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Scrutinizing Physical Activity as Economic Behavior and the Possibilities of Neuromarketing

RESEARCH

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ABSTRACT

60–80% of adults and adolescents are physically inactive. This paper studied how individuals' risk and time preferences predicted their physical activity stages of change processes and assessed which behavioral profiles towards physical activity could be influenced through neuromarketing. The study was conducted in a North European organization among mostly young adults (n = 144, mean age 25.96, SD 7.82). Data analyses consisted of ordinal logistic regression and exploratory factor analysis. Based on the analyses, the factors of older age, perceiving physical activity as a habit or a status quo, and habit and status quo as a factor increased advancement in the stages of change (1.07–1.08, 3.43, 1.88, and 12.18 times respectively), whereas an intertemporal, pessimistic attitude towards physical activity decreased 0.57 times. This pessimistic attitude focused on the current benefits overriding the future ones, i.e., not seeing the future health benefits of physical activity, and therefore, could be the target profile for neuromarketing studies for encouraging people to choose more physical activity.

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INTRODUCTION

Insufficient physical activity is among the top causes for death worldwide (USDHHS 2018; WHO 2022), whereas sufficient physical activity was proven to enhance both physiological and mental health (Chekroud et al. 2018; USDHHS 2018; Biddle et al. 2019; WHO 2022). Recommended physical activity is 75–300 minutes per week depending on the intensity, in combination with muscle-strengthening and balance training twice a week (UKKI 2021; WHO 2022). Nevertheless, it was widely estimated that roughly 60–80 percent of adults and adolescents lack sufficient physical activity on a weekly basis (Husu et al. 2016; Kokko et al. 2016; Husu et al. 2018; USDHHS 2018; EIGE 2022; WHO 2022; CDCP 2023; cf. Guthold et al. 2018).

Physical activity habits were scrutinized through the Stages of Change model (PASC) initiated by Prochaska and DiClemente (1983) and later DiClemente et al. (1991). PASC had at least a moderate effect in enhancing physical activity and other positive health behavior change in many studies (Bezyak et al., 2011; DiClemente et al., 1991; Haas & Nigg, 2009; Marcus et al., 1992; Patterson et al., 2006; Plotnikoff et al., 2010; Riebe et al., 2005). The model focuses on the stages the individual goes through in a behavior change process: precontemplation, contemplation, preparation, action, and maintenance (Leonard et al., 2013; Marcus et al., 1992; Prochaska & DiClemente, 1983). The power of the model in behavior change was reasoned to be in the subject's intention that precedes the aimed behavior (Webb & Sheeran 2006; Dumith et al. 2007; cf. Dearden & Sheahan 2002). PASC was then connected with the risk and time preferences studied in neuromarketing. Both economic preferences were successfully linked with physical activity earlier (Leonard & Shuval, 2017; Leonard et al., 2013; Shuval et al., 2017; Shuval et al., 2015). Yet, as the earlier research was conducted in the United States among African American communities and households with older participants, this study was conducted in North Europe focusing mostly on young adults in organizational context.

In risk preferences, human behavior is displayed on a spectrum from risk-seeking to risk-aversive (Concina, 2014; Ert & Haruvy, 2017), where most people are located at the risk-aversive end of the spectrum (Leonard & Shuval, 2017; Tversky & Kahneman, 1992). Risk aversion was defined as behavior where certainty undercuts expected value (Bayer et al., 2019; Concina, 2014), and risk preferences were tested in various gambling settings with alternating prizes to distinguish risk-seeking individuals from the risk-aversive (Anderson & Mellor, 2008; Conell-Price & Jamison, 2015; Coppola, 2014; Holt & Laury, 2002; Israel et al., 2014; Leonard et al., 2013; Tversky & Kahneman, 1992). Risk aversion was mostly linked with positive health behaviors: exercising, eating healthy, overall health, and lower Body Mass Index (BMI), but also with being depressed or anxious (WHO 2010; Conell-Price & Jamison 2015). Risk-prone behavior was related to more negative behavior such as cigarette smoking, obesity, and alcohol abuse, but also with more sports activity (Anderson & Mellor, 2008; Conell-Price & Jamison, 2015; Coppola, 2014).

