Int. J. New. Chem., 2019, Vol. 6, Issue 4, pp. 224-235.

International Journal of New Chemistry
Published online 2019 in http://www.ijnc.ir/.

Online ISSN 2383-188X
Open Access

Original Research Article

The Assessment of Perceived Risk of Chemical-related Illness Among Inhabitant Community Adjacent to an Industrial Unit

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ABSTRACT

The perceived risk is assessed in order to conduct subjective evaluation of individual or community of probability of occurrence of accidents, crashes, and way of exposure to the related consequences. Although such estimation may not comply with what it occurs in real situation since this part is totally related to psychological aspect and at the same time it should be incorporated in planning for risk management. With respect to literacy, cultural, and gender levels and beliefs in communities, perception of the probable risk may be followed by some fluctuations. It has been tried in the present project to explore effect of factor of fear of disease on perceived possible risk among the people who live at neighborhood of MDF Manufacturing Companies. To analyze the rate of effect of fear of disease on the perceived possible risk at region and their relationship with demographic attributes including age, gender, education, having children, and employment in factory, the questionnaire with close-end questions of Likert spectrum type was administered. Data were analyzed by SPSS (v.16) and two-sample t-test and Pearson's correlation coefficient and linear regression with ($p<0.05$). Based on the results, out of total respondents 228 persons (79.2%) were males and 60 one (20.8%) were females and among

these respondents 180 members (62.5%) had children. The maximum average age (30-40years) and the highest educational level belonged to high school diploma with 125 members (43.4%) and the maximum annual expenses were estimated (50-100 million Rials).
Keywords: Perceived Risk Assessment, Fear from disease, Perceive risk, Pollution, MDF Industries

Introduction

The field and goal of communication for possible risk is efficient dialogue between all of effective and affective persons in implementation of this project [10]. Various techniques of communications for possible risk may reduce environmental adverse effects and lead to improve level of trust among the interest group, rising reliability, and proper planning for decrease of ecologic destruction and pollutions as well as enhancing level of public health[13]. Analysis on the perceived risk assessment in local community regarding risk is deemed as requisite for communication for the possible risk perception thereby one can reduce environmental destruction by change in behavior of the interest [9]. The main subject is perception of possible risk or public opinion in discussion about risk paradigm and perception of possible risk is intended to execute subjective assessment by individual and community toward probability of occurrence of accidents, crashes, and way of confrontation to the given [8]. However, such an estimation may not comply with what it takes place in reality [5].This part of subject that is totally related to psychological aspect should be embedded into planning for risk management Perception of possible risk may be accompanied to several fluctuations with regard to level of literacy (education), culture, gender, and beliefs in communities [7] This study deals with analysis on perception of the probable risk or public opinion of risks and adverse effects of MDF1 Factories on surrounding natural biologic and human environment. [12]. MDF products are derived from composition of some materials such as primary soft wood along with an aldehyde resin coatin[20].The space of MDF manufacturing factories includes a mixture of wood dust and haze, free formaldehyde[14]., and also particulates that store and convey formaldehyde and resinous fibers and their derivatives by adsorption mechanism[16].And these materials cause serious pollution in ambience due to contents of chemical compounds including phenol urea and phenol form, aldehyde extender[15]., and types of aldehydes and hardener substances. Given these manufacturing companies produce waste materials from this product at scale of tons per day so vulnerability of adjacent communities to such industries should be examined [18]. Formaldehyde is disseminated in air, products, and foods at very low quantity and it is used in industries of woods, construction, and paper production and it may create disorder in respiratory tracts, lung, throat, and eye[19]. The symptoms of high- level exposure to formaldehyde include allergy and burning of eye and nose and discharge of tear, coughing, and spasm in larynx. Similarly, it may be assumed as an allergen for skin that causes inflammation and irritation in skin. Likewise, aldehyde has been characterized as a carcinogen by US Environmental Protection Unit and Cancer Research Institute and it is identified as carcinogen at rank 2A [2]. High dosage of this material is led to more severe disorders, cancer, comma, and sometimes death. Formaldehyde is easily synthetized in environment therefore it may not remain in water for long period [22].The maximum level of formaldehyde existing in air is synthetized over day and night. Formic acid and carbon monoxide are the products from synthesis of formaldehyde [3].

