surroundings." Objects considered "conspicuous," therefore, do not require extensive visual search to be successfully detected. Rather, they quickly grab the attention of the observer and focus it on the object (Engel, 1971). Hills (1980) defined conspicuity as the extent to which an object, such as a pedestrian, is above the "just visible limit" (JVL), thus allowing it to be detected. According to Signal Detection Theory (e.g., Parasuraman, Masalonis, and Hancock, 2000), more "conspicuous" objects

would have a higher hit rate for accurate signal detection due to increased signal sensitivity.

While conspicuity mainly refers to "bottom up" perceptual processes (i.e., correctly detecting the object), consequent processing also involves "top-down" cognitive processes, such as vehicle driver expectations (Langham et al., 2003). Most vehicle crashes involving pedestrians occur when the driver does not expect the encounter (Langham et al., 2003). How an unexpected object, such as a pedestrian, attracts attention relates to its attentional conspicuity (Langham et al., 2003). Attentional conspicuity, i.e. the object's ability to be detected, is affected by its size, its contrast with the background, the ambient light levels, the presence of glare, and its physical properties (Hughes and Cole, 1986). Relative conspicuity depends on the context. Thus, something conspicuous in one environment may not be conspicuous in another environment.

One solution to make pedestrians more conspicuous at night is to have reflective material on clothing. Beith, Sanders, and Peay (1982) showed that reflective material placed on clothing increased detection accuracy compared with non- or minimally reflective clothing. Harrell (1993, 1994) showed that pedestrians wearing highly conspicuous clothing were more likely to cause drivers to stop in marked crosswalks than when pedestrians were wearing less conspicuous clothing. This increase in detection accuracy at a greater distance allows the machine or vehicle operator more time to avoid hitting a worker or pedestrian and thus would

likely contribute to accident rate reductions (Beith et al., 1982).

While reflective material can be found on some clothing and footwear, the assessment of its perceived value to consumers has not been adequately addressed in the research literature. The addition of reflective material to clothing would necessitate a relatively small increase in the selling price of the garment or footwear to cover the increase in cost of goods. Thus, a concern is that consumers may not be willing to pay even a relatively small dollar amount more for increased conspicuity at night. Little is known regarding consumers' interest in purchasing reflective clothing. In addition, little is known regarding the marketability of the added safety benefit reflective material offers. Therefore, the principal purpose of this research was to assess whether consumers are willing to pay a somewhat higher price for the added safety of reflective clothing and to identify specific target groups most interested in the feature.

**METHOD**

Two studies were conducted with samples of volunteers from the Raleigh-Durham area of central North Carolina. In the first study, 340 individuals were recruited to complete a questionnaire. Approximately 43 percent of respondents were non-students employed in a variety of occupations or retired. Fifty-seven percent of respondents were North Carolina State University (NCSU) students, majoring in various subject areas. The overall mean age was 28 (SD = 13.2 years; range = 17 to 80 years old). Sixty-two percent of participants were male.

In the second study, 325 individuals participated. Thirty-two percent were non-students and the remainder were NCSU students. Mean age was 25 (SD = 9.8 years; range = 18 to 79 years old). Sixty-five percent of participants were male.

In the first study, participants were asked to read the paragraph below, and then to indicate whether they would be more likely to purchase a piece of clothing *with* or *without* the reflective material:

*Pedestrians are sometimes not seen at night by drivers. Sometimes (though not all of the time) they can be seen better if they are wearing clothing that has reflective material like that found on some athletic-type shoes. Assume that at a department store there are two articles of clothing (for example, a sweat shirt and light jacket) that you like, and you are considering purchasing one of them. Suppose that they differ only by the fact that one is trimmed with a small amount of reflective material in places that did not impair the clothing's attractiveness. The garment without the reflective material sells for \$30, and the garment with the reflective material sells for \$3 more or \$33.*

Participants responded by marking one of the alternatives. One alternative was to purchase clothing *with* reflective

material for \$33. The other alternative was to purchase clothing *without* reflective material for \$30.

In the second study, participants were asked to complete two tasks. First, participants read a statement nearly identical to the one above. The difference was that instead of asking about a generalized article of clothing, they were asked specifically about purchasing athletic shoes. Participants responded by marking one of the alternatives mentioned above, i.e., would purchase athletic shoes *with* reflective material for \$33 or athletic shoes *without* reflective material for \$30.

Also in the second study, participants were asked to report how often they walk/run/jog at dusk or in the dark. They responded by checking one of the following five alternatives: approximately every day, approximately once or twice a week, approximately once or twice a month, approximately once or twice a year, and never. Participants responded by marking one of the above alternatives.

