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Psychosocial benefits and positive mood related to habitual bicycle use

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ABSTRACT

This study explores the relations between cycling habits, eudaimonic well-being and positive mood. Specifically, this study investigates whether cycling contributes to the formation of positive physical, social, and self-actualisation concepts, which in turn could affect the mood and well-being of travellers. A survey was administered to 1131 inhabitants of the Brisbane area in Australia to elicit their socioeconomic traits and travel habits, as well as to measure self-concepts related to self-actualisation and the relation between cycling and mood. Structural equation modelling explored the system of relations between socioeconomic characteristics, observed travel habits, and latent self-concepts. The results of this study highlight that there exists a positive relation between bicycle use, self-actualisation on physical, psychological, social and self-efficacy dimensions and positive mood. Also, the findings of this study suggest that policy implications follow: (i) active travel to school and work should be promoted as a mean to increase the eudaimonic capacity through cycling, as this is one of the most important capacities for both children and adults; (ii) improvements in cycling infrastructure would not only foster higher cycling rates, but also reduce stress for commuter cyclists; (iii) eudaimonic benefits should be included in multi-criteria and cost-benefit analyses to better grasp cycling benefits.

1. Introduction

Cycling has the potential of contributing significantly to the future of cities and regions by building healthier and more sustainable communities while reducing motorised traffic and pollutant emissions (Tight et al., 2011). In fact, a modal shift from car to bicycle use has the potential of providing benefits from the climate, health and environmental perspectives (see, e.g., Maibach, Steg, & Anable, 2009; de Nazelle et al., 2011; Lindsay, Macmillan, & Woodward, 2011; Rojas-Rueda, de Nazelle, Tainio, & Nieuwenhuijsen, 2011; Borken-Kleefeld, Fuglestvedt, & Berntsen, 2013; Scheepers et al., 2013). Cycling has also the potential of reducing commute stress (Avila-Palencia et al., 2017; Rissel, Petrunoff, Wen, & Crane, 2014) and supporting sustainable travel trends as cycling habits relate to not only short-term daily travel choices but also long-term lifestyle choices that are passed from parents to children through travel socialisation processes (Prato, Halldórsdóttir, & Nielsen, 2017; Sigurdardottir, Kaplan, Møller, & Teasdale, 2013).

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Hypothetically, the reduction of car use should be possible by promoting sustainable travel modes (e.g., Banister, 2011; Schwanen, Banister, & Anable, 2012; Marsden, Mullen, Bache, Bartle, & Flinders, 2014) or penalising motorised traffic via road pricing (e.g., de Groot & Steg, 2006; Gärling & Schuitema, 2007; Graham-Rowe, Skippon, Gardner, & Abraham, 2011) and reward schemes (e.g., Ben-Elia & Ettema, 2009; Knockaert, Tseng, Verhoef, & Rouwendal, 2012; Abou-Zeid & Fujii, 2016). Practically, the aforementioned potential comes very rarely to fruition as car use is preferred even for short trips with the purpose of picking up and dropping off children and spouses, transporting goods, staying within time constraints, and enjoying comfort and convenience (e.g., de Nazelle, Morton, Jerrett, & Crawford-Brown, 2010; Prato et al., 2017). Notably, the assessment of the potential for the reduction of car use is often the analysis of travel choices under the lens of utility maximisation models.

When considering the lack of results and the traditional approach, the current study moves into a different research direction inspired by existing work in the social context (see, e.g., Whitaker, 2005; Marsden et al., 2014; Spotswood, Chatterton, Tapp, & Williams, 2015; Rowe, Shilbury, Ferkins, & Hinckson, 2016). Specifically, the current study draws from existing research focusing on the psychosocial benefits of car use by posing the question about whether cycling could generate positive self-concepts that affect the mood and the well-being of travellers. Namely, if it is true that individuals travel by car because of benefits other than the traditional variables that enter utility functions, is it possible that they would travel by bicycle if there exist psychosocial benefits of bicycle use?

Looking at cycling from the perspective of psychosocial benefits aligns with existing literature addressing the relation between travel satisfaction and mode choice. Existing studies reveal that trip characteristics, travel preferences, mode attributes and level of service, individual socio-economic characteristics and urban environment are often predictors of travel satisfaction (e.g., St. Louis, Manaugh, van Lierop, & El-Geneidy, 2014; de Vos, Mokhtarian, Schwanen, Van Acker, & Witlox, 2016). Also, existing studies show that the affective dimension of travel satisfaction is characterized by stress and tiredness reduction rather than mood or positive self-concepts (de Vos, Schwanen, Van Acker, & Witlox, 2015). Notably, travel satisfaction and travel related emotions are entirely different concepts (Gärling, 2019): satisfaction is a retrospective cognitive evaluation that considers both the momentary affective reaction as well as cognitive utilitarian evaluation, while emotions are momentary affective reactions that can be retrospectively recalled but are felt in action.