[1] - Medium Density Fiberboard

The cellulose industries are deemed as major industries in countries with massive forests. Also due to presence of massive forests at north of Iran, this industry is considered as the biggest manufacturing industries [17]. These industries consume huge amounts of water and discharge about 80-85% of their consumed water as runoff and wastewater into the environment [6]. The output runoff of these factories includes organic and pollutant compounds as well as colorful substances. It consists of liquid in dark brown color with properties of BOD (biochemical oxygen demand), and COD (chemical oxygen demand), and high content of color etc [4]. Discharge of runoff into environment and entry into the water stream in their path causes numerous ecologic damages. Dark color of output runoff from paper manufacturing factory restricts the penetration of sunlight beam on water surface [19]. This factor prevents from life of aquatic plants that need to light for photosynthesis [2]. Some part of lignin in wooden tissue exists in these industries. Lignin is a tridimensional and heterogeneous polymer that is composed of phenyl propane units. It is one of compounds with very low biodegradability potential and it is the main factor for dark color and high COD in the studied runoff [1].

The present research is conducted in Arian Sina MDF factories which have been exploited since 2007. These factories are assumed as examples of industrial plants without appropriate location-finding (topography). At present, despite of two active phases and an under-construction phase this unit has caused concern and dissatisfaction for regional people. The aforesaid complex is currently considered as the largest MDF manufacturing factory in the Middle East and as one of the three national MDF factories under exploitation. This factory is situated at kilometer 18 of Farah Abad Road in Sari city in residential texture of Esfandan Village at this town (while according to Approval of Board Ministers regarding project of balance of industry and agriculture at northern area of Iran (Guilan and Mazandaran) and due to their strategic role the allowed distance between these industries and cities shall be in radius of 50km) and public opinion of this region about pollution of this industrial unit is based on this paradigm that most of ecologic problems have been created in this region after date of starting activity in this complex (such as increase in quantity of farming pests and invasive insects, reduction of yield of paddy fields crops, and destruction of gardens and citrus and black root products within hectares) that are directly and indirectly related to the given factory. In this study, we intend to explore the methods for reducing ecologic destruction and also improving level of public health by benefitting from various techniques of assessment of public opinion about risk and paradigm of risk. The present research is focused in this point that how much demographic factors may impact on perceived risk of disease in adjacent inhabitants to such industries so that to propose the best choice for problem solving in addition to protection from environment and acquiring public consent.

Method of study

The studied zone

The case study includes the regional inhabitants adjacent to Arian Sina MDF Factories Complex situated at kilometer 18 of Farah Abad Road in Sari city in Northern Roodpey County that is located 7km distant from Mazandaran Sea. The review on meteorological reports in this city indicates that prevailing direction of wind of this region is west and northwest. With respect to direction of prevailing wind and visiting the regions in which wind direction is against the prevailing wind direction and at the same time the watercourses led to Tajan River, the path was

selected as the studied zone in which the major pollution of this factory was placed such as particulates of saw dust settled on ground and trees and path of transferring of the discharged runoff into watercourses in four villages (Abmal, Esfandan, Kordkheil, and Hamid Abad) and this region was explored. The given industrial complex is limited from north to double-lane Farah Abad Road, and from east and southeast to Esfandan village, of south to Kordkheil, and adjacent to Abmal village from the west.

Studied parameters

In order to collect the needed data about effect of factor fear from disease on perception of risks of probable pollutions, questionnaire was used as tool and method of present interview with the regional villagers. Design of inventory included two groups of general and special questions that mainly of Likert five-scale spectrum type. The questions have been prepared as plain and perceivable and at different levels of literacy. With respect to the existing relationship among economic- social level and gender with the perceived risk in scientific sources, the given questions with these specifications were embedded in this questionnaire.

