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Personality and Walkability: Predicting Walking Behaviour in Urban Settings using the Higher Order Factors of the Big Five amongst Malaysian Adults

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ABSTRACT

Walkability has now been a popular policy to be adopted in the city centre as traffic congestion and inefficient public transportation have affected the mobility of the urban users prior to the pandemic. The pandemic has paved more efforts to improve the design of urban spaces to increase walkability in the cities. In the attempt to predict walking activity amongst Malaysian adults psychologically, a personality test using Big Five Aspect Scales (BFAS) was conducted in relation to individual walking frequency in urban settings. Structural equation modelling (SEM) was used to analyze the predicting capacity of personality constructs control by general intelligence in relation to walking behaviour. The results show that the higher order meta-traits of the big five personality traits which are Stability (Neuroticism, Agreeableness, and Conscientiousness) and Plasticity (Extraversion and Openness to Experience) can be used as a reliable predictor for individual walking behaviour. As hypothesized, walking behaviour amongst Malaysians was characterized by reversed Stability (r = -.58) and high Plasticity (r = .76). The implication suggested the necessity of cognitive navigability and design predictability metrics of urban design cognitive performance in influencing the psychological factor of walking behaviour.

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1. Introduction

The increasing concern on environmental and health problems resulted in the rise of studies on how built environment can influences public health through travel behaviour (Saelens et al., 2003; Ewing & Cervero, 2010; Adkins, Dill, Luhr, & Neal, 2012). The causal relationship between the increase in environmental walkability and the increase in pedestrian activity however seems to lack sufficient evidence to support the presupposition (Dovey & Pafka, 2020; Liao et al, 2020; Cambra & Maura, 2020). Cambra & Moura (2020) suggested that the scale of environmental interventions is a significant factor in influencing walking behaviour but not effective in increasing walking activity. The complexity is shown to be exclusively embodied in the urban morphology, and that it should not be measured simply by levels of walking (Dovey & Pafka, 2020). Jacob (1961) in Dovey & Pafka (2020) contended that the pioneer isolation of the city into mono-functional zones had the impact of avoiding near associations of domestic to work, school, shopping, and amusement. Jacobs centred on the significance of quality sidewalks for urban priorities, social integration, and security.

There is currently much talk about creating walkable environments and improving walkability. Walkability is the extent to which the built environment supports and encourages

walking by providing for pedestrian comfort and safety, connecting people with varied destinations accessible within a reasonable amount of time and effort, and offering visual interest in journeys throughout the network. Contributing attributes include urban density, land use mixing, street connectivity, traffic volume, distance to destinations, sidewalk width and continuity, city block size, topographic slope, perceived safety, and aesthetics. There are nine key themes that defined by walkability: traversable environments, compact places, safe for walking, physically enticing environment, lively and sociable, sustainable transportation, exercise-inducing environment, proxy for better design (Claris et al., 2016). Studies on the geographical factors of personality differences have supported the presupposition of the association between individual personality and different environmental attribution of regions (Allik et al., 2009; Buecker et al., 2020; Rentfrow, 2010), cities (Bleidorn et al., 2016; Wei et al., 2017) and neighbourhoods (Jokela, 2020; Jokela et al., 2015).

Significant evidence revealed the importance of individual traits such as personality in influencing behavioural choices (Tucker et al., 2006; DeYoung et al., 2007; Faullant et al., 2011; Liu & Campbell, 2017). Psychometricians have identified that you can measure personality into 5 factor traits also known as the Big Five which are Neuroticism, Agreeableness, Conscientiousness, Extraversion and Openness to Experience (McCrae & Costa, 1997). The personality traits can be further categorized into two meta-traits based on the underlying biological representation which are Stability (alpha) and Plasticity (beta) (DeYoung et al., 2007). The meta-traits of personality also known as the Big Two is characterized by Plasticity (exploration and goal creation), and Stability (goal maintenance) (DeYoung, 2015). Plasticity meta-trait consist of traits Extraversion and Openness to Experience (DeYoung et al., 2007). Extraversion is typically characterized by gregariousness, excitement-seeking, and positive affect (Mesurado et al., 2014) whilst Openness to Experience is characterized by intellect, creativity, aesthetic, religious, philosophy, and experience seeking (Goldberg, 1992; McCrae & Costa, 1997; Peterson et al., 2002). Gotz et al. (2020) claims that there is evidence to support the association between Extraversion with walkability in the relation with preference to interactive social urban settings.