While recent efforts have been dedicated to investigating travel satisfaction, limited efforts have been devoted to addressing emotions evoked by travel (Gärling, 2019). When considering car travel, the literature has revealed that car use evokes positive emotions such as a positive self-presentation feeling (Mokhtarian & Salomon, 2001), a projection of positive qualities such as skills and mastery onto the self (Hiscock, Macintyre, Ellaway, & Kearns, 2002), a feel of freedom and pleasure to use (Johansson, Heldt, & Johansson, 2006; Steg, 2005), a sense of personal identity (Macintyre, Ellaway, Der, Ford, & Hunt, 1998; Mann & Abraham, 2006), a feel of effortlessness (Gardner & Abraham, 2007), and a perception of affective superiority to the car (Ellaway, Macintyre, Hiscock, & Kearns, 2003; Gardner & Abraham, 2008; Tertoolen, Van Kreveld, & Verstraten, 1998). In comparison with public transport users, car users have higher self-esteem (Stradling, Carreno, Rye, & Noble, 2007) and higher satisfaction with travel (Ettema et al., 2011; Morris & Guerra, 2015; Olsson, Gärling, Ettema, Friman, & Fujii, 2013; Ory et al., 2004). In comparison with cyclists, car users have lower travel satisfaction (Duarte et al., 2010; Morris & Guerra, 2015; Olsson et al., 2013). When considering sustainable travel, the literature has showed that pro-environmental behaviour may stem from both normative and hedonic goal framing while viewing them as either complementary or conflicting (Lindenberg & Steg, 2007). In order to sustain pro-environmental behaviour, normative goals are the strongest in the long run, while hedonic goals are only powerful in the short run (Steg, Lindenberg, & Keizer, 2016). Accordingly, finding a relation between normative and hedonic goal framing may be the key to sustainable pro-environmental behaviour (Steg et al., 2016).

Looking at cycling from the perspective of psychosocial benefits also aligns with recent anecdotal evidence. In Italy, 22 elderly cyclists mentioned that cycling contributes to experiencing social inclusion, coping with challenges, and feeling happier and younger (Whitaker, 2005). In the U.K., women stated that they felt happy while cycling and considered cycling as personal time dedicated to themselves (Spotswood et al., 2015). In Australia, women brought forward that cycling evokes a feeling of enjoyment associated with being fit, taking control, feeling young and free, and challenging oneself (Rowe et al., 2016). These anecdotal findings support the notion that bicycle use might have psychosocial benefits in terms of both self-concepts and mood, beyond the typically cited health and transportation ones (de Geus, de Bourdeaudhuij, Jannes, & Meeusen, 2008; Morris & Guerra, 2015).

While aligning with existing literature, the current study differs from previous ones in terms of perspective and methods. While most research about travel satisfaction has focused on the hedonic perspective, which is based on the idea that satisfaction results from experiences of happiness or pleasure (Ryan & Deci, 2001), this study concentrates on the eudaimonic perspective, which is based on the idea that satisfaction results from the enactment of qualities such as excellence, virtue and self-realisation (Aristotle, 1998). A review of the literature has revealed the eudaimonic perspective to be far less investigated than the hedonic one (de Vos, Schwanen, Van Acker, & Witlox, 2013), but travel has been discussed to induce both eudaimonic and hedonic values, even though these two elements are seen as independent (Shliselberg & Givoni, 2018). While most research about travel satisfaction has focused on the satisfaction with travel in relation to a specific activity and/or travel episode, this study concentrates on positive mood as the affective state evoked by cycling and its relation to cycling self-concepts. Accordingly, the current study is the first to support empirically the relation between the eudaimonic (normative) and the hedonic perspectives by showing empirical relations between eudaimonic self-concepts and hedonic positive mood.

A tailor made survey was designed to elicit travel habits and socioeconomic characteristics of individuals alongside measures of self-concepts (the eudaimonic perspective) and measure of the relation between cycling and mood (the retrospective measure). Scales were drawn from the literature on self-concepts and mood, and they were administered to a large sample of 1131 residents of the Brisbane area in Australia. Structural equation models (SEM) were estimated to express the system of relations between socioeconomic characteristics, observed travel habits and latent self-concepts with the aim of verifying the two hypotheses. Ultimately, results were interpreted with the aim of proposing a different look at cycling in the attempt of increasing its marketability and attractiveness and hopefully realising its potential to substitute car use.

The remainder of this paper is structured as follows. Section 2 presents materials and methods for the current study by describing the sample, the survey instruments and the modelling approach. Section 3 illustrates results of the modelling effort in terms of measurement of the self-concepts and relations between latent self-concepts and observed characteristics of the individuals, as well as direct and indirect relations between cycling habits and positive mood. Section 4 discusses the results, draws conclusions and proposes future research directions.

2. Methods

2.1. Research hypotheses

The current study investigates whether habitual cycling contributes to perceived positive mood both directly and indirectly via the formation of cycling self-concepts. Fig. 1 illustrates the research hypotheses.

The first hypothesis is that cycling as a physical activity triggers positive mood. This relation can be related to chemical brain activity that is triggered by the physical activity: clinical studies showed that, for small groups, indoor cycling exercises improve the subjective mood state and reduce anxiety (Hansen, Stevens, & Coast, 2001; Yeung, 1996), as well as decrease the cortisol level and subjective depression levels (Ida et al., 2013). While these studies were small scale clinical trials for short periods (10–30 min) in controlled settings, the current provides empirical evidence for the relation between cycling and positive mood for a large sample performing habitual cycling activity in uncontrolled settings.

The second hypothesis is that habitual cycling contributes to the formation of positive physical, social and psychological self-concepts, in line with both the normative goal framing suggested by Lindenberg and Steg (2007) and the eudaimonic perspective proposed by Shliselberg and Givoni (2018).