Statistical population and sample

Among the studied population in this project (total villages situated in north Roodpey County), three villages i.e. Abmal and Esfandan and Kordkheil have been identified as more vulnerable by taking into account given parameters and regional conditions and at the same time Hamid Abad village was assumed as an example of studied villages where no pollution from the factory was observed there. For example, due to position of this zone at northwest of factory and toward prevailing wind direction air pollution has no effect on this village but nonetheless due to governing climate over this region and the discussed subject in this study the inhabitants of this village feel sense of insecurity because of perceived risk of the existing factory. The factory is located in texture of Esfandan village and farming and gardening lands and canals of inhabitants in these three villages are perfectly connected to wall of factory. Therefore, these villages have become vulnerable to both of studied subjects including air pollution and water pollution. Location of these villages through path of prevailing wind (west and northwest) in this region is crucially important in terms of air pollution and adhesive wooden runoff powders with resin contents and given farmlands and also health of village dwellers. These villages were selected by means of meteorological information and superposition of factory site and land uses maps and watercourses in GIS environment. Sampling was carried out by technique of opportunistic or emergent sampling and sample size was determined using Morgan's Table. As a result, our statistical population comprises of 3590 members that composed of 1005 families. Quantity of members of this population was not considered because most of questions proposed in this inventory concerned with items of having children and income etc. therefore head of families were addressed in this study. The method of sampling in this project is of proportional classified random sampling type. Morgan's Table was utilized to determine sample size accordingly 278 questionnaires needed for 1000 families. Given this ratio, number of needed questionnaires for studied statistical population was estimated 280 with 1005 families where portions of these four villages were 70 questionnaires designated for Esfandan village, 50 questionnaires for Abmal village, 28 questionnaires for Kordkheil village, and 140 questionnaires for Hamid Abad. Cronbach alpha coefficient was used for determination of reliability of questionnaire.

Methods of data analyses

Descriptive and inferential methods have been addressed in data analysis of study. In part of descriptive statistic, distribution of attributes of respondents were explored within framework of descriptive statistics including frequency, percentage, central tendency (mean, median, and mode), and central dispersion (standard deviation and variance) and variance coefficient and in part of inferential statistics, two-sample independent t-test was utilized to identify presence of significant difference in rate of awareness of pollution (perceived possible risk of pollution) along with demographic variables such as gender (females and males) and also persons with/ without children. Pearson's correlation coefficient was used in order to explore presence of significant difference in rate of awareness of pollution (perceived possible risk of pollution) along with demographic variables such as age, education, expenses, and employment in factory where this coefficient is supposed as one of the most widely used techniques for determination of rate of correlation among two variables and shown by symbol 'r'. This coefficient varies among + to -1 to determine the correlation.

Findings

The results of following descriptive statistics for tests of variables of awareness of the existing pollution and incidence of human and livestock diseases and farming pests and diseases are given in Tables (1) to (5):

Table (1): The descriptive statistics relating to awareness of the existing pollution

Items	Not at all	Low	Average	High	Very high
Air pollution due to vehicles	0	144	0	54	90
Air pollution caused by factories	11	0	11	81	185
Dust and haze caused by factories	6	60	0	71	205
Noise caused by factory and vehicles	11	30	11	162	74
River water pollution	0	18	6	112	152
Pollution in farming soils	11	27	6	89	155
Pollution in fishes extracted from river	6	62	40	98	82
Present of pollution in farming crops	6	12	19	118	133
Polluted drinking water	5	67	25	119	72
Pollution in industrial waste landfill site	22	51	32	115	68
Pollution at sites of industrial runoff discharge	6	23	10	100	149

Table (2): Descriptive statistics relating to incidence of disease

Items	Strongly disagree	disagree	fair	Agreed	Strongly agreed
Disease caused by polluted drinking water	11	25	43	141	68
Pollution due to working in factory	11	11	0	142	124
Concern about existing toxics around life place	6	16	0	83	183
Disease of inhabitants due to inappropriate nutrition	21	157	14	79	17
Dermal diseases due to swimming in river	17	0	0	95	176
Occurrence of respiratory complications due to dust and haze in person and family members	6	36	12	85	149
Rising disease among students due to exposure of school to polluted area	11	23	12	77	165
Disease of inhabitants due to polluted farming crops	24	0	28	132	104
I have all needed information about risks due to presence of industrial factory in my living site.	76	0	5	128	79

Primarily, this issue is examined that if there is any significant correlation among the perceived risk of pollution and fear from incidence of diseases or not; in other words, analysis of this subject that if there is more sensitivity to the pollution because the inhabitants believe in presence of adverse effect on health therefore we used test of Pearson's correlation coefficient in Tables (3):

Table 3: Results of Pearson's test in analysis the relation of incidence of disease caused by the existing pollution (result in total region)

Test	Pearson's correlation coefficient	Significance level	Quantity	Existing relation	Type of relation
Disease	1.000	0.000	288	Has	Direct

With respect to value of Pearson's correlation coefficient in study on total region of research, this correlation value is 1.000 with significance level 0.000 that is smaller than (α=0.05). Thus, it can be concluded that there is significant difference among perceived risks of pollution and diseases by people in this region with direct correlation. This test expresses that as the level of fear from incidence of disease is increased, the fear from pollution caused by factory is also added in this region and perception of pollutant nature of factory activity also becomes further and vice versa.