Plasticity is generally characterized with the degree of flexibility of the individual. High in plasticity responds with environmental anomalies flexibly and seek out novelties of the unknown voluntarily (Liu & Campbell, 2017). Dopaminergic effect is associated with Plasticity because of the link to reward seeking and award (Hirsh et al., 2009). Stability however is characterized by the capacity to resist disturbance towards goal seeking. Stability is associated with reversed Neuroticism (emotional stability), Agreeableness and Conscientiousness (DeYoung et al., 2007). Neuroticism involves the degree of proneness to anxiety, worrying, and negative emotions (Friedman, 2019). Agreeableness is usually associated with cooperation and empathy, selflessness, and identification with others (Graziano & Eisenberg, 1997). Conscientiousness is characterized by the ability to control impulses and goal-driven behaviour (Bogg & Roberts, 2004). Serotonergic effect is usually associated with Stability because of the link to low levels of anxiety and the ability to remain calm (Liu & Campbell, 2017). In general, high Stability have low levels of impulsive behaviour (Hirsh et al., 2009).

In terms of environmental cognition, the existential effects towards those who are high in plasticity or stability are different but associated. High in plasticity facilitate the ability to navigate complex environmental setting. Wayfinding, a part of navigational process is a crucial spatial behaviour in navigating urban settings. It can also be understood as spatial problem solving. Kevin Lynch posited wayfinding must be "consistent use and organization of definite sensory cues from the external environment" (1960:3). The five elements that he introduced play an important role in integrating urban navigation and its environment. The cognitive process of familiar environment is the result of psychological process that people capture surrounding environment through their acquired knowledge of locations, distances, directions, elements, and patterns (Rapoport, 2013). People high in stability dislikes anomalies and complexities of the setting. Due to individual differences, the ability for the environmental setting to cater for both personality differences are necessary for to achieve maximum usability. As Jacobs (1961) suggested for the need of the street to cater for both locals and strangers equally to achieve safety.

The nature of car-depended society indicates that the possibility of primarily use of personal vehicles as the main transportation choice are associated to convenience as we perceive the world as tools and obstacles as claimed by Peterson (2012). The inference concluded is that walking as a primary mode of transportation is not convenient and that only those with high levels of plasticity would be more incline to walk due to the interest in novelties and experience. In this study, to suppress the halo effect which is the tendencies to answer positively for desirability, Stability and Plasticity will be analyzed independently as latent variables. Academic achievement was included in the model to test the additional hypothesis that general intelligence covariate with Openness should be positively associated with walking behaviour whilst direct relation should be negatively associated to behaviour (DeYoung et al., 2007). Therefore, based on the assumptions we hypothesized that:

H1: Stability is negatively associated with walking activities
H2: Plasticity is positively associated with walking activities
H3: Intelligence by Openness is positively associated, whilst intelligence by education background is negatively associated with walking activities

The urban setting or space is made up of various forms, such as different structures and colours, each of which visually and semantically conveys a message to the observer and, depending on its role, elicits different mental and emotional responses at other times. These reactions begin with the viewing and processing of the environment's form and colours, and these perceptual processes raise cognitive schemas that elicit a wide range of human emotions. Perceptions of environmental capability are heavily influenced by the personality traits and motivations of the individual or group. The necessity to understand the psychological implication of environmental attraction can be beneficial to examine the relationship between walkability and personality.

2. Methodology

2.1 Participants

110 participants were taken randomly online consisting of 66 females and 44 males. The samples were limited to those above 18 of age and Malaysian nationality. The oversampling of female was conducted unintentionally due to the nature of online surveying.

