Published in final edited form as:

J Transp Health. 2015 June 1; 2(2): 195–198. doi:10.1016/j.jth.2014.11.003.

Interactions between psychological and environmental characteristics and their impacts on walking

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Abstract

Due to walking's benefits to physical and mental health as well as to environmental and economic sustainability, numerous studies have examined psychological and environmental characteristics on their impacts on walking. However, understanding of how the interactions between psychological and environmental characteristics influence walking remains limited. Recently, both competitive mechanism and synergetic mechanism have been proposed, and a number of empirical studies have examined the interactions between psychological and environmental characteristics, but the results were inconsistent. We reviewed 11 recent studies and discussed their difference in terms of studies population, outcomes, environmental characteristics, and psychological characteristics. We propose a framework that integrate both mechanisms and provides an explanation to the inconsistency. More important, the framework may stimulate further empirical researches and provide implications for policy intervention to promote walking.

Keywords

Walking; Attitude towards walking; Environment; Interaction

1. Background

Over the past two decades, numerous studies (Saelens, Sallis et al. 2003, Owen, Humpel et al. 2004, Transportation Research Board 2005, Cerin, Leslie et al. 2009) have examined characteristics that influence walking due to walking's benefits to physical and mental health as well as to environmental and economic sustainability (Lee and Buchner 2008, Pucher and Buehler 2010). Walking is known to be correlated with environmental characteristics including population density, land use, street connectivity, street design, aesthetics, traffic safety, violence, and social support (Saelens, Sallis et al. 2003, Owen,

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Conflict of interest statement

No

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Humpel et al. 2004, Heath, Brownson et al. 2006, Saelens and Handy 2008). Walking is also influenced by psychological characteristics such as attitude, preference, intention, and self-efficacy (Cerin, Leslie et al. 2009, Van Dyck, Deforche et al. 2009, Joh, Nguyen et al. 2011). However, understanding of how the interactions between psychological and environmental characteristics influence walking remains limited (Panter and Jones 2010). Two interaction mechanisms have been proposed (Beenackers, Kamphuis et al. 2013). In competitive mechanism, the environment is more important to walking among those who have less positive psychological characteristics. For example, a study on Dutch adults (Beenackers, Kamphuis et al. 2014) found that positive built environmental characteristics contributed to leisure-time walking more in residents with a less positive attitude toward physical activity. On the contrary, in synergetic mechanism, the environment is more important to walking among those who have more positive psychological characteristics. For example, a study on older adults in two US metropolitan areas (Carlson, Sallis et al. 2012) found that living in a walking-friendly environment (compared with less friendly environment) was related to more minutes of physical activity for participants with more positive psychological characteristics.

2. Literature review

Recently, a number of empirical studies emerged. To provide an overview of this study area, we identified 11 studies (see Table 1) for a narrative review, using three criteria: (1) walking as outcome; (2) explicitly examine the interactions between psychological and environmental characteristics; and (3) were published within ten years. The conclusions from the 11 studies are inconsistent. Some (Cerin, Vandelandotte et al. 2008, Van Dyck, Deforche et al. 2009, Joh, Nguyen et al. 2011, Van Dyck, Cardon et al. 2011, Ding, Sallis et al. 2012, Beenackers, Kamphuis et al. 2013) support competitive mechanism while others (Rhodes, Brown et al. 2006, Deforche, Van Dyck et al. 2010, Carlson, Sallis et al. 2012, Friederichs, Kremers et al. 2013) support synergetic mechanism. Some studies found both mechanisms may exist; that is, the mechanism depends on the combination of the specific psychological and environmental characteristics. For example, the same study found that positive environmental characteristics contributed toward leisure walking only among those who have a less positive attitude toward physical activity (competitive mechanism), and living in a walking-friendly neighborhood contributed to leisure walking more significant for those who have a more positive social impact to engage in physical activity (synergetic mechanism) (Beenackers, Kamphuis et al. 2014). Moreover, some findings are not consistent with either mechanism. For example, higher land use mix was found to be negatively associated with active transportation among youths with high self-efficacy (neither competitive nor synergistic interaction) (Deforche, Van Dyck et al. 2010).