The third hypothesis is that positive self-concepts induced by cycling are related to a positive mood state related to the inferred cognition of positive self-concepts. Thus, we hypothesize that cycling has an indirect effect on positive mood through generating positive self-concepts as mediators. The third hypotheses seeks to validate the relation between the eudaimonic and the hedonic dimensions related to cycling.

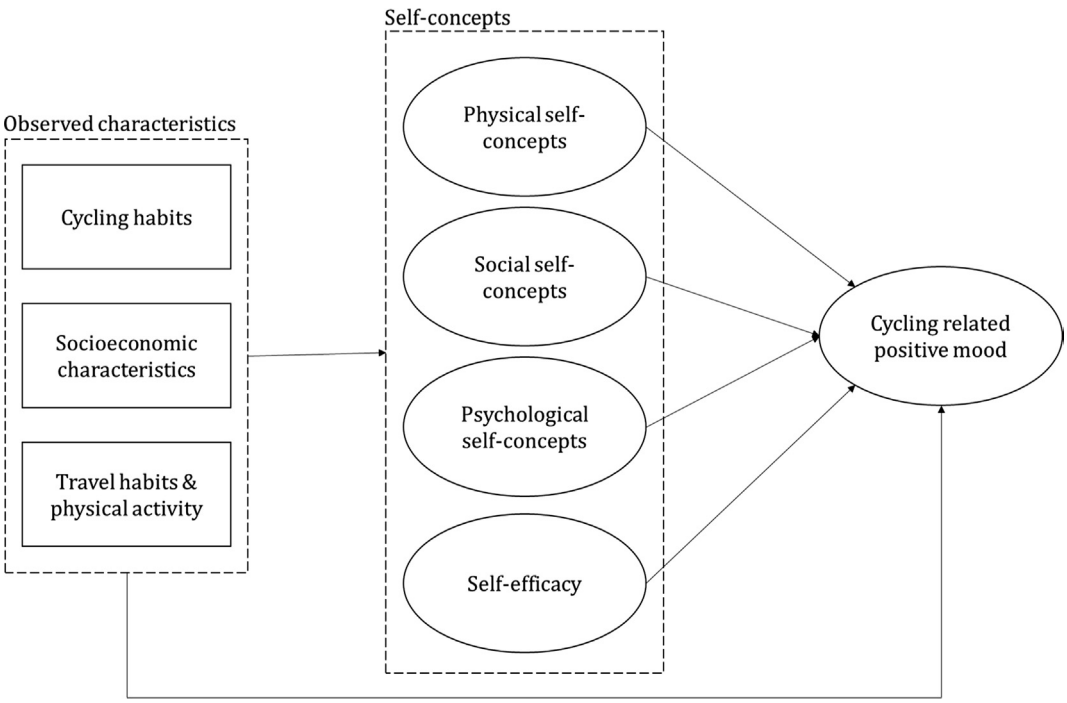

Fig. 1. Research hypotheses.

2.2. Survey design

A survey was designed to verify the hypotheses by eliciting socioeconomic characteristics, travel habits, cycling self-concepts and cycling mood influence. Given the retrospective evaluation perspective, the cycling self-concepts measured positive mood with cycling to be related to the habit of travelling by bicycle.

Socio-economic characteristics included age, gender, body type, relationship status, children, employment, income, residential area and residential arrangements. Travel habits were measured retrospectively via traditional self-reports of habitual behaviour by looking at the recurrence of the use of the bicycle (Aarts, Verplanken, & van Knippenberg, 1997; Gärling & Axhausen, 2003). Habits were retrieved for cycling as well as alternative travel modes such as walking, travelling by car, and using public transport. Habits were retrieved also for other physical activities in order to control for their possible effects on self-appreciation and well-being (see, e.g., Taylor, 2000; Acevedo & Ekkekakis, 2006; Biddle, 2006).

The selection of the physical activities to control for encompassed the possible physical activities according to their functionality and their popularity in Australia and Queensland. The types of activities included strength (weight training, circle training, body pump), conditioning (cardio, running), spinning, power (Crossfit, high intensive training, boxing), dance (dancefit, Zumba, latin), and mindful (yoga, pilates). All covered muscle strength, endurance, stamina and body awareness through exercise. These types are also the most popular indoor and outdoor sport activities in Australia in general, and Queensland in particular. The most popular activities in Australia are cardio (47.9%), gym and weight training (15.4%), jogging and running (11.7%), yoga and pilates (8.2%), dancing and aerobics (5.5%) (Roy-Morgan, 2018). Similarly, the most popular activities in Queensland are cardio (22.5%), gym and fitness (16.7%)m cycling (7.5%), jogging and running (6.6%) (Queensland Government, 2012).

Cycling self-concepts were measured via statements focusing on different dimensions. The current study adopted a multifaceted approach that postulates that the concept of the self is multi-dimensional and consists of four abilities: physical, social, emotional and contextual ability (Fleming & Courtney, 1984). The physical self-concept consists of self-perceptions regarding physical appearance and abilities, the social self-concept comprises a sense of togetherness and the regard of peers and significant others, the psychological self-concept concerns emotional well-being, and the contextual ability self-concept involves mastery in a particular domain (Bong & Skaalvik, 2003; Fleming & Courtney, 1984). It should be noted that the last dimension relates to self-efficacy as an evaluation of context specific competences (Bong & Skaalvik, 2003). Alderfer (1969) proposed the Existence, Relatedness and Growth (ERG) theory of human needs and argued that self-esteem stems from both the relatedness and the growth dimensions. Moreover, Ryan and Deci (2008) contended that the basic psychological needs of competence, relatedness and autonomy serve not only as wants and desires, but also as essential nutriments for the development of healthy self-concepts. Historically, self-concept research favoured a global construct representing general self-concepts, detached from particular specific context. However, this approach has been heavily criticized and replaced with domain-specific self-concepts (Bong & Skaalvik, 2003). Accordingly, the current study focuses on the derivation of self-concepts within the cycling context.