**RESULTS**

Responses to the questions regarding willingness to pay more for clothing or athletic footwear with reflective material are presented in **Table 1** below. Forty-nine percent of Study 1 participants reported being willing to pay an additional \$3 for clothing that offers the added safety of reflective material, and over 60 percent of Study 2 participants were willing to pay the same \$3 premium for athletic footwear. In both studies, women were significantly more willing to purchase clothing with reflective material compared to men (Mantel-Haenzel  $X^2$  [1, n = 340] = 4.4,  $p < 0.05$  in Study 1; Mantel-Haenzel  $X^2$  [1, n = 325] = 10.3,  $p < .001$  in Study 2).

**Table 1.** Response percentages on willingness to purchase reflective clothing (Study 1) or athletic footwear (Study 2) and as a function of gender

		Willing to pay \$30 for item <i>without</i> reflective material	Willing to pay \$33 for item <i>with</i> reflective material
<i>Study 1</i>			
Clothing	(n=340)	50.3	49.7
	Males (n=210)	54.8	45.2
	Females (n = 130)	43.1	56.9
<i>Study 2</i>			
Footwear	(n=325)	39.7	60.3
	Males (n=213)	46.0	54.0
	Females (n=112)	27.7	72.3

**Table 2** provides findings comparing reports of how often individuals walk, run or jog at dusk or after dark with their willingness to purchase clothing with reflective material. For

data analysis purposes, the frequency of outdoor activity at night responses were divided into two categories: *more* (one or more times a month), and *less* (once or twice a year or less). The data in **Table 2** below suggest that individuals who report spending *more* time walking, running or jogging outdoors at dusk or after dark are significantly more willing to pay more for athletic footwear with reflective material than individuals who spend *less* time outdoors at dusk or after dark (Mantel-Haenzel  $X^2 [1, n = 325] = 14.9, p < .001$ )

**Table 2.** Response Frequencies for item asking how often individuals walk, run or jog at dusk or in the dark with item asking willingness to purchase athletic footwear with or without reflective material (Study 2, n = 325).

	Willing to pay \$30 for item without reflective material	Willing to pay \$33 for item with reflective material
Walk/run/jog <i>less</i> at dusk or in the dark	88	91
Walk/run/jog <i>more</i> at dusk or in the dark	41	105

## DISCUSSION

The findings of these two studies suggest that there is a potentially large market for clothing and athletic footwear items that offer the added safety of increased conspicuity at night in an aesthetically attractive manner. Approximately 50 percent of respondents in Study 1 indicated they would pay \$3 more for non-specific clothing with reflective material, and over 60 percent of respondents in Study 2 said they would pay the same additional amount for athletic footwear with reflective material. These findings suggest a substantial number of consumers find the concept of clothing with reflective material attractive.

The difference in response rates when asking about willingness to purchase non-specific clothing with reflective material versus willingness to specifically purchase athletic footwear suggests that consumers may have different pricing expectations for different types of products. Marketers would benefit from future research providing insights into consumer preferences regarding willingness to pay for a variety of clothing and footwear items featuring reflective material.

Consumer responses in Studies 1 and 2 regarding willingness to purchase clothing with reflective material were made based on the assumption that the reflective clothing would be as aesthetically appealing as the same item without reflective material. Limited consumer research is available in the literature to guide clothing design decisions regarding

consumer preferences for the aesthetic presentation of reflective material on clothing. In order to successfully position reflective material in the consumer's mind as a valuable added safety feature to clothing that is worth paying more for, consumer research is warranted to help guide reflective clothing design and marketing decision making regarding product aesthetics.

Research findings from Beith and colleagues (1982) suggest that reflective material placement and configuration play a role in providing the greatest amount of conspicuity to the pedestrian or worker. To successfully marry aesthetics with conspicuity, additional consumer research is needed to better understand how such considerations as type, quantity and placement of reflective material, as well as product durability, influence clothing purchase decision making. Since conspicuity is also context dependent, studies assessing what types of reflective materials work best for what types of nighttime environments and activities would be helpful in addressing consumers' reflective clothing needs.

In both studies, women were significantly more likely to pay \$3 more for the added safety benefit of reflective material than men. Women often influence the purchase decision of other target groups, such as men and children. Children are especially at risk for pedestrian-related vehicle crashes. To capitalize on women's influence on purchase decisions of others, advertising and promotional efforts could target their message toward women, thus more cost effectively tapping into both the potential male and child market segments.

Individuals in Study 2, who reported spending *more* time outdoors at dusk or after dark, were significantly more willing to pay an additional \$3 for reflective athletic footwear than individuals reporting spending *less* time outdoors at dusk or after dark. Other investigations might examine how reflective material could best serve this consumer group.

