

Cultural Ergonomics and the Pesticide Risk Divide

Smith-Jackson, Tonya L.

**Grado Department of Industrial and Systems Engineering /
Virginia Polytechnic Institute and State University / 250
Durham Hall, MC0118 / Blacksburg / VA 24061-1445 USA
E-mail: smithjack@vt.edu**

Wogalter, Michael S.

**Department of Psychology / North Carolina State University /
640 Poe Hall/ Raleigh / North Carolina 27695-7650 USA
E-mail: wogalterm@aol.com**

Quintela, Yvette

**Sirota Survey Intelligence / One Manhattanville Road /
Purchase / New York 10577 USA
E-mail: yquintela@sirota.com**

ABSTRACT

Pesticide safety is a significant global health concern. We conducted a series of studies to explore factors associated with the risk divide, a term used to describe disparities in injuries and fatalities between majority and minority workers. One study is reported here. Forty (40) farmworkers from the South-Atlantic region of the USA were recruited. Results revealed significant differences between ethnic groups on several measured constructs. Latino migrant workers reported lower perceived control of their work environment and higher risk perception compared to European-Americans. Preliminary recommendations relevant to cultural ergonomics, risk communication usability, and safety climate are provided.

Keywords

Risk communication, cultural ergonomics, pesticide safety, cultural, usability, disparities

INTRODUCTION

Chronic exposure to pesticides has been linked to death, cancer, birth defects, sterility, spontaneous abortion, cognitive and psychomotor deficits, and neurological damage that precipitates suicide and other psychopathologies (Ciesielski et al., 1994, Coye, 1985, Green, 1987, Moses, 1989, Reidy et al., 1992). Short-term effects of exposure can also lead to death, or can involve dizziness, headaches, fatigue, and acute respiratory problems (Ciesielski et al., 1994).

Within the USA and other countries, pesticide exposure statistics support the presence of a risk divide, where minority cultures experience higher exposure levels and exposure rates compared to majority or dominant cultures (Morello-Frosch & Jesdale, 2006). In the USA, annual pesticide usage rates by farmers exceed 1.2 billion

pounds (NIOSH, 2007), and the Environmental Protection Agency (EPA) estimates up to 20,000 pesticide poisonings occur each year.

Migrant and seasonal work is predominantly populated by ethnic and class minorities within many countries. In the USA, eighty-five percent (85%) of farmworkers are ethnic minorities, consisting mostly of Latinos followed by African-Americans, Haitians, Thais, Jamaicans, and Laotians (National Center for Farmworker Health, 2002). The combination of a high risk work environment and labor differentiation that mimics social stratification within a culture leads to a higher likelihood of exposure to unsafe working conditions (Perfecto, 1992; Pinderhughes, 1996). Some researchers have focused on training as the major contributor to risk disparities in the workplace. The Worker Protection Standard requires all workers who apply, mix, or handle pesticides to receive pesticide training. However, training has been shown to be ineffective, culturally incompatible, or non-existent (Arcury, Austin, Quandt, and Saavedra, 1999; Quandt, Austin, Arcury, Summers, and Saavedra, 1999).

Another layer of complexity occurs when cultural groups develop attitudes regarding risk within the workplace that are aligned with their social status within a culture. Unfortunately, the role of culture and the extent to which it is coupled with safety climate has thus been examined relatively little. For the most part, safety programs consider translation of materials into multiple languages to be an adequate solution to cultural usability. However, language is only one factor that influences safety training and risk communication effectiveness (Brunette, 2004). And, even with some acknowledgement of language needs, some organizations have failed to provide translations that have an acceptable degree of fidelity or consistency in meaning and representations across groups (Triandis, 1995). Despite these challenges, the importance of culture is given relatively little consideration in safety and health. Although no methods have been established to examine culture, human factors researchers have repeatedly emphasized the need to give more attention to the systematic examination of cultural influences on system design, training, and injury prevention (Chapanis, 1974; Kaplan, 1995; Smith-Jackson, 1999; Smith-Jackson and Wogalter, 2000).