2.2 Measurement

2.2.1 Personality Questionnaire

The participants completed a multilingual version (English and Malay) of the Big Five Aspect Scales (BFAS) to measure the two higher order meta-traits of personality (DeYoung et al., 2007). Cronbach's alphas for the Big Five were .78 (Neuroticism), .60 (Agreeableness), .72 (Openness), .75 (Agreeableness), and .87 (Conscientiousness).

2.2.2 Walking Frequency Index

Self-report walking activity was measured using Likert scale on the frequency of walking categorized by purpose (Thielman et al., 2015). The item includes walking to work, walk to public transportation, walk to shop, walk to social activities, walk for leisure. The Cronbach's alpha for the self-report walk activities are .79.

2.2.3 Education Background

Intelligence is the best single predictor of academic achievement (Laidra et al., 2007). Therefore, education background was included in the questionnaire to imply association to general intelligence. Note that the most optimum result was to also conduct IQ test but due to limitations, g associated to education achievement was taken as a controlling variable for personality association. The item scale for education is from "SPM/Certificate to PhD".

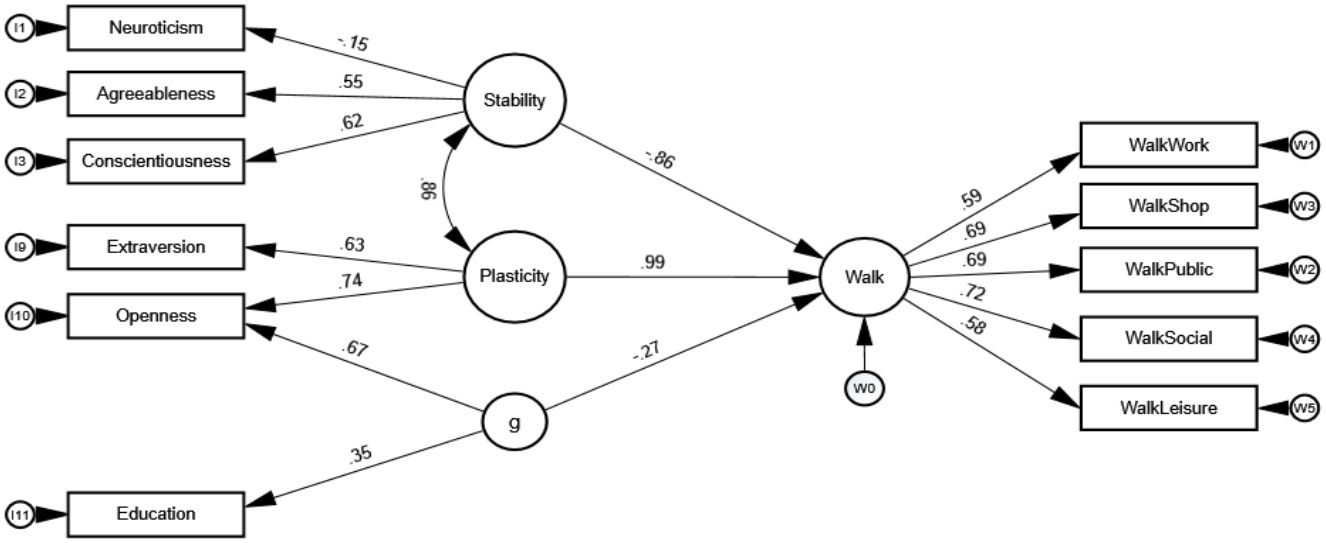

Figure 1 Stability, Plasticity, and g predict walking frequency. N= 110. All paths shown are significant at $p < .05$. g = General Intelligence. See Table 1 for model indices for fit.

