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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.

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1. Background

Over the past two decades, numerous studies (Saelens et al., 2003; Owen et al., 2004; Transportation Research Board, 2005; Cerin 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 et al., 2003; Owen et al., 2004; Heath et al., 2006; Saelens and Handy, 2008). Walking is also influenced by psychological characteristics such as attitude, preference, intention, and self-efficacy (Cerin et al., 2009; Van Dyck et al., 2009; Joh 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 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 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 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 et al., 2008; Van Dyck et al., 2009, 2011; Joh et al., 2011; Ding et al., 2012; Beenackers et al., 2013) support competitive mechanism while others (Rhodes et al., 2006; Deforche et al., 2010; Carlson et al., 2012; Friederichs et al., 2013) support synergetic mechanism. Some studies found both mechanisms may exist;

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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)	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)	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)	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)	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)	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)	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)	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)	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)	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
Beenackers 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)	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

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 signifcant for those who have a more positive social impact to engage in physical activity (synergetic mechanism) (Beenackers 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 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 et al., 2008), Belgium (Van Dyck et al., 2009, 2011), Canada (Rhodes et al., 2006), the Netherland (Beenackers et al., 2013, 2014; Friederichs et al., 2013), and the US (Joh et al., 2011; Ding et al., 2012), Belgium youths (Deforche et al., 2010), and older adults in the US (Carlson 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 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 et al., 2009, 2011; Carlson et al., 2012; Ding et al., 2012). Some used self-reported total minutes of walking while others used the self-reported count of walking trips (Joh 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 et al., 2010), this may increase the count of walking trips but may decrease total walking distance. (3) Environmental characteristics. Two studies (Van Dyck et al., 2009, 2011) simplified the neighborhoods as urban versus rural or high versus low walkable, and five studies (Rhodes et al., 2006; Cerin et al., 2008; Deforche et al., 2010; Beenackers et al., 2013; Friederichs et al., 2013) used self-reported measures on the neighborhood environment, that is, resident's perceptions, and one most recent study (Beenackers et al., 2014) used measures from field observations. Only three (Joh et al., 2011; Carlson et al., 2012; Ding 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 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

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