The need for more attention is the result of an increasingly visible pattern within the risk literature that reveals several factors that seem to correlate with minority status in a variety of risk scenarios. These variables include perceived control over work environment, locus of control (LOC), and self-efficacy (Earle and Cvetkovich; 1997; Grieshop et al., 1996; Karasek and Theorell, 1990; Kouabenan, 1998; Levi 1990; Lundberg, 1999; Thorbjornsson et al., 1999; Wuebker, 1986). In summary, minority cultures tend to report significantly lower degrees of perceived control over work pace, work periods, and type of work conducted, while also reporting lower levels of participation in workplace decisions. Likewise, minority workers tend to report higher degrees of external locus of control within work environments, indicating a belief that work outcomes such as accidents and injuries are not prevented by their own behaviors or precautions, but by external others (management, fate, etc.). Not surprisingly, minority workers also report a lower sense of self-efficacy or confidence in their ability to prevent or facilitate negative or positive outcomes in the workplace. Self-efficacy and LOC are important in health belief models used to predict the likelihood that individuals will engage in prevention or protective behaviors (Weinstein, 1993 in Taylor, Peplau, & Sears, 1997, p. 395). Based on these models, users who are unfamiliar with safety-related information such as warnings will not develop the appropriate risk perception or take precautions that will lead to the adoption of safe behaviors. A lack of control and confidence in one's own ability to prevent hazards and a belief that hazards or exposures are controlled by others is a detrimental combination of factors, and the contribution of these factors to risk perception and exposure risk was the focus of our research effort.

Three studies were undertaken to apply a cultural ergonomics approach to determine factors associated with disparities in pesticide exposure among migrant and seasonal farm workers. A second objective was to design and test culturally-valid labels and educational materials. A mixed-methods approach was used to explore the model shown in Figure 1, which illustrates the relationships between culture and other psychosocial variables and their influence on exposure risk. What may account for disparities are the differences among cultures and how those differences interact with variables that influence exposure risk. Another goal of this research was to capture culturally-centered guidelines that could potentially be applied when developing prevention tools.

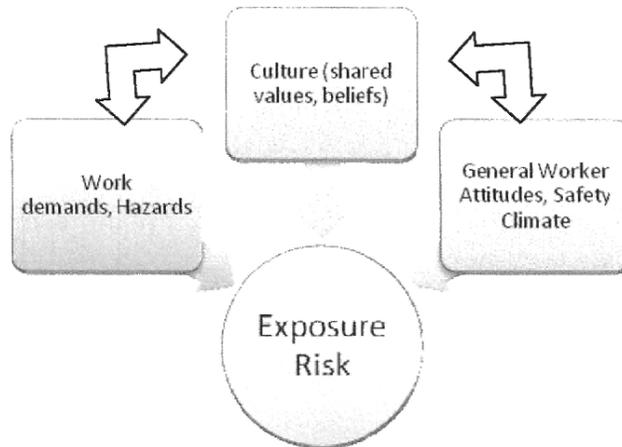


Figure 1. Conceptual model explored by the series of studies.

METHOD

Participants

Forty participants were recruited who self-identified as European-American ($n = 17$; $M_{age} = 44.00$, $SD=10.96$) or Latino ($n = 23$; $M_{age}=35.17$, $SD=7.95$). In this study, ethnicity served as the proxy for culture. Participants were recruited with the assistance of community-based organizations, farm worker outreach organizations, flyers, and newspaper advertisements. Participants were workers on in tobacco farms, apple orchards, cucumber and tree farms in the South Atlantic region of the USA. Latino farmworkers reported a mean weekly income of \$289.78 ($SD=80.13$) with a mean of 9.42 years of farming experience ($SD=9.78$) and 8.17 years of education ($SD=3.39$). European-American farmworkers' mean weekly income was \$511.56 ($SD=212.23$), 25.59 years of experience, and 13.29 years of education ($SD = 2.95$)

Questionnaires

Questionnaires were administered in English and Spanish to elicit demographic information, use of protective equipment, health symptoms associated with pesticide exposure, and awareness of health problems and risk information associated with pesticide exposure. We also used six common warning symbols to test comprehension and nine phrases that could be found on pesticide warning labels. Questionnaire items were a mix of open-ended, yes/no, and Likert ratings. Triandis' (1995) back-translation method to verify translation fidelity was applied to all questions on the questionnaire. Two bilingual translators worked independently to verify translation fidelity. A primary goal of the overall questionnaire design was to develop a practical, efficient, yet valid measure of the constructs of interest.