3. Result

3.1 Structural Equation Modelling (SEM)

The relationship between Stability and Plasticity to walking frequency while controlling for general intelligence (g) was tested using structural equation modelling (Figure 1). Using Amos 26, the model was analyzed to predict the maximum likelihood of the full covariance matrix. Openness was loaded on g due to the independence between variance shared by openness and extraversion and variance of openness with general intelligence (DeYoung et al., 2007).

Rigdon (1961) claims that for a model to be fit enough to produce interpretable parameters and basis for further theory development, measuring the goodness-of-fit test of a model is necessary. For this SEM model, the parameters observed are chi-square, degree of freedom, probability of discrepancy, comparative fit index (CFI), Tucker–Lewis index (TLI), and root-mean-square error of approximation (RMSEA). Based on these parameters, the first model tested to be poorly fitted (see Table 1). Although initial testing indicated strong relationships between variables, the model fit suggests low performance probability. Initial testing indicated a root-mean-square error of approximation (RMSEA) value of above .05 indicate a poor model fit. To improve this, Amos modification indices suggested freeing certain paths of the model to achieve better fit for the model. The suggestions are that the latent variable of stability should be directly connected to certain observable variables of walking activities and covariances amongst walking activities. Hence, the model was revised (see Figure 2).

Table 1 Fit of the Models in Figures 1 and 2 of Traits Predicting Externalizing Behaviour

Model	χ^2	*df*	*p*	CFI	TLI	RMSEA	*P*(Close)	*Fit*
Figure 1	64.1	40	.009	.894	.855	.074	.120	Poor
Figure 2	43.2	37	.224	.973	.960	.039	.618	Good

Note. N = 110. $\chi 2$ = chi-square; df = degree of freedom; p = probability of discrepancy; CFI = comparative fit index; TLI = Tucker–Lewis index; RMSEA = root-mean-square error of approximation.

The revised structural hypothesis was tested by the model in Figure 2. The prediction of significant association between Stability (H1) and Plasticity (H2) control by intelligence (H3) with walking frequency are supported. Table 1 indicates the goodness of fit of the model. The revised model 2 indicated a better fit than the previous model 1. Sample size plays an influencing role in chi-square values and will often be significant at $p < .05$ (Kline, 2005). However, the lower the value, the higher the correlations between sets of data tested. For exploratory cases, the comparative fit index (CFI) is better suited for evaluation. CFI value of .95 or greater indicates a good model fit (Rigdon, 1996). The Tucker-Lewis index was valued above .90 which is an acceptable threshold for the model (Hoe, 2008). For confirmatory cases, RMSEA is better suited (Rigdon, 1996). RMSEA value of below .05 indicates close fit of the model (Kline, 2005). The P(close) indicates whether the RMSEA value is significantly greater than .05 (DeYoung et al., 2007).

Uniqueness's for walking to shops and walking for leisure were allowed to correlate because the similarity of these behaviors might render their correlation stronger. Therefore, walking to shop and for leisure were allowed to correlate and proven significant by .36. This indicates that those who prefer to walk to shops tend to prefer walking for leisure. Two additional paths were suggested and tested. Stability is shown to be more specific in association with walking to work (.17) and to shop (-22). However, the value indicated that the association was adequate but not significant enough. Generally, those high in Stability tend to walk to work more but less likely to shop. This is a possible indication of trait Conscientiousness in behaviour of dislike wasting time. However, the two new path decreases the association between meta-traits Stability and Plasticity by .28 and .23 respectively with walking activity.

Stability is shown to be negatively associated with walking activity. In general, those high in Stability tend to walk less. Stability is more specific in association with walking behaviour as compared to plasticity signifying suppressed goal-oriented mobility and possible perceived disruptive environmental obstacles. The significant correlation between Stability with Plasticity (.81) is typical for personality studies (DeYoung et al., 2007). Association of Agreeableness (.57) and Conscientiousness (.65) with walking activity is significant whilst Neuroticism (-12) is less significant. Therefore, fear or anxiety associated with walking is less significant as compared to cooperativeness or goal driven. In summary, these results substantiate Gotz et al. (2020) claims that distances in terms of conveniences of walking are necessary to improve walkability.