The mixed findings may be not surprising due to these studies' difference from the following perspectives. (1) Populations. The examined populations ranged from adults in Australia (Cerin, Vandelandotte et al. 2008), Belgium (Van Dyck, Deforche et al. 2009, Van Dyck, Cardon et al. 2011), Canada (Rhodes, Brown et al. 2006), the Netherland (Beenackers, Kamphuis et al. 2013, Friederichs, Kremers et al. 2013, Beenackers, Kamphuis et al. 2014), and the US (Joh, Nguyen et al. 2011, Ding, Sallis et al. 2012), Belgium youths (Deforche, Van Dyck et al. 2010), and older adults in the US (Carlson, Sallis et al. 2012). As

we know, some European countries have much higher rates of walking and the social norm towards walking and private vehicles also differ considerably (Pucher, Buehler et al. 2010, Buehler and Pucher 2012). (2) Outcomes. Most studies relied on self-reported walking but objective measures such as pedometer and accelerometer were also used (Van Dyck, Deforche et al. 2009, Van Dyck, Cardon et al. 2011, Carlson, Sallis et al. 2012, Ding, Sallis et al. 2012). Some used self-reported total minutes of walking while others used the self-reported count of walking trips (Joh, Nguyen et al. 2011). However, the same environment characteristics may have different impact on the total minutes of walking and count of walking trips. For example, a higher density and mixed land use may reduce distances because destinations are closer to each other (Frank, Greenwald et al. 2010), this may increase the count of walking trips but may decrease total walking distance. (3) Environmental characteristics. Two studies (Van Dyck, Deforche et al. 2009, Van Dyck, Cardon et al. 2011) simplified the neighborhoods as urban versus rural or high versus low walkable, and five studies (Rhodes, Brown et al. 2006, Cerin, Vandelandotte et al. 2008, Deforche, Van Dyck et al. 2010, Beenackers, Kamphuis et al. 2013, Friederichs, Kremers et al. 2013) used self-reported measures on the neighborhood environment, that is, resident's perceptions, and one most recent study (Beenackers, Kamphuis et al. 2014) used measures from field observations. Only three (Joh, Nguyen et al. 2011, Carlson, Sallis et al. 2012, Ding, Sallis et al. 2012) used both objective and perceived measures. The studied environmental characteristics vary widely. For perceived measures, the most commonly included characteristics are land-mix use, accessibility, street connectivity, infrastructure quality, neighborhood esthetics, traffic, and crime. For objective measures, the most commonly included characteristics are walkability index (Frank, Sallis et al. 2009), crime rates, and number of certain facilities/locations within a certain size of buffer. The impact of environment to walking varies by environmental characteristics and walking purposes (McCormack, Giles-Corti et al. 2008, Brownson, Hoehner et al. 2009, Sugiyama, Neuhaus et al. 2012). For example, utilitarian walking is strongly associated with proximity and mix of destinations but not too much with neighborhood esthetics and safety. And on the contrary, recreational walking is positively associated with neighborhood esthetics and safety but less with land use mix and density. Another example is that hill slope is positive to recreational walking while negative to utilitarian walking (Lee and Moudon 2006). (4) Psychological characteristics. The examined characteristics include attitude, self-efficacy, social support, perceived benefits, perceived barriers, and intention. Among the studies which examined a single characteristics, two used self-efficacy (Cerin, Vandelandotte et al. 2008, Deforche, Van Dyck et al. 2010), one used attitude towards walking (Joh, Nguyen et al. 2011) and one used action orientation (Friederichs, Kremers et al. 2013). Although these psychological characteristics may overlay and interact each other, they have different meanings, and we have no reason to assume they influence walking by the same mechanism.