Seven items from the Risk Perception Scale (Leonard, Hill, and Karnes, 1989) were administered. Six of the items were revised to apply directly to pesticide hazards

(Table 1), and a Likert scale was employed (five alternatives from *strongly disagree* to *strongly agree*). Items used were:

1. In the past month, I often had thoughts or fears about the health effects of pesticides.
2. Pesticides could affect the health of children born to farmworkers.
3. Farm workers will experience health problems in the future that are due to pesticide exposure.
4. I will experience health problems in the future that are due to pesticide exposure.
5. Getting pesticides on my skin can cause an illness that could last a long time.
6. To me, it is more important to work than to worry about getting sick from pesticides.
7. If you are a strong individual, you will not get sick from pesticides. (Reverse coded).

Five items from Jones' and Wuebker's (1993) Safety Locus of Control questionnaire were used to assess workers' beliefs in the source of control over hazard exposures. The content of the items were modified to be directly relevant to pesticide hazards. Two items measured internal locus of control (1, 4) and three items measured external locus of control (2, 3, 5). The scale items were:

1. I have a great deal of control over keeping myself from getting sick because of pesticides.
2. I have no control over the amount of pesticides that I am exposed to.
3. There is no point in worrying about being exposed to pesticides. What will be will be.
4. If I become exposed to pesticides and become sick, it is my own fault.
5. Regarding safety from pesticide exposure, I can only do what the supervisor/boss tells me to do.

The authors developed a Safety Self-Efficacy Scale that was based upon Bandura's (1977) and Mayer and Sutton (1996) definitions of the construct of self-efficacy. In addition, the content of the items was selected by using health and safety information on precautionary behaviors necessary to prevent or control pesticide exposure, as well as common barriers to the display of precautionary behaviors. The seven items were reviewed for face validity by independent reviewers who gave feedback on the relevance of the items to safety and self-efficacy. These items were:

1. I am confident that I can prevent myself from being exposed to pesticides.
2. I am confident that I can prevent my family from being exposed to pesticides.
3. If I needed advice on how to safely handle a given pesticide, I am confident that I would be able to get that advice.
4. I am confident that I can use personal protective equipment correctly to protect myself when mixing/applying pesticides or when harvesting crops that sprayed by pesticides.
5. I am confident that I can stay out of the fields during the restricted entry interval (time period after spraying).
6. I am confident that I can reduce the chance of pesticide exposure by washing my hands before I eat.
7. I am confident I can use the recommended personal protective equipment in hot weather or when I am tired.

A final scale was administered to explore behavioral intent to display precautionary behaviors. Similar to Safety Self-Efficacy, the Behavioral Intent items were reviewed by independent judges for face validity. Content was selected on the basis of individual pesticide safety behaviors that can prevent or control pesticide exposure. The eight items were:

1. In the future, I will read the warnings on pesticide labels before using a pesticide.

2. If the label instructions indicate to do so, I will wear gloves the next time I work in fields where pesticides have been sprayed.
3. In the future, I will be careful when handling crops that have been sprayed with pesticides.
4. In the future, I will wash my hands before eating after working in areas where pesticides are used.
5. In the future, I will not enter a field immediately after it has been sprayed with pesticides.
6. I will not go see a doctor the next time I am exposed to pesticides while applying them. (Reverse coded)
7. I will not go see a doctor the next time I become dizzy after working in the fields. (Reverse coded)
8. In the future, I will wash my work clothes after working in areas where pesticides have been used.

Participants also reported whether they experienced any symptoms associated with pesticide exposure. The checklist is shown below:

Skin rashes	Allergic reactions
Headache	Chest pain
Coughing	upset stomach/nausea
Vomiting	Dizziness/weakness
Loss of appetite	Problems with memory or thinking
Trouble breathing	Fainting
Itchy eyes	Jumpiness, Edginess
Excessive sweating	

The six warning symbols tested are shown in Figure 2. Participants were asked to report the meaning of the symbol if they saw it on a label or brochure.