Mean rate of fear incidence of disease was initially examined more accurately among respondents for any village in SPSS environment and they are given in Tables (4) to (7) with the highest fear from incidence of disease in this region separately for each of studied villages:

Table 4: The result of mean test regarding type of perceived risk of disease in Esfandan village:

Type of pollution	Quantity
Respiratory disease due to dust	59
Inhabitants'' concern for toxics	5
Dermal disease due to swimming	61

Table 5: The result of mean test regarding type of perceived risk of disease in Abmal village:

Type of pollution	Quantity
Disease due to farming crop/ disease caused by nutrition	16
Inhabitants'' concern for toxics	13
Respiratory disease due to dust/ inhabitants' awareness level	12

Table 6: The result of mean test regarding type of perceived risk of disease in Hamid Abad village:

Type of pollution	Quantity
Disease of students in region	102
Inhabitants'' concern for toxics/ dermal disease due to swimming	99
Disease in personnel/ respiratory disease due to dust	67

Table 7: The result of mean test regarding type of perceived risk of disease in Kordkheil village:

Type of pollution	Quantity
Disease of students in the region	21
Inhabitants'' concern for toxics	20
Dermal disease due to swimming/ respiratory disease due to dust	19

The highest perceived risk of diseases was calculated separately for each of villages after the conducted researches where the related results are given in Table (8):

Table 8: The highest perceived risk of disease in the region

Type of disease	Region
Inhabitants' concern for toxics	Total region
Dermal disease due to swimming	Kordkheil, Hamid Abad, and Esfandan
Disease of students in the region	Kordkheil and Hamid Abad
Respiratory disease due to dust	Total region
Disease in personnel	Hamid Abad

Most of inhabitants of the studied villages commonly believed in their concerns and worry about toxins and respiratory disease caused by dust and haze from the factory. At the second phase, we have explored the relationship among age, educational level, expenses (costs), gender, and having children or not with the perceived risk of disease in the region:

- Age and disease: Pearson's coefficient was utilized to determine significance level for correlation among age of inhabitants in adjacent villages and fear from incidence of disease. The results of this test are given Table (9):

Table 9: The result of Pearson's coefficient test in determination of correlation among perceived risk of disease and age of persons in total region

Variable	Age				
Test	Pearson			Existing relation	Type of relation
	Correlation coefficient	Significance	Quantity		
Disease	0.059	0.004	288	Has	-

With respect to value of Person's correlation coefficient between two above variable that is 0.059 and p-value (significance level) as 0.004 which is smaller than (α= 0.05) therefore it can be concluded that there is significant relationship among disease and age in total region.

- Educational level and perceived risk of disease: Pearson's correlation coefficient was utilized to determine significance level and correlation among educational level of inhabitants in adjacent villages and perceive risk of disease. The results of this test are given Table (10):

Table 10: The result of Pearson's coefficient test in determination of relationship among perceived risk of disease and educational level of inhabitants in total region

Variable	Educational level				
Test	Pearson			Existing relation	Type of relation
	Correlation coefficient	Significance	Quantity		
Disease	-0.039	0.507	288	Has not	-

With respect to quantity of Pearson's correlation coefficient between two above variables as -0.039 and p-value is 0.507 (significance level) therefore it is greater than significance level (α= 0.05) so it can be concluded that there is no relationship among fear of disease and educational level in total region.

- Expenses and diseases: Pearson's correlation coefficient has been used for determination of significance level for correlation among expenses of inhabitants of adjacent villages and perceived risk of disease. The results of this test are displayed in Tables (11).

Table 11: The result of Pearson's correlation coefficient in determination of relation among perceived risk of diseases and expenses in total region

Variable	Expenses				
Test	Pearson			Existing relation	Type of relation
	Correlation coefficient	Significance	Quantity		
Disease	0.138	0.019	288	Has	Direct

With respect to Pearson's correlation coefficient among two above variables as 0.138 and p-value (significance level) as 0.015 that is smaller than significance level ($\alpha = 0.05$) therefore it can be concluded that there is direct relationship among disease and expenses in total region.