The physical dimension focused on the self-evaluation of attaining exercise quotas for healthy living, perceiving physical functionality, maintaining high energy, and feeling younger. Its statements were based on recent findings about body functions and feels being stronger predictors of body appreciations than appearance (Tylka & Homan, 2015). The psychological dimension inquired environmental contribution, self-actualisation, solution-oriented approach, empowerment, optimistic life perspective and feeling good about oneself. Its statements were based on the growth dimension of the ERG model (Alderfer, 1969). The social dimension investigated easily countable actual activities and overt interactions with others, namely sharing activities and communicating with friends and family in the social circle. Its statements were based on the relatedness dimension in the ERG model (Alderfer, 1969). The contextual ability (self-efficacy) dimension concentrated on the willingness to engage in cycling under challenging conditions such as hilly terrain, hot weather, rainy weather, long distance, high speed, adherence to a dress code, and shower unavailability at the workplace. Its statements were based on recent findings about actual performance being preferable to self-rating of hypothetical performance (Moore & Healy, 2008). The relation between cycling and positive mood was measured with a scale adapted from the profile mood states scale (Sacham, 1983) that explored positive mood states that are associated with happiness and vigour and negative mood mitigation states that are related to relieving tension and anxiety. The agreement with the statements was captured on 5-point Likert scales from "strongly disagree" to "strongly agree.

2.3. Survey administration and sample

The survey was administered online in the Brisbane area at the core of South East Queensland during the summer of 2016. The area is an emerging cycling region with recent investments of 6.14 AUD per capita for bicycle infrastructure (Heesch, James, Washington, Zuniga, & Burke, 2016) and the popular "CityCycle" bike-sharing system with 209,232 yearly trips made using 1800 bikes located in 148 docking stations (Fishman, Washington, Haworth, & Mazzei, 2014). Also, a recent survey among CityCycle users revealed that fun, health and environmental benefits were among the five motivators for using the system (Fishman et al., 2014), pointing out the importance of self-appreciation for bicycle use.

The survey was advertised via forums of cyclists as well as university channels throughout the Brisbane area from the Central Business District (CBD) to the surrounding suburbs, and participation was incentivised by a prize raffle that invited

respondents to increase their chances of winning by not only responding, but also referring acquaintances. The survey obtained 1131 complete responses with the characteristics of the sample being summarised in Table 1.

The analysis of the large sample revealed a good representation of the population of the Brisbane area. The gender distribution is close to the equal proportion of men and women in the population of the area, and similarly the age distribution is in line with the adult categories according to the Census 2016: 34.7% of the population is up to 25 years old, 15.6% is between 26 and 35 years old, 14.5% is between 36 and 45 years old, 13.6% is between 46 and 55 years old, and the remaining 21.6% is over 55 years old (Australian Bureau of Statistics, 2018). The employment distribution is quite accurate, in particular for what concerns the 60.0% of full time employees, the education levels are properly represented, in particular for the limited percentages of higher degree students, and the family compositions reflect a very young population where the married and de facto couples amount at 48.5% of the population (Australian Bureau of Statistics, 2018).

Also, the sample included a little bit over the 3.0% of commuters using cycling in at least one part of their trip to work, and the bicycle accessibility of about 60%, the weekly basis for cycling above 20%, the share of CityCycle users slightly above 15%, and the larger share of recreational cycling reflect recent samples from the same area (Chataway, Kaplan, Nielsen, & Prato, 2014; Heesch et al., 2016). The sample also included less than the 63.0% of commuters using car, but while the Census collected data regarding a specific day, this study investigated habitual use and frequency. Hence, the Census tends to overestimate car use and to overlook that travellers are multimodal (as emerges from the study) with an underestimation of active travel. In particular, the engagement in cycling at least 2/3 times monthly reflects the cycling rate in Queensland (Australian

Table 1
Sample characteristics.