Figure 2. Symbols displayed to participants to test comprehension.

Several phrases and signal words were selected from pesticide product labels. Participants were asked to report the meaning of the phrases. The phrases were:

- Pesticide drift
- Harmful if absorbed through skin
- Avoid breathing vapor
- Harmful if inhaled
- Get medical attention if irritation persists
- Organophosphate insecticide
- WARNING
- DANGER
- CAUTION

Procedure

Information was gathered from advocacy and community groups to identify farms and farm workers who could be classified as migrant or seasonal. Questionnaires were administered at different sites near farms. Workers were interviewed in locations away from their occupational settings. All documents, including informed consent, were read aloud in English or Spanish unless a worker wished to read and complete the document on their own. Once informed consent was acquired, one copy of the informed consent document with researchers' contact information was provided to participants. Participants were compensated \$10 for participation. At the end of the interview, information with Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA) hotline numbers as well as pesticide safety brochures were provided to workers. Interviews lasted between 25 and 45 minutes.

RESULTS

A Shapiro-Wilk test of normality was conducted on summated ratings of risk perception, safety self-efficacy, internal and external safety locus of control, and behavioral intent. All variables were normal, with *W*-values ranging from .88 to .94. Internal consistency reliability of the questionnaires was determined using Cronbach's alpha coefficients. Four of the seven items (items 2 – 5) were retained for the Risk Perception Scale resulting in an r_{alpha} of .68. All items on the Safety Self-Efficacy Questionnaire and the Behavioral Intent Questionnaire were retained with r_{alphas} of .75 and .63, respectively. Given the small number of items on the Internal Safety LOC (2) and the External Safety LOC (3) questionnaires, no reliability assessments were conducted. Analyses were conducted to test the hypothesis that migrant and seasonal farm workers from ethnic and language minority groups will have lower risk perception of pesticide hazards, higher external LOC, and lower self-efficacy compared to farm workers who are not minority group members.

Correlations between safety-related variables tested in the hypotheses were conducted using the Pearson coefficient (Table 1). Three variables had significant positive relationships with Behavioral Intent. Safety internal locus of control was correlated with Safety self-efficacy.

Table 1. Correlation Matrix

Constructs	Risk Perception	Safety IntLOC	Safety ExtLOC	Safety Self-Eff
Safety Locus of control (Internal)	.09			
Safety Locus of control (External)	.20	-.22		
Safety Self-Efficacy	.01	.39*	-.30	
Behavioral Intent	.32*	.38*	-.06	.38*

*significant at $p < .05$

An independent samples t-test was conducted to test the hypothesis of differences between Latinos and European-American farmworkers (Folded-F indicated variances were equal). Figure 2 shows the significant differences identified among ratings of Risk Perception [$t(38) = 3.79, p < .0005$]; Safety Self-efficacy [$t(38) = 3.37, p < .01$]; and Safety External LOC [$t(38) = 4.24, p < .0001$]. Behavioral Intent and Safety Internal LOC did not differ between groups. Latino farmworkers reported

significantly higher Risk Perception and Safety External Locus of Control. European-American workers reported significantly higher Safety Self-efficacy.