- **Employment in factory and diseases**: Pearson's correlation coefficient has been used to identify significance level and presence of relationship among employment in factory and perceived risk of disease for total region and results of this test are listed in Table (12).

Table 12: The result of Pearson's correlation coefficient in determination of relationship among perceived risk of disease and employment in factory

Variable	Employment in factory				
Test	Pearson			Existing relation	Type of relation
	Correlation coefficient	Significance	Quantity		
Disease	-0.438	0.000	288	Has	Inverse

Given that the value of Pearson's correlation coefficient among above variables is -0.438 and p-value (significance level) as 0.000 is lesser than significance level ($\alpha = 0.05$) thus it can be concluded that there is reverse and indirect relationship among disease and expenses in total region.

- **Gender and disease**: two-sample t-test was employed to determine relationship among perceived risk of disease and gender and their results for the studied region are given in Table (13).

Table 13: The result of t-test in determination of relationship among perceived risk of disease and gender in total region

Leven's test: Variance as criterion for decision making (Sig)	Rejected hypothesis	Decision-making criterion for means (Sig)	Rejected hypothesis	Confidence interval (95%) for differences	
				Upper boundary	Lower boundary
0.011	H0	0.000	H0	0.39987	0.12508

The equality of variances was initially analyzed to conduct this test where the result denoted inequality of variances for them so H0 was rejected. Then, H0 was tested for second hypothesis based on two-sample t-test and P-value was estimated 0.000 for it where this value was derived smaller than 0.05 therefore H0 was disproved and the relationship was confirmed for effect of gender on perceived risk of disease.

- Having children and disease: Two-sample t-test was utilized to determine relationship among perceived risk of disease and having children and their results for the studied region are given Tables (14).

Table 14: The result of t-test in determination of relation among perceived risk of disease and having children in total region

Leven's test: Variance as criterion for decision making (Sig)	Rejected hypothesis	Decision-making criterion for means (Sig)	Rejected hypothesis	Confidence interval (95%) for differences	
				Upper boundary	Lower boundary
0.429	H1	0.042	H0	0.22078	0.00432

The equality of variances was initially reviewed for conducting this test which confirmed equality of variances therefore H1 hypothesis was rejected. Then, H0 was tested for second hypothesis based on two-sample t-test and P-value was estimated 0.042 for them where this value was derived less than 0.05 for this hypothesis so H0 was disproved. The relationship was verified for effect variable of having children on perceived risk of disease.

Discussion and conclusion

With respect to educational level, culture, gender, and beliefs etc., the perception of possible risk is followed by some fluctuations in various communities [12].Perception is unique interpretation and expression about status nit accurate recoding of situation. In other words, perception is very complex cognitive process that introduces unique image of world and it may be completely different from reality and it is under influence of the relevant factors and outside environment. The external factor may be also received by others. The perceptions of an individual, source, and their supporters are deemed as a group that individual follows them. His/ her tendencies are direct to reflection of beliefs, values, and norms of his/ her group and the individual should attract supporting from the people with the same ideas in order to preserve his/ her tendencies. Uniformity of tendency among members of a cultural group is relatively due to this fact that the members of that group have common beliefs about objects, people, events, activities and the like. The collective values play important role in development and organizing individual tendencies. When behavior or tendency emerges prior to awareness it has been due to imitation or compulsion. Although there is a relationship among awareness, tendency, and behavior, it is also possible to create a behavior without awareness or tendency and or without awareness but together with tendency [11].For this reason, the perceived risk of villagers caused by fear of disease was examined in this project. Total inhabitants of the studied villages commonly believed in concern about toxins and worry about respiratory disease caused by dust and haze created by the factory. As a result, it was identified that there was significant relationship among perceive risk of disease between local people northern Roodpey County at Sari city with age, expense, gender, and having children or not. But no significant relationship was observed among

educational level, fear of disease. According to these findings, females more than males and persons with children further than individuals without children enjoy perception of pollution risk and as age is increased in these individuals, perceive risk of pollution is also increased among them. Similarly, the studies indicated that employment in factory as well as expenses were inversely related to perceived risk of disease.