Socio-economic characteristics			Travel habits		
Variable	Categories	%	Variable	Categories	%
Age	Less than 17 years old	15.4	Car driver	Never	29.8
	17–20 years old	10.1		2–3 times per month	7.2
	21–25 years old	12.6		Once per week	17.6
	26–35 years old	16.1		2–3 times per week	17.2
	36–45 years old	16.1		Daily	28.2
	46–55 years old	11.8	Car	Never	33.0
	56–65 years old	10.4	Passenger	2–3 times per month	32.2
	More than 65 years old	7.5		Once per week	22.1
Gender	Female	46.8		2–3 times per week	9.2
	Male	53.2		Daily	3.5
Family status	Living with the parents	23.9	Public	Never	15.7
	Single, living alone	11.2	Transport	2–3 times per month	11.8
	Single, living with friends	7.5		Once per week	17.8
	In a relationship, living alone	8.3		2–3 times per week	30.8
	In a relationship, living together	49.1		Daily	23.9
Children	No	61.1	Walk	Never	0.0
	Yes, living with me	27.1		2–3 times per month	0.0
	Yes, living elsewhere	11.8		Once per week	21.5
Personal	Below average (less than 750)	13.8		2–3 times per week	43.4
Income	Average (750–1250)	63.0		Daily	35.1
(AUD/week)	Above average (more than 1250)	23.2	Bicycle	Never	43.8
Employment	High school student	15.4		2–3 times per month	30.9
status	Bachelor student	7.1		Once per week	16.4
	Postgraduate student	3.6		2–3 times per week	5.1
	Part-time employment	9.5		Daily	3.7
	Full-time employment	56.0	Cycling	Commuting to work/school	3.7
	Retired	5.7	Purpose	Shopping/errands	3.8
	Unemployed	2.7		Going out at night	6.5
Residence area	Brisbane CBD	23.7		Socialising with family/friends	15.3
	Brisbane Northern suburbs	20.3		Recreation	34.2
	Brisbane Western suburbs	14.4		Competitive sport	2.7
	Brisbane Southern suburbs	25.1		I do not cycle	43.8
	Brisbane Eastern suburbs	16.5	Bicycle type	Regular bicycle	34.7
Physical	Spinning	10.3		Electric bicycle	1.4
Activity	Conditioning	31.1		Racing bicycle	8.8
	Strength	19.3		Mountain bike	11.2
	Power	6.2		I use CityCycle	16.4
	Dance fitness	4.4		I do not have a bicycle	44.0
	Mindful	8.2			
	None	41.9			

Bureau of Statistics) and the engagement in gym activities reflects the national average stating that Australians engage in gym and weight training, yoga, pilates, dance-fitness, cardio and cycling as a routine activity at least twice a week.

2.4. Data analysis

The hypotheses were tested via a structural equation model (SEM) that is a well-established and widely-applied method for validating a multivariate correlation structure across latent and observed variables in a series of equations (Pugesek, Tomer, & von Eye, 2003). SEM allowed accommodating (i) the latent constructs measured by the multiple statements, and (ii) the correlation structure across the multiple latent constructs.

In the current study, the SEM contains three sets of equations: (i) measurement equations (Eq. (1)) relating the latent constructs (i.e., the self-concepts) to their observed indicators (i.e., the answers to the statements); (ii) structural equations (Eq. (2)) relating the latent self-concepts to the socioeconomic characteristics and the travel habits of the individuals; (iii) structural equations (Eq. (3)) relating the positive mood to cycling self-concepts, socio-economic characteristics and travel habits.

$$I_{rn} = X^*_{ln}\alpha_r + \upsilon_{rn} \text{ and } \boldsymbol{\upsilon}_n \sim N(0, \Sigma_\upsilon) \quad \text{for } r = 1, \cdots, R \tag{1}$$

$$X^*_{ln} = X_{ln}\beta_l + \omega_{ln} \text{ and } \boldsymbol{\omega}_n \sim N(0, \Sigma_\omega) \quad \text{for } l = 1, \cdots, L \tag{2}$$

$$X^*_{mn} = X^*_{ln}\gamma_m + \varphi_{mn} \text{ and } \boldsymbol{\varphi}_n \sim N(0, \Sigma_\varphi) \quad \text{for } m \neq l, \; l = 1, \cdots, L \tag{3}$$

where I_{rn} is the value of an indicator r of the latent construct X^*_{ln} as perceived by respondent n, X^*_{ln} (X^*_{mn})is the value of latent construct l (m) for respondent n, and X_{ln} is a vector of observed characteristics of respondent n relating to latent construct l. The vectors of error terms $\boldsymbol{\upsilon}_n$, $\boldsymbol{\omega}_n$and $\boldsymbol{\varphi}_n$follow a normal distribution with respective covariance matrices Σ_υ, Σ_ω and Σ_φ. The vectors of parameters to be estimated are α_r, $\beta_l$and γ_m.

The parameters were estimated simultaneously with the software M-Plus by using Maximum Likelihood with Huber-White covariance adjustment. Goodness of fit was assessed relatively via the Comparative Fit Index (CFI), with a value of 0.90 or above to indicate very close-fit between the model and the data, and absolutely via the Root Mean Square Error of Approximation (RMSEA), with a cut-off value of 0.05 representing a very good model (Yuan & Bentler, 2000).

3. Results

3.1. Model estimates

Statistical tests verified that the sample had very high internal reliability (Cronbach' Alpha = 0.858) and factor analysis adequacy (Kaiser-Meyer-Olkin, KMO = 0.846). Subsequent tests verified that the removal of single items would not improve significantly the reliability, and that the inclusion of each item in the factor analysis would be adequate (KMO at the item level = 0.801–0.881). The test results indicated that every item could be retained in the exploratory factor analysis that aimed at verifying whether the hypothesised latent constructs were uncovered.

Exploratory factor analysis revealed four factors for the cycling self-concepts and one factor for positive mood due to cycling. The four factor solution was supported by the scree plot and parallel analysis method as well as the semantic structure and interpretation of the factors.