In summary, the data from these two studies suggest there is a viable potential market for reflective clothing and footwear. Half or more of all respondents in both studies would purchase clothing or athletic footwear with reflective material even though the items cost more. Women and individuals who spend more time outdoors at dusk or after dark were significantly more willing to pay extra for the added safety feature of reflective material. In addition to targeting these interested consumer groups, individuals not currently interested in reflective clothing or footwear might be more willing to purchase it if exposed to consumer campaigns designed to increase awareness of the safety benefits associated with reflective material, as well as its aesthetic appeal.

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## REFERENCES

- Beith B.H., Sanders, M.S. & Peay, J.M. (1982). Using retroreflective material to enhance the conspicuity of coal miners. *Human Factors*, 24, 727-735.
- Blomberg, R.D., Hale, A. & Preusser, D.F. (1986). Experimental evaluation of alternative conspicuity-enhancement techniques for pedestrians and bicyclists. *Journal of Safety Research*, 17, 1-12.
- Bloomfield, J.R. (1973). Experiments in visual search. In *Visual Search* (pp. 1-25). Washington, DC: National Academy of Science.
- Cole, B.L. & Jenkins, S.E. (1984). The effect of variability of background elements on the conspicuity of objects. *Vision Research*, 24, 261-270.
- Engel, F.L. (1971). Visual conspicuity, directed attention and retinal locus. *Vision Research*, 11, 563-576.
- Goodwin, P.B. & Hutchinson, T.P. (1977). The risk of walking. *Transportation*, 6, 217-230.
- Greatrix, G. & Smithies, J. (1999). Conspicuity of pedestrians. *Impact*, 8, 59-61.
- Harrell, W.A. (1993). The impact of pedestrian visibility and assertiveness on motorist yielding. *Journal of Social Psychology*, 133, 353-360.
- Harrell, W.A. (1994). Effects of pedestrians' visibility and signs on motorists' yielding. *Perceptual and Motor Skills*, 78, 355-362.
- Hills, B.L. (1980). Vision, visibility and perception in driving. *Perception*, 9, 183-216.
- Hughes, P.K. & Cole, B.L. (1986). What attracts attention when driving? *Ergonomics*, 29, 377-391.
- Jenkins, S.E. & Cole, B.L. (1982). The effect of the density of background elements on the conspicuity of targets. *Vision Research*, 22, 1241-1252.
- Langham, M.P. & Moberly, N.J. (2003). Pedestrian conspicuity research: A review. *Ergonomics*, 4, 345-363.
- Lesley, G. (1995). Enhancing the daytime conspicuity of pedestrians through the usage of fluorescent materials. *Color Research and Application*, 20, 117-123.
- Luoma, J. & Penttinen, M. (1998). Effects of experience with retroreflectors on recognition of nighttime pedestrians: comparison of driver performance in Finland and Michigan. *Transportation Research Part F: Traffic Psychology and Behavior*, 1F 47-58.
- Luoma, J., Schumann, J. & Traube, E. C. (1996). Effects of retroreflector positioning on nighttime recognition of pedestrians. *Accident Analysis and Prevention*, 28, 377-383.
- Martinez, R. (2000). How to reach the optimal traffic safety environment: the American perspective. In von Holst, H., A. Nygren & A. E. Andersson (Eds.) *Transportation traffic safety and health: Man and machine*. Berlin, Germany: Springer-Verlag.
- Moberly, N.J. & Langham, M.P. (2002). Pedestrian conspicuity at night: failure to observe a biological motion advantage in a high-cluster environment. *Applied Cognitive Psychology*, 16, 477-485.
- Olson, P.L., Halstead-Nussloch, R. & Sivak, M. (1981). The effect of improvements in motorcycle/motorcyclist conspicuity on driver behavior. *Human Factors*, 23, 237-248.
- Owens, D.A. & Sivak, M. (1993). *The role of reduced visibility in nighttime road fatalities*. Ann Arbor, MI: University of Michigan Transportation Research Institute. Report No. UMTRI-93-33.
- Owens, D.A., Antonoff, R.J. & Francis, E.L. (1994). Biological motion and nighttime pedestrian conspicuity. *Human Factors*, 36, 718-732.
- Owens, D.A. & Sivak, M. (1996). Differentiation of visibility and alcohol as contributors to twilight road fatalities. *Human Factors*, 38, 680-689.
- Parasuraman, R., Masalonis, A. J. & Hancock, P.A. (2000). Fuzzy signal detection theory: Basic postulates and formulas for analyzing human and machine performance. *Human Factors*, 42, 636-659.
- Shinar, D. (1978). *Psychology on the road: The human factor in traffic safety*. New York, NY: Wiley.