Comparing current utility with future benefits is the basis of time preferences in economic decisions (Bayer et al., 2019; Smith et al., 2005). People could be categorized as patient and impatient according to their time preferences (Leonard & Shuval, 2017), or people's time preferences could be categorized according to present bias, time consistency, and future bias (Rabin & O'Donoghue, 1999). Mostly, humans tend to be impatient (Rabin & O'Donoghue, 1999). Being impatient has its costs: impatience was linked with higher BMI, obesity, smoking, worse teeth, ill health, and early death (Komlos et al. 2004; Smith et al. 2005; Zhang & Rashad 2008; Golsteyn et al. 2014; Kang & Ikeda 2016; Stoklosa et al. 2018; Miura 2019; cf. Khwaja et al. 2006; Anderson & Mellor 2008). Patience on the other hand, predicted a greater likelihood of meeting physical activity guidelines (Kosteas, 2015; LeComte et al., 2020; Shuval et al., 2015). Until today, time preference testing tradition consisted of a rather broad methodology with the common aim for scrutinizing the patience-impatience scale with other behavior (Conell-Price & Jamison, 2015; Faralla et al., 2017; Howard, 2016; Israel et al., 2014; Kosteas, 2015; Shuval et al., 2017; Shuval et al., 2015; Zhang & Rashad, 2008).

Risk preferences were also studied from the perspective of loss aversion (LA), status quo (SQ) bias, and habit (H), and time preferences of licensing effect (LE) and intertemporal choice (IC)—all of which were suggested to have an influence on physical activity or other health-promoting behavior (Acland & Levy, 2015; Gardner et al., 2011; Gardner et al., 2012; Kang & Ikeda, 2016; Leonard & Shuval, 2017; Milkman et al., 2008; Prinsen et al., 2019; Roberto & Kawachi, 2014; Shuval et al., 2017; Stoklosa et al., 2018; Thorgeirsson & Kawachi, 2013; Volpp & Asch, 2017;

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Zimmerman, 2009). These biases were focusing to understand better any possible obstacles in engaging in physical activity and building a bridge for neuromarketing.

Neuromarketing is still an effective approach to influence consumers after almost two decades (Fugate, 2007; Lee et al., 2018; Reimann et al., 2012; Shiv et al., 2005). Neuromarketing could be used to decrease the gap between self-reported survey studies and the actual thought processes preceding physical activity that might be discovered through functional magnetic resonance imaging (fMRI) scanning (Fugate, 2007). Where there was hypothesized behavior, a field-test could be targeted towards subjects to nudge (Thaler et al., 2010) them in physical activity by creating environments that encourage individuals to choose physical activity more often. Research on neuromarketing recognized impulsive consumer behavior (Hubert et al., 2018), predicted consumer choice (Lichters et al., 2016; Telpaz et al., 2015) and variation in weight due to food marketing (Masterson et al., 2019; Petit et al., 2016; Yokum et al., 2014), and aided with antismoking campaigns (Modica et al., 2018). Yet, the study field is rather new, and the fMRI testing success rates varied according to testing conditions and the subjects' cultural background (Falk & Scholz, 2018; Mostafa, 2014). At best, neuromarketing supported consumers make healthier choices (Gurgu et al., 2020; Harris et al., 2018), but there was not yet enough research on the role of neuromarketing in understanding the actual intention and behavior towards physical activity.

The aim of this study was to develop a new of understanding how to increase physical activity among people with theoretical frameworks of the stages of change model, risk- and time-related economical preferences, and neuromarketing. There were two objectives: First, to build a model that predicts the subjects' stages of change in physical activity. The second objective was to factor risk and time preferences as behavioral profiles towards physical activity and neuromarketing research, to decrease the gap between self-reported and actual subconscious intentions towards physical activity.

MATERIAL AND METHODS

The research was correlative: research was designed based on theory, data were collected and analyzed, and the conclusions were drawn afterwards (Nummenmaa, 2009). The study was conducted in a medium-sized Finnish company in the city of Tampere in Western Finland. The company reported to operate in the telemarketing industry (YTJ 2020). Employees consisted mainly of younger males with lower education: the median age was 23 and 68% reported higher secondary school or vocational as their highest educational level. The employee count was 165 person-years in 2017 (STO 2017), when scope of the study was planned, and the final survey response rate totaled at 87% (n = 144).

DATA COLLECTION

Data were collected through a self-completion, cross-sectional online questionnaire (Rhodes et al., 2003), where subjects evaluated their physical activity and risk and time tolerance in coin tossing and willingness for short- or long-term prizes. The survey was created based on earlier studies and theorizations (Leonard & Shuval, 2017; Leonard et al., 2013) and the synthesized literature review. A survey pre-testing was conducted with a separate focus group in 2018 and some of the questions varied according to the feedback given. The questionnaire was sent to employee emails, and the response period was June 15^{th}–21^{st}, 2018. Taking part in the survey was non-compulsory but anonymous to minimize nonresponse. Participants gave their self-willed, informed consent before responding to the survey. The study was conducted in accordance with the Declaration of Helsinki and the guidelines of Finnish National Board on Research Integrity, then National Advisory Board on Research Ethics (NABRE, 2009).