Following the exploratory factor analysis, SEM analysed the sample according to the aforementioned formulation: the loadings from the factor analysis confirmed the specification of the measurement equations for the latent constructs (Eq. (1)); the socioeconomic characteristics and travel habits were related to the latent constructs for the specification of the structural equations (Eq. (2)); the latent constructs were related across themselves for the specification of the remaining structural equation (Eq. (3)). The measurement equations represent confirmatory factor analysis following the exploratory factor analysis procedure and thus represent the factor structure. An iterative process found the best model specification where all the parameters associated to the indicators in the measurement equations were significant at the 0.01 level, and all the parameters associated with the socioeconomic characteristics and the relations between latent constructs in the structural equations were significant at least at the 0.10 level. Moreover, multi-collinearity was checked for all variables in order not to present spurious relations. The best model specification showed a very good fit in both absolute and relative terms, with a CFI equal to 0.97 and a RMSEA equal to 0.02.

Table 2 presents the estimates of the measurement equations for the self-concepts as well as the positive mood related to cycling. Cronbach's Alpha measures support the internal reliability at the construct level: "physical self-concept" (0.830), "self-efficacy" (0.851), "social self-concept" (0.856), "psychological self-concept" (0.829), and "positive mood" (0.857). As mentioned in the description of the survey design, the self-concepts are expressed with respect to actual performance. It should be noted that the estimated parameters in Table 2 represent regression coefficients and not correlations and thus can be either smaller or larger than one in magnitude: values smaller than one indicate an orthogonal solution and values larger than one indicate an oblique solution (Jöreskog, 1999). The physical self-concept is relate to the improvement of core strength and mobility, the perception of cycling as a great cardio workout, and the feel of awareness of physical abilities because of cycling. Self-efficacy is linked overcoming the challenges of riding faster, longer, and on hilly terrain. The

Table 2
Estimates of the measurement equations.

	Est.	t-Stat
Physical self-concept		
Cycling helps me stay in shape	1.000	–
Cycling helps me look and feel younger	1.041	28.89
Cycling improves my core strength and mobility	1.138	31.61
Cycling helps me maintain high energy throughout the day	1.036	26.56
Cycling is my favourite cardio workout	1.112	30.89
Cycling helps me reach my fitness goals	1.051	30.05
Cycling helps me get the exercise that I need	1.026	32.56
Cycling makes me more aware of my high physical abilities	1.052	30.05
Self-efficacy		
I like the challenge of cycling faster	1.000	–
I like the challenge of cycling on a hilly terrain	0.971	32.37
I like the challenge of cycling longer distances	0.973	30.88
I cycle regardless if it is a hilly road	0.944	26.98
I cycle regardless if it is raining	0.986	29.88
I cycle regardless if it is hot	0.952	27.98
I choose not to cycle if I need to follow a dress code at my destination (R)	0.933	27.42
I choose not to cycle if there is no shower at my destination (R)	0.958	28.17
Psychological self-concept		
I live life to the fullest when I cycle	1.000	–
I feel good with myself when I cycle	0.945	26.99
I feel good that I contribute to the environment by cycling	0.962	27.47
I feel empowered when I cycle	0.967	26.13
I feel good vibes and high energy when I cycle	0.923	26.37
Cycling makes me feel that I am optimistic and high on life	0.887	26.08
Cycling makes me feel that I make the best out of every situation	0.903	27.33
Social self-concept		
Cycling is an activity I do with my friends	1.000	–
Cycling increases my social network	0.932	24.52
Cycling is always a good conversation topic	1.069	27.41
Cycling is part of my social life	1.093	28.76
I do more activities with my friends/family thanks to cycling	1.073	27.51
Positive mood		
Cycling makes me feel happy	1.000	–
Cycling makes me feel enthusiastic	1.001	32.30
Cycling helps me relax when I am anxious or stressed	1.027	29.35
Cycling helps me relieve tension	0.952	31.72
Cycling helps me clear my head	1.017	32.79
Cycling helps me stay focused	1.028	34.28
Cycling helps me calm down when I feel restless	1.042	32.54

Note: Est. parameter estimate; t-stat critical ratio (estimate/standard error); the estimates of constants and elements of the covariance matrix are not reported for brevity; (R) recoded item.

psychological self-concept is connected to feelings of living life to the fullest, empowering the self, and contributing to the environment. The social self-concept is associated with cycling being part of the social life and especially giving more opportunities with friends and family. Lastly, positive mood is related to cycling helping individuals in calming down, reducing stress and staying focused.

Table 3 presents the estimates of the structural equations that relate the latent constructs of the cycling self-concepts and positive mood to socioeconomic characteristics, travel habits and physical activities. Parameters are presented for each equation representing one latent construct, and thus overall parameters are showed for five structural equations (one for each of the four self-concepts and the last one for the mood). Most importantly, the estimates presented in Table 3 support the three research hypotheses.

Estimates support empirical evidence of the first hypothesis that habitual cycling leads directly to positive mood. Controlling for socioeconomic characteristics and the engagement in physical activities, cycling at least 2/3 times per week and cycling for recreational purposes contributes to positive mood. Interestingly, while cycling frequently contributes positively, commute cycling contributes negatively to positive mood.

Estimates corroborate also the second hypothesis that habitual cycling contributes to the formation of positive physical (existence), social (relatedness) and self-actualisation (growth) concepts, as cycling at least 2/3 times per week is positively correlated with all four self-concepts. Notably, commute cycling is positively associated only with developing self-efficacy, while recreational cycling is positively related to the other three self-concepts. When looking at other travel habits, frequent car use is expectedly negatively linked across all dimensions of cycling self-concepts, while frequent public transport use is positively linked to the relatedness and growth dimensions. When looking at other physical activities, cycling habits are

Table 3
Estimates of the structural equations.