Suggestions

● The following suggestions are proposed to achieve successful risk paradigm and reaching to mutual understanding and sustainable development:

● To take some measures for environmental protection by the factory to reduce pollution including installation of filtering systems to decrease dust and haze, proper wastewater treatment before discharge into environment, and creating green belt at the margin of factory etc.

● Employing of local manpower and establishment of transactional and economic relations with them to realize participatory approach along local people of the region;

● Holding of periodic visit plan of factory for students and members of village councils and or regional health houses;

● Cooperation of owners of factories in improvement of ecologic status in villages, publication of brochures about real risks of factory and methods of reduction, and also exchange of information regarding the risks wrongly attributed to the factory;

● Purchase of the lands surrounding the specific limit and allocation of it to cultivation of trees and green belt; of course, this issue needs to sponsorship of the relevant authorities with respect to budget of factory;

● The created problems in this industrial unit should be considered in planning for construction of similar factories in order to prevent from wasting capital, time, health, and energy belonging to investor and inhabitants and for establishment of sustainable development in the region.

References

[1] C. Ackel, *TAPPI J.*, 41, 37 (1988).

[2] R. A. Bradford, J. J. O'Sullivan, I. M. van der Craats, J. Krywkow, J. Aaltonen, J. Bonaiuto, V. De Dominicis, S. Waylen, K. Schelfaut, *Nat. Hazards. Earth. Sys. Sci.*, 12, 2299 (2012).

[3] R. Dixon. P. S. Jose, *J. A. M. Cardiol. Int. V.*, 2, 91 (2009).

[4] T. Horlick-Jonesa, A. Prades, *J. Risk. Res.*, 7, 213 (2009).

[5].Horlick-Jonesa, T.,1998.. *Reliab. Eng. Syst. Safe.*, 59, 79-89

[6] S. Jasanoff, *Reliab. Eng. Syst. Safe.*, 59, 91 (1998).

[7] K. Kalantari, Data processing and analysis in social- economic researches using SPSS software, Saba Pub, (2012).

[8] F. Karami, Quantitative determination of formaldehyde in industrial wastewater by MCR-ALS Spectrometry method, Zanjan University, (2008).

[9] M. Ugurlu, M. H. Karaoglu, İ. Kula, *Polish. J. of Environ. Stud.Vol.* 15, 647 (2006).

[10] S. J. Maisey, S. M. Saunders, N. West, P. J. Franklin, *Atmos. Environ.* 81, 546 (2013).

[11] V. Mymrin, S. A. S. Meyeer, K. P. Alekseev, U. Pawlowsky. L. H. Fernandes, C. B. Scremim. R. E. Catai, *Constr. Build. Mater.,* 50, 184 (2014).

[12] N. Tantemsapya, W. Wirojanagud, S. Sakolchai. *J. Sci. Technol.,* 26, 1 (2004).

[13] B. Nebel, B. Zimmer, G. Wegener, *Int. J. L. C. A.*, 11, 172 (2006).

[14] P. krief, D. Coutrot, F. Conso, *I. Environ.,* 69, 655 (1998).

[15] R. Dove, *J. Volcanol. Geotherm. Res.*,172, 329 (2008).

[16] O. Renn, *Reliab. Eng. Syst. Safe.*,59, 49 (1998).

[17] M. Rivela, T. Beatriz, J. Moreira, G. Feijoo, *Int. J. L. C. A.*, 12, 143 (2007).

[18] W. Ronald, W. Perry, M. Lindell, *J. Volcanol. Geotherm. Res.*,172, 170 (2008).

[19] H. Sadeghifar, M. A. Khalilzadeh, (1999), 'Lignin melanin and applications', Islamic Azad university Ghaemshahr Branch, Chemistry Group (1999).

[20] Ch. S. Lee, L. W. Lim, Y. H. Kim, J. Yang, D. Chun Shin, 2012. *Environ. Sci. Pollut. Res.*,19, 1629 (2012).

[21] V. C. Srivastava, I. D. Mall, I. M. Mishra, *Colloids. Surf. A.*, 260, 17 (2005).

[22] D. Venables, N. F. Pidgeon, K. A. Parkhill, K. L. Henwood, P. Simmons, 2012. *J. Environmen. Psychol.,* 32, 371 (2012).