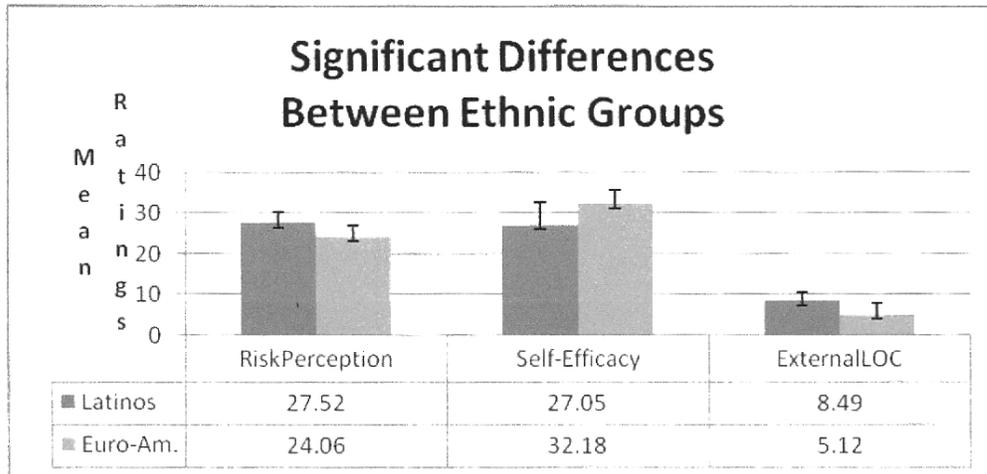


Figure 2. Graph displaying means for the three rating scales that showed significant differences between ethnic groups; ($p < .0005$, $p < .01$, and $p < .0001$, respectively).

Differences in total self-reported symptoms were explored to identify any patterns of differences between ethnic groups. An independent groups t-test revealed that significantly more symptoms [$t(38) = 4.20$, $p < .001$] were reported by Latino farmworkers ($M = 7.56$, $SD = 3.23$) than by European-American farmworkers ($M = 3.47$, $SD = 2.79$).

Fisher's exact tests were conducted to compare individual symptom reports. Proportionally more Latinos reported experiencing skin rashes, dizziness/weaknesses, nervousness/jumpiness, and loss of appetite compared to European-American workers ($p < .05$). Proportionately more European-American farmworkers reported experiencing nausea, itchy eyes, and sweating ($p < .05$).

Fisher's exact tests were also used to explore differences between ethnic groups and knowledge of warning symbols and phrases associated with pesticides. Knowledge was assessed using a variable assignment of correct and incorrect. European-American farmworkers gave proportionately more correct responses (71%) compared to Latino farmworkers (35%) for the meaning of *pesticide drift*. The LIGHTNING BOLT symbol was found to be proportionately different between groups, with European-American workers giving more correct responses (80%) compared to Latino farmworkers (20%), $p < .01$. The overall percentages of *correct* responses for each of the symbols and phrases are shown in Table 2.

Table 2. Percent (%) correct responses reported by Latinos and European-American workers.

Symbol/Phrase	Latinos	European-Americans
Skull/Deadly	54%	46%
Exclamation/Alert	47%	53%
Lightning Bolt/Electrocution*	20%	80%
Yuck/Poison	40%	60%
Prohibition	57%	43%
Asterisk/Alert	40%	60%
Pesticide Drift**	35%	71%
Harmful if absorbed	55%	45%
Avoid breathing vapor	54%	46%
Harmful if inhaled	68%	32%
Get medical attention if irritation persists	53%	47%
Organophosphate insecticide	25%	45%
WARNING	50%	50%
DANGER	47%	53%
CAUTION	50%	50%

*Significant at $p < .05$. **Significant at $p < .01$.

DISCUSSION AND CONCLUSIONS

The quantitative data reported here revealed interesting differences, that support the relationships in Figure 1; there are cultural differences in variable known to influence risk exposure. The descriptive data revealed that Behavioral intent to display precautionary behaviors was significant and positively correlated with Risk perception, Safety Internal LOC, and Safety Self-efficacy. Higher Risk Perception and Internal LOC were associated with higher ratings of behavioral intent to display precautionary behaviors. Higher Safety Self-efficacy was also associated with higher behavioral intent ratings. These results validate previous studies focused on disparities in other occupational settings among minority and majority group members (Earle and Cvetkovich; 1997; Grieshop et al., 1996; Karasek and Theorell, 1990; Kouabenan, 1998; Levi 1990; Lundberg, 1999; Wuebker, 1986).

Significant differences in ratings were found among ethnic groups. Latino farmworkers reported higher risk perception ratings compared to European-American farmworkers. Since lack of awareness is associated with lower risk perception, this research implicitly assumed that Latino farmworkers' lower levels of knowledge (due to lack of access to relevant information) would lead to lower risk perceptions. However, studies by Finucane, Slovic, Mertz, Flynne, and Satterfield (2000) indicate a tendency of younger white males to report relatively lower perceptions of risks for many different hazards compared to other gender and ethnic groups. Although European-American farmworkers in this sample tended to be older than the Latino participants, some of the 'white male effect' may account for the differences in risk perceptions. Latino workers may be more aware of their lack of knowledge associated with pesticides

compared to European-American workers.