The model indicates that Plasticity is positively associated with walking frequency. The individual high in plasticity is likely to walk more. General intelligence plays a positively significant role in predicting walking activity. Direct association between generalized intelligence with walking behaviour is negative (-.26). However, intelligence associated with openness is positively significant. This result supports the presupposition on the association between trait Openness and cognitive ability (DeYoung et al., 2007). Intelligence through education is negatively associated with walking activity. To put it simply, the higher the education background, the less likely the person will walk.

4. Discussion

Stability is negatively correlated confirming **H1**. Stability is associated with habitual and routine behaviour (DeYoung, 2015). Based on the concern for Malaysia's car centric mobility, the data supported the presupposition that pedestrian journey should be legible and predictable for walking activity to be increase. The indication that walking in Malaysian cities is considered less convenient than driving is evident based on those who are high in Stability is negatively associated with walking. The characteristics of those who are high in stability is that they dislike disorders and unpredictability. Therefore, foot traffic mobility in Malaysia should be studied in its ability to achieve predictable navigability in the attempt to increase walking frequency effectively. However, further studies on predictable pedestrian path and the association with meta-trait Stability while controlling for walking frequency need to be conducted to support the claim.

High in conscientiousness and agreeableness is significant in predicting walking frequency. The traits are associated with dutifulness and cooperativeness. The evidence indicated that time concern is a possible factor towards the negative association between stability and walking. Those high in conscientiousness and agreeableness tend to be hard working but has a less aggressive temperament. A trait normally associated with woman who universally tend to be more agreeable than man. Whyte in Jensen (2017) argued that social and physical features of high-quality public spaces attract more people, and especially females, but without formally evaluating walkability as currently understood. In contrast with the earlier findings by Jensen et al. (2017) that men always outnumbered females, but they are consistent with those of walkability is about gender, especially on female proportions. To confirm the gender contribution towards these results, replications by controlling for gender is necessary.

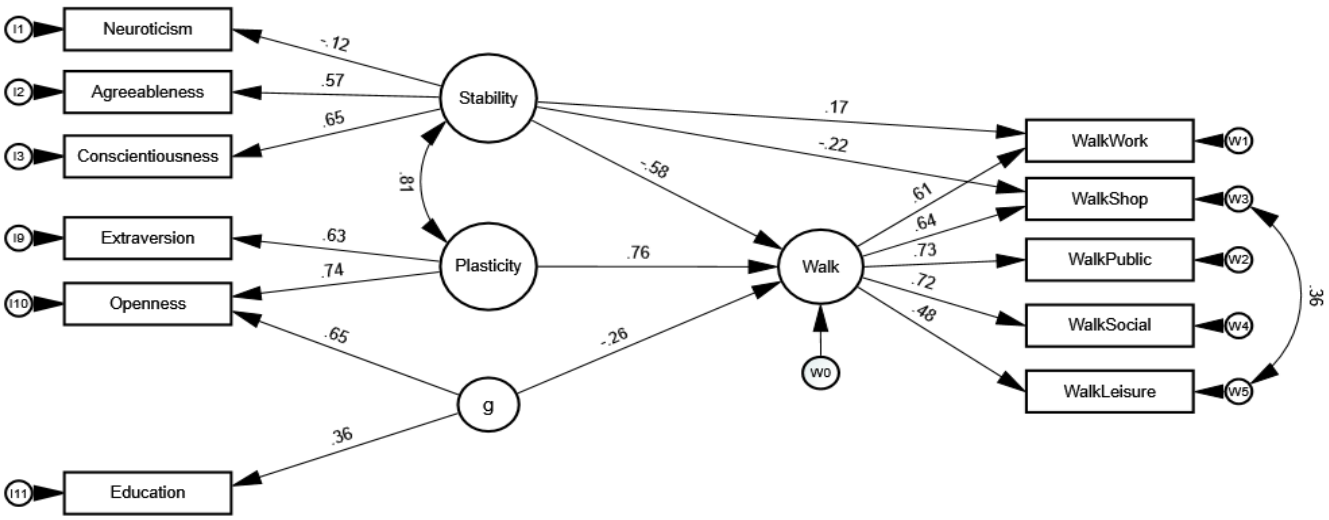

Figure 2 Revised Stability, Plasticity, and g predict walking frequency. N= 110. All paths shown are significant at $p < .05$. g = General Intelligence. See Table 1 for model indices for fit.