Interactions between environmental and psychological characteristics are complicated. As suggested by a hierarchy of walking need (Alfonzo 2005), environmental characteristics are not necessarily considered simultaneously and the decision may be like a tree structure, that is, some conditions need to be satisfied before other conditions are considered depending on a person's psychological characteristics. For example, safety concern may be more fundamental than pleasantness and convenience for certain groups such as females and

elderly. As reviewed (Panter and Jones 2010), when habit is strong, the relationship between attitude and behavior is weak; when habit was weak, the relationship was strong, suggesting interactions among psychological characteristics may have significant impact to behavior as well.

3. Proposed framework

We argue that either competitive or synergetic mechanism (Beenackers, Kamphuis et al. 2013) alone is inadequate to explain the interaction and we propose a framework to integrate the two mechanisms (Figure 1). First, most previous studies simplified the psychological and environmental characteristics as dichotomous variables, thus failed to identify more subtle relationships. The environment may not affect much on those who are highly or poorly motivated to walk (Handy 1996). That is, for people with very positive or very negative attitude toward walking, they may walk or not walk regardless of the environment. For people in the middle of the attitude spectrum, the environment is likely to influence. Second, the levels of environmental and psychological characteristics may be only with relative sense in the same population (or the same study). The same level of a certain characteristic may not be comparable among different studies. For example, a person's attitude toward walking, must be understood together with social norm of the society. The "very positive" attitude towards walking from an American who living in a car-oriented society may be similar to a "neutral" level of attitude from a person living in more walking-friendly society such as some European countries. Third, one mechanism may be dominant in one population but not in another one. In a specific population, the "very positive" or "very negative" levels in the general framework may not exist or with a neglectable percentage. For example, in the US population, maybe few people are at the level of "very positive" (not by the relative sense within US population but by the absolute sense in the general framework). Thus, the synergetic mechanism may be more likely to be identified in these populations. On the contrary, the competitive mechanism may be more common in these populations among them walking is more common.

The framework we propose is a hypothesis. We are in early stage on the study of the interactions between psychological and environmental characteristics, and current empirical evidences may be not enough to enable us to see the whole picture. Furthermore, as reviewed before, most existing studies are not comparable due to their difference in various perspectives. A second limitation is that our framework is actually based on the interactions between attitude towards walking and neighborhood environment in general. The mechanism may vary by the combination of specific psychological and environmental characteristics as reviewed earlier.

The primary purpose of this hypothetical framework is to stimulate further empirical studies. To examine the proposed framework, ideally we need studies that cover the full spectrum in terms of both psychological and environmental characteristics. Alternatively, we need to piece together studies based on various populations. As indicated by Table 1, studies based on developing countries are few. Another challenge is that we need standardized measures on walking, psychological and environmental characteristics (Brownson, Hoehner et al. 2009).

A better understanding of the interactions between psychological and environmental characteristics will lead to effective intervention strategies tailored to a specific population, and contribute to the development of multi-level interventions (Ding, Sallis et al. 2012). We may prioritize environmental interventions or interventions that promote attitudes towards walking, depending on the targeted population. For example, in USA, where changing the built environment is challenging and the social norms are against walking in general, the first priority may be the interventions to promote positive attitude towards walking and eventually reverse the social norm. Because, under a negative social norm towards walking, interventions focus on the built environments alone are unlikely to be effective. However, positive attitudes alone without a supporting built environment may be not sustainable to promote walking, as indicated by a modeling research (Yang, Diez Roux et al. 2012). Essentially, social norm and built environment interact with each other and interventions on one dimension may trigger improvement on the other gradually. Overall, further empirical evidences are needed.

Acknowledgments

This research was funded by the National Heart, Lung and Blood Institute (grants R21-HL106467 and R01-HL071759).