As expected, Latino workers reported lower confidence in their ability to protect themselves from hazards in the workplace. This lower self-efficacy could be related to the power dynamics within the workplace settings and the status of Latino workers, which might increase the chances that they are not provided with necessary personal protective technologies or information about hazards. Likewise, Latinos reported a higher external locus of control, which supports the interpretation that Latinos attribute control over safety-related outcomes to external others (bosses, supervisors, fate). Given the combination of low self-efficacy, high risk perception, and lower external locus of control, an inference could be made that a number of dynamics associated with social status that occur among cultures are replicated in occupational settings and safety climates. Latino farmworkers reported a higher awareness of the dangers of their work, but in the face of higher risk perception, reported less control and less confidence in their ability to protect themselves. This pattern is important in that it may represent the consequences of power dynamics within the workplace.

In addition to the differences in important psychosocial variables, Latino workers reported significantly more total symptoms associated with pesticide poisoning. The lack of awareness of symbols and phrases did not differ to a great extent between ethnic groups. With the exception of the LIGHTENING BOLT and the *pesticide drift* phrase, no other significant differences were found. The pattern of these two differences was within the predicted direction; European-Americans reporting significantly more correct responses. Interestingly, among the non-significant findings, there were several symbols and phrases that indicated a disturbing lack of knowledge among both groups. For example, only 40% of Latinos and 60% of European-American farmworkers gave correct answers for the MR. YUCK and ASTERISK/ALERT symbols. Also, only 25% of Latinos and 45% of European-Americans comprehended the phrase *organophosphate insecticide*.

Cultural usability, as applied to risk communication design, needs more emphasis in the following areas:

- The differences between groups relevant to language and the cognitive representations communicated by language.
- Factors that relate to the context of use for different cultural groups, some of which may involve high power distances and social stratification.
- Specific cultural attributes that may account for varying beliefs and expectations among groups, i.e., this research and Hofstede's constructs (1997).
- Identification of relatively universal symbols and signal words.
- Testing within the context of use.
- Inclusion of cultural groups through the use of participatory design.

Recent work by Smith-Jackson, Leonard, and Essuman-Johnson (2003) examined symbol primes as basic sets of symbols that could be generalized across cultures. Basic geon/symbol parts indicating "to do" and "not to do/prohibition" were generally well-understood by Ghanaian and American industry and trade workers. Previous studies by Smith-Jackson and Wogalter (2000) also showed some agreement in the hazard connotations associated with the color red between two Latino and non-Latino participants. The *Globally Harmonized System for Classification and Labelling of Chemicals* has been adopted by the United Nations and the EPA as a universal set of symbols, but extensive testing in a variety of global contexts has not been conducted. Since testing in various contexts is the only way to identify symbols that will be usable across cultures, efforts thus far have questionable validity. Warnings and risk communications are part of a larger system and organizational context. Thus, the effectiveness of warnings and risk communications must also consider the context of use in order to evaluate overall effectiveness. Additional efforts incorporating different cultural groups can contribute to our understanding of cultural usability. Disparities

will continue to exist until equitable and culturally-valid risk communications and other interventions can be designed.