Neuroticism is associated with prone to fear and anxiety. Neuroticism is less significant in association with walking indicating the supposition of unlikeliness of safety in influencing walking. Perceived fear is a possible contributing factor towards the experience of walking. However, the evidence we found suggested that the relationship between fear or anxiety towards walking frequency is less significant. Indication of association between health consciousness is also negatively correlated. Stability is normally associated to healthy behavior indicating the disassociation between being healthy and walking in perceive value.

As hypothesized in **H2**, Plasticity is shown to be positively associated. Plasticity is a meta-trait associated to the degree of explorational ability. Those high in plasticity are better at navigating complicated environmental settings. High correlation is typical because individuals high in both Extraversion and Openness appear to be strongly motivated to explore and approach (Depue & Collins, 1999; McCrae & Costa, 1997). However, high positive correlation with Plasticity and negative correlation with Stability can also suggest the level of perceived complexity of foot traffic mobility. There is also possible suppression of habitual preferences in mobility choice. The evidence suggested that individuals high in plasticity would find it easier to navigate or possibly the interest in novelty of experience in wandering around cities. In the matter of Plasticity, a walkable environment should cater to individuals who are low in Plasticity to support the concept of universal design. Certain disorders such as autism spectrum disorder (ASD) possess neurological disability to abstract out of complex pattern would find it difficult to navigate in an environment catered for those high in Plasticity (American Psychiatric Association, 2013).

Intelligence is negatively associated with walking behaviour confirming **H3**. However, intelligence covariate with openness which is the openness trait intellect indicate the significance of cognitive ability in navigation. Education background is negatively associated to walking activity indicating that the possibility of suppression based on interest. The result suggested that intelligence in relation to navigate environment is significant in influencing walking frequency. This is related to Plasticity meta-trait ability in navigating complex situation. Direct correlation is negative supporting that academic achievement is negatively influencing walking activity. The higher the academic achievement, the less likely the person would walk. Further testing on the underlying variables of work positions and IQ is necessary.

According to Gehl's (2011) research in Life Between Buildings, urban design can either "integrate or segregate." The studies show that the presence of major streets can influence people's walking habits and social lives. Even in dense urban areas, traffic infrastructure can cause physical and social segregation, reducing accessibility between neighbourhoods. Jacobs (1961:348) statement clarifies the importance of walking in the cities as “consideration for pedestrians in the cities are inseparable from consideration for city diversity, vitality and concentration of use” and Speck (2012 :6) on “get walkability right and so much of the rest will follow”. He posits General Theory for walkability into four main variables: useful walk, safe walk, comfortable walk, and interesting walk.

5. Conclusions

The study indicated that personality could be used to predict walking behaviour in urban setting. This provides another boost in understanding the phenomena of walkable cities. Every person has different set of personality traits that can be generalized into Stability and Plasticity. The study highlights the necessity of the ability to navigate and the predictability of pedestrian journey in predicting pedestrian mobility. To manipulate the design of a city in catering to personality

differences, the study on cognitive navigability and predictability in design needs to be concentrated to maximize the utilization of urban design to achieve walkability. Although the factor size indicates that a large proportion of the phenomena of walking behaviour still unexplained, the predictability through personality can have practical utility in demographic studies to predict potential group walking behaviour.

Limitations

To validate these results, replication needs to be conducted with added constraints to the model. Sample sizes affect the correlation between personality even by personality study standard, hence the need to increase sample size for more accuracy. The addition of cognitive ability or IQ testing can help to clarify the association of walkability with general intelligence.

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