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Figure 1.
A general framework of the interaction between attitude towards walking and neighborhood environment, providing a possible explanation of the two contrary mechanisms identified in previous studies

Table 1

The characteristics of a number of recent empirical studies on the impact of the interactions between psychological and environmental characteristics on walking.

Study	Population	Outcomes	Environmental characteristics	Psychological characteristics	The mechanism to support
Rhodes et al. 2006 (Rhodes, Brown et al. 2006)	Canadian urban adults	Self-reported walking for leisure	Perceived measures: land-mix use, walking infrastructure quality, neighborhood esthetics, traffic, and crime	Attitude towards leisure-time walking, subjective norm, perceived behavioral control, and intention	Synergetic
Cerin et al. 2008 (Cerin, Vandelandotte et al. 2008)	Australian urban adults	Self-reported recreational walking	Perceived access to convenient facilities for leisure-time physical activity	Self-efficacy	Competitive
Van Dyck et al. 2009 (Van Dyck, Deforche et al. 2009)	Belgium adults	Mean steps of walking per day using pedometer	High versus low walkable neighborhoods based on street connectivity and residential density	Preference for active or passive transport, self-efficacy, social support, perceived benefits, perceived barriers, and intention	Competitive
Deforche et al. 2010 (Deforche, Van Dyck et al. 2010)	Belgium youths	Self-reported active transport and leisure-time sports	Perceived measures: land use mix, access to services, street connectivity, sidewalks, neighborhood esthetics, traffic, crime, and access to recreational facilities	Self-efficacy	Synergetic
Van Dyck et al. 2011 (Van Dyck, Cardon et al. 2011)	Belgium adults	Self-reported physical activity and objective pedometer	Urban versus rural neighborhoods based on street connectivity and residential density	Modeling from family and friends, social support, self-efficacy, perceived benefits, and perceived barriers towards physical activity	Competitive
Joh et al. 2011 (Joh, Nguyen et al. 2011)	Adults from Los Angeles County, California	Self-reported counts of walking trips	Objective measures: businesses density, street connectivity, and crime rates. Perceived measures: perceptions about crime and safety	Attitudes toward walking	Competitive
Carlson et al. 2012 (Carlson, Sallis et al. 2012)	Older adults in the Baltimore, Maryland and Seattle, Washington	Self-report walking and using accelerometer	Objective measures: walkability (based on intersection density, residential density, retail floor area ratio, and land use mix), access to parks and recreation facilities; perceived measures: neighborhood esthetics and walking facilities	Self-efficacy, perceived barriers, and social support	Synergetic
Ding et al. 2012 (Ding, Sallis et al. 2012)	Adults in the Baltimore, Maryland and Seattle, Washington	Self-report walking and using accelerometer	Objective measures: walkability (based on intersection density, residential density, retail floor area ratio, and land use mix), number of parks and recreation facilities within 1 km buffer; Perceived measures: walking/cycling facilities and neighborhood esthetics	Self-efficacy, social support, enjoyment, perceived benefits, and perceived barriers	Competitive
Friederichs et al. 2013 (Friederichs, Kremers et al. 2013)	Dutch adults	Self-reported total minutes of walking per day	Perceived measures: residential density, walking distances to stores, access to services, streets in the neighborhood, places for walking and cycling, esthetics, and safety	Action orientation	Synergetic

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Study	Population	Outcomes	Environmental characteristics	Psychological characteristics	The mechanism to support
Beenackers et al. 2013 (Beenackers, Kamphuis et al. 2013)	Dutch adults	Self-reported walking for leisure	Perceived measures: safety, social cohesion, social network, and feeling at home	Attitude, self-efficacy, social influence, and intention	Competitive
Beenackers et al. 2014 (Beenackers, Kamphuis et al. 2014)	Dutch adults	Self-reported walking for leisure	Field observations: accessibility, safety, comfort, and pleasurability	Attitude, self-efficacy, social influence, and intention	Both competitive and synergetic