References

- Arcury, T.A., Quandt, S.A., Austin, C.K., Preisser, J. and Cabrera, L.F. (1999). Implementation of the EPA's worker Protection Standard training for agricultural laborers: An evaluation using North Carolina Data. *Public Health Reports*, 114, 5, 459-468.
- Bandura, A. (1977) Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, 84, 191-215.
- Brunette, M. (2007). Construction safety research in the United States: Targeting the Hispanic workforce. *Annual International Conference of Associated Schools of Construction*, Northern Arizona University, April 12 – 14.
- Chapanis, A. (1974). National and cultural variables in ergonomics. *Ergonomics*, 17, 153-175.
- Ciesielski, S., Loomis, D.P., Mims, S.R., Auer, A. (1994). Pesticide exposures, cholinesterase depression, and symptoms among North Carolina Migrant farmworkers. *American Journal of Public Health*, 84 (3), 446- 451.
- Coye, M.J. (1985). The health effects of agricultural production: I. The health of agricultural workers. *Journal of Public Health Policy*, 6, 349 – 370.
- Duncker, E., Theng, Y.L., and Mohd-Nasir, N. (2000). Cultural usability in digital libraries. *Bulletin of the American Society of Information Science*. Online: http://findarticles.com/p/articles/mi_qa3633/is_200004/ai_n8897321. Retrieved: March 23, 2008.
- Earle, T.C. and Cvetkovich, G. (1997). Culture, cosmopolitanism, and risk management. *Risk Analysis*, 17, 54-65.
- Environmental Protection Agency. *Globally Harmonized System for Classification and Labelling of Chemicals*. Online: <http://www.epa.gov/oppfead1/international/globalharmon.htm>, retrieved 3/17/08.
- Finucane, M.L., Slovic, P., Mertz, C.K., Flynn, J., and Satterford, T. A. (2000). Gender, race, and perceived risk: The 'white male' effect (2000). *Health, Risk, and Society*, 2, 159 – 172.
- Grieshop, J.I., Villanueva, N.E., and Stiles, M.C. (1994). Wash day blues: Secondhand exposure to agricultural chemicals. *Journal of Rural Health*, 10, 247 – 257.
- Jones, J.W. and Wuebker, L.J. (1993). Safety locus of control and employees' accident. *Journal of Business and Psychology*, 7, 449 – 457.
- Kaplan, M. (1995). The culture of work: Cultural ergonomics. *Ergonomics*, 38, 606 – 615.
- Karasek, R.A., Jr., & Theorell, T. (1990) *Healthy work: Stress, productivity, and the reconstruction of working life*. New York: Basic Books.
- Kouabenan, D. R. (1998). Beliefs and the perception of risks and accidents. *Risk Analysis*, 18, 243-253.
- Leonard, S.D., Hill, G.W., and Karnes, E.W. (1989). Risk perception and the use of warnings. *Proceedings of the Human Factors Society 33rd Annual Meeting*, 550 – 554. Santa Monica, CA: Human Factors Society.
- Lundberg, U. (1999) Stress responses in low-status jobs and their relationship to health risks: Musculoskeletal disorders. *Annals of the New York Academy of Sciences*, 896, 162-172.
- Mayer, F. S. and Sutton, K. (1996) *Personality: An Integrative Approach*. Upper Saddle River, NJ: Prentice Hall.
- Morello-Frosch & Jesdale (2006). Separate and unequal: Residential segregation and estimated cancer risks associated with ambient air toxicity in U.S. metropolitan areas. *Environmental Health Perspectives*, 114.
- Perfecto, I. (1992). Pesticide exposure of farm workers and the international connection. In B. Bryant and P. Mohai (Eds.). *Race and the Incidence of Environmental Hazards*. Boulder, Colorado: Westview Press.
- Pinderhughes, R. (1996). The impact of race on environmental quality: An empirical and theoretical discussion. *Sociological Perspectives*, 39, 231 – 248.
- Smith-Jackson, T. L., Leonard, S.D., and Essuman-Johnson (2003). Comparison of USA and Ghanaian Interpretations of Prohibition and "To-Do" symbols. *International Society for Occupational Ergonomics and Safety*.
- Smith-Jackson, T.L. and Wogalter, M.S. (2000). Users' hazard perceptions of warning components: An examination of colors and symbols. *Proceedings of the 14th Triennial Conference of the IEA/HFES*, 6, pp. 55 - 58.
- Smith-Jackson, T. L. and Wogalter, M.S. (2000). Applying cultural ergonomics to safety information research. *Proceedings of the 14th Triennial Conference of the International Ergonomics Association and the 44th Annual Meeting of the Human Factors and Ergonomics Society*. Santa Monica, CA: Human Factors and Ergonomics Society, 6, pp. 150 – 153.

ACKNOWLEDGEMENTS

This research was funded by a grant from the National Institute for Occupational Safety and Health (NIOSH) as part of the Southern Coastal Agromedicine Center. The authors are thankful for the resources provided by NIOSH and the Center. In addition, the authors are grateful for the assistance of Dr. Ray Lim with data collection associated with this project.