	Est.	t-Stat		Est.	t-Stat
Physical self-concept			***Social self-concept***		
Female	−0.183	−3.67	Female	−0.275	−5.73
Age 25 or less	0.196	2.20	Age 25 or less	0.256	2.85
Age 26–45	0.296	2.95	Age 26–45	0.194	2.18
Single, living alone	0.216	1.86	Single, living alone	−0.292	−2.54
In a relationship, living alone	0.168	2.85	Single, living with friends	0.200	1.96
Income over the average	0.136	1.74	In a relationship, living alone	−0.436	−3.76
Resident in Brisbane CBD	0.248	3.21	In a relationship, living together	0.196	3.21
Resident in Brisbane west or south	0.146	2.02	Resident in Brisbane CBD	0.428	5.55
Resident in Brisbane north or east	0.128	1.83	Resident in Brisbane west or south	0.138	1.96
Car driver everyday	−0.318	−3.28	Car driver 2/3 times per week	−0.146	−2.15
Bicycle 2/3 times per week	0.217	2.38	Car driver everyday	−0.338	−3.59
Bicycle everyday	0.414	3.53	Public transport everyday	0.165	2.75
Bicycle for recreational activities	0.496	4.96	Bicycle 2/3 times per week	0.479	3.84
Physical activity: conditioning	0.657	5.06	Bicycle everyday	0.508	4.74
Physical activity: strength	0.805	6.49	Bicycle for recreational activities	0.440	4.41
Physical activity: power	0.793	5.69	Physical activity: conditioning	0.321	5.10
Constant	−0.220	−4.52	Physical activity: dance	0.385	3.01
Self-efficacy			Physical activity: mindful	0.328	3.65
Female	−0.467	−8.18	Constant	0.223	4.46
Age 25 or less	0.341	2.52	***Positive mood***		
Age 26–45	0.180	1.73	Female	0.240	4.36
In a relationship, living together	0.255	2.22	Age 25 or less	−0.319	−3.15
Children living with me	−0.321	−3.21	Age 26–45	−0.295	−2.93
Resident in Brisbane CBD	−0.217	−2.66	Age 46–65	−0.252	−1.91
Resident in Brisbane west or south	−0.189	−2.28	In a relationship, living together	0.255	1.93
Resident in Brisbane north or east	−0.176	−2.28	Children, living together	0.204	1.80
Car driver 2/3 times per week	−0.168	−2.15	Resident in Brisbane CBD	−0.296	−3.57
Car driver everyday	−0.339	−3.20	Resident in Brisbane west or south	−0.217	−2.91
Public transport 2/3 times per week	0.183	2.08	Resident in Brisbane north or east	−0.176	−2.02
Public transport everyday	0.186	1.86	Bicycle 2/3 times per week	0.536	5.10
Bicycle 2/3 times per week	0.469	3.59	Bicycle everyday	0.530	4.19
Bicycle everyday	0.510	5.00	Bicycle for commuting	−0.141	−1.88
Bicycle for commuting	0.408	7.41	Bicycle for recreational activities	0.427	7.91
Physical activity: conditioning	0.399	5.70	Physical activity: strength	0.394	5.87
Physical activity: strength	0.551	3.77	Physical activity: power	0.643	4.66
Physical activity: mindful	0.388	3.80	Physical activity: mindful	0.314	3.14
Constant	−0.344	−7.39	*Physical self-concept*	*0.386*	*22.56*
Psychological self-concept			*Self-efficacy*	*0.474*	*22.76*
Female	−0.261	−4.75	*Psychological self-concept*	*0.491*	*25.66*
In a relationship, living alone	−0.207	−2.08	*Social self-concept*	*0.461*	*24.33*
In a relationship, living together	0.331	3.03	Constant	−0.141	−2.75
Income average	0.231	1.86			
Income over the average	0.299	2.33			
Resident in Brisbane CBD	0.260	3.20			
Resident in Brisbane west or south	0.162	2.16			
Car driver 2/3 times per week	−0.173	−2.25			
Car driver everyday	−0.296	−2.96			
Bicycle 2/3 times per week	0.539	4.99			
Bicycle everyday	0.522	4.05			
Bicycle for recreational activities	0.411	7.91			
Physical activity: conditioning	0.300	4.55			
Physical activity: power	0.441	3.15			
Physical activity: mindful	0.296	3.05			
Constant	0.125	5.01			

Note: Est. parameter estimate; t-stat critical ratio (estimate/standard error).

more important than other habits in developing growth and social self-concepts. Interestingly, dance activities are the second most important in developing self-concepts in the relatedness dimension, while mindful activities are more important than cycling habits in developing cycling efficacy. Moreover, cardio, strength and power are more important than cycling habits in developing the physical self-concept.

Estimates back also the third hypothesis that a relation exists between positive mood and habitual cycling not only directly from the cycling activity but also indirectly from satisfying the existence, relatedness, and growth needs. Notably, physical activity in general, and cycling for recreational purposes in particular, play an important role. When looking at the structural equation relating positive mood with the cycling self-concepts, the indirect effect of habitual cycling emerges even stronger as, evidently, higher psychological self-concept, self-efficacy, social self-concept, and physical self-concept correlate to more positive mood of individuals.

The estimated model controls for the link between individual socioeconomic characteristics and psychological well-being. The socio-economic characteristics are associated with all four cycling self-concepts. Higher cycling self-concepts are observed for individuals who are male, young, in a relationship, and live with friends or a life partner. Living in the Brisbane CBD and partly in the west and south neighbourhoods is associated with better physical, psychological and social self-concepts, but also lower self-efficacy. Income over the average is related to physical and psychological self-concepts. The estimated model also controls for the effect of physical activities other than cycling on self-concepts and mood. Both positive self-concepts and positive mood are related to physical activities including conditioning, strength, power and mindfulness. However, even for people who regularly engage in other physical activity, cycling can contribute to both positive self-concepts and mood.

4. Discussion and conclusions

The current study looked at cycling from the perspective of the psychosocial benefits that are associate to bicycle use. The search for a different research direction has been motivated by the consideration that a reduction in car use is not observed and the assessment of behavioural change is usually based on a utilitarian approach predicting market share variations after travel time and cost modifications.

Increasing self-esteem and feeling mastery of a skill are typically psychosocial benefits associated with car use (Ellaway et al., 2003; Gardner & Abraham, 2008; Hiscock et al., 2002), and a sense of personal identity is also linked to car ownership (Mann & Abraham, 2006). This study highlights that there exists a positive relation between using the bicycle, improving the self and feeling a positive mood. Cycling has the potential of making individuals feel better about themselves from a physical and psychological perspective, feel able to overcome challenges and difficulties, and perceive themselves as a part of a social milieu where values are shared.

Results show that cycling has the potential of contributing directly and indirectly to positive mood in individuals, in particular for recreational purposes as commuting negates the benefits of habitual cycling. Previous studies showed active travel giving more satisfaction than car use and public transport use (Duarte et al., 2010; Ingvardson et al., 2018; Morris & Guerra, 2015; Olsson et al., 2013). The current study adds to the body of knowledge that cycling induces not only travel satisfaction but also positive self-concepts and positive mood, thus generally contributing to personal well-being. The current study reaffirms that the results about the relation between cycling and positive mood obtained from interviews and clinical tests involving small groups are also valid for a large sample of the general population. The similarity between the qualitative results reported by Whitaker (2005) for Italian elderly, Spotswood et al. (2015) for British cyclists, Rowe et al. (2016) for Australian female cyclists and the current quantitative study for a large Australian sample shows that the relation between cycling and positive mood is transferable across regions. However, notably these results are obtained in car-oriented countries, when on the one hand cycling is more a hobby rather than a routine activity, and on the other hand cycling in mixed traffic induced higher stress than in cycling–friendly countries. Thus, the question whether the same relation exists in cycling-friendly countries where bicycle use is a routine activity remains open.

One intuitive policy and planning implication is that the utility maximisation approach used to assess the potential for reducing car use and encourage cycling does not capture the full benefits from cycling. Although latent constructs have been incorporated in choice models in recent years, psychological benefits have not been sufficiently investigated. The findings from this study confirm previous findings that encouraging cycling as a social practice requires not only technical solutions but also seeking psychological approaches where the focus should be not only on the practice itself, namely the change towards cycling, but also on the meaning of bicycle use (see, e.g., Spotswood et al., 2015). Specifically, a direction for further research could entail the in-depth consideration of the full extent of the psychosocial benefits that cycling can generate and their embedment into the traditional utilitarian perspective.

Another policy implication is that a reduction of car use in favour of bicycle use requires making cycling more attractive, convenient, and appealing, as well as making driving less attractive and psychosocially advantageous. Similar conclusions have been presented when advocating for public transport use (Ellaway et al., 2003) and discussing about the enjoyment of the commute with various travel modes (see, e.g., Mokhtarian & Salomon, 2001; Duarte et al., 2010; Paez & Whalen, 2010; Olsson et al., 2013). The findings from this study suggest that cycling for recreation and higher frequency of cycling contribute positively to self-concepts and mood while cycling as commute mode is negatively associated with positive mood. The difference between cycling for recreation and cycling as commute mode could be related to stress associated with cycling in mixed traffic, cycling in an urban environment versus green areas and cycling using habitual route. Thus, making cycling more attractive requires also increasing the feeling of safety and security, as well as creating a pleasant urban environment for cycling. Studies addressing bikeability and cycling experience (e.g., Nielsen & Skov-Petersen, 2018) could provide technical solutions towards creating more cycling-friendly urban environments. In addition, the results of the current study show that a strong pro-cycling argument could use insights about enhancing self-concepts being possible not only via car ownership and use, but also via bicycle use. An avenue for further research could look into the effect of providing customised information about the psychosocial benefits of sustainable travel modes within travel feedback programs (see, e.g., Fujii & Kitamura, 2003; Taniguchi & Fujii, 2007; Richter, Friman, & Gärling, 2011).

This study suggests that cycling not only is a fun and healthy activity that encourages travel independence, but also helps building mental strength through self-efficacy and positive physical and social self-perceptions. A last, and perhaps most

important, policy implication is that cycling should be encouraged from a young age due to its positive impact on the eudaimonic well-being. For children, building eudaimonic capacity from a young age is of the outmost importance to their adult life. For adults, the eudaimonic well-being could be associated with higher productivity. Accordingly, this study provides another reason for communities to encourage cycling by improving infrastructure and promoting educational programs of active travel to work and school.

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