As there was a tradition of measuring physical activity of natural groups representing larger populations (Ng et al., 2019; Obrien et al., 2020), the sampling method was chosen cluster sampling that targets natural groups such as organizations (Holopainen & Pulkkinen, 2013; Nummenmaa et al., 2019). The cluster was studied as a complete enumeration to collect a sample of over 100 units (Holopainen & Pulkkinen, 2013; Nummenmaa, 2009).

DATA ANALYSIS

Data were analyzed through explorative factor analysis (EFA) and ordinary logistic regression (OLR) using IBM SPSS Analytics 27. EFA was used for testing the new survey questions of five economic cognitive biases with 5-step Likert scales—a similar method has been earlier applied in the context of biases and self-reported behaviors in many studies (Baker et al., 2019; Baklouti, 2015; Gifford & Chen, 2017; Lim & Rogers, 2017; Sahi, 2017; Scopelliti et al., 2015; Steenbergh et al., 2002; Xiao & Porto, 2019; Zhang et al., 2020; Zhang et al., 2019). OLR was chosen because the model incorporates multiple, mostly ordinal variables, and the research interest was in the logarithmic likelihood and odds ratio for the engagement. Either logistic or linear regression methods were also used for relatively similar studies (Bezyak et al., 2011; Faralla et al., 2017; Leonard et al., 2013; Plotnikoff et al., 2010; Shuval et al., 2015; Walton et al., 1999; Xiao & Porto, 2019).

SURVEY

PASC was a sum variable consisting of the subjects' own evaluation about their weekly physical activity, according to the official Finnish physical activity guidelines (UKKI 2021): weekly amount of moderate physical activity, vigorous physical activity, and muscle-strengthening and balance training. The length of engaging in any current physical activity habit was modified from Leonard et al. (2013) by deciding any physical activity over two years would count as most active, and by assuming most variation—i.e., relapses and starting over—in anyone's physical activity habit stabilization would happen during the first two years. Originally, Marcus et al. (1992) referred only to six months in maintaining physical activity. Other physical activity questions were subjects' evaluations of their sedentary behavior and perceived health status.

Risk and time preferences were adapted from Leonard et al. (2013) to a Finnish environment in an online setting. Answers to the risk question were handled as such: The first 40/40 € option indicated risk aversion, the last three options between 100/10 € and 130/-10 € indicated risk-seeking behavior, and other options were risk-neutral. Each of the options were valued between 1 and 6 according to their risk weight—even if the expected value of the coin tosses increased respectively from 40 to 60. The time preference question differed from the risk question: Subjects were to answer on each row which prize they would prefer: 50 € now or X sum after six months. Individuals who always chose the *now* options were classified as present biased. Choosing the now option in the first 1–3 questions and the future option otherwise indicated time consistency. Individuals who always chose the future options were classified as future biased. A total of six rows were then added up and categorized respectively.

Finally, the survey consisted of 16 statements on cognitive biases connected with either risk or time preferences: status quo bias, habit, loss aversion, intertemporal choice, and licensing effect. The statements were created merely for this research and tested for the first time. A statement was assumed to measure one bias, consisting of 3–4 statements for each bias. Loss aversion was described how "losses loom larger than corresponding gains", (Tversky & Kahneman 1991: 1039). The original finding was already denoted in the prospect theory (Kahneman et al., 1979) and was scrutinized in many studies (e.g. Camerer et al., 1997; Concina, 2014; Post et al., 2008; Tversky & Kahneman, 1992). Loss aversion was connected to exchanging time and energy for physical activity benefits in this study: "Practicing physical activities decreases my other activities" (Q18), "Practicing physical activity on a weekly basis takes me energy and time" (Q24), and "Being physically active doesn't guarantee me a better health" (Q29). The basis of the status quo bias statements was the willingness to continue in the current state and the lack of desire to change circumstances (Concina, 2014; Tversky & Kahneman, 1991). Status quo referred to possible means for avoiding risk and uncertainty on a general level, whereas loss aversion targeted to certain gains and losses (Samuelson & Zeckhouser, 1988). Therefore, the statements described the contentment of stability: "I engage in a sufficient amount of physical activity on a weekly basis" (Q16), "My current amount of practicing physical activities is good" (Q20), and "I wouldn't change anything in my weekly activity habits" (Q26). Habit is another way to beat the current—this time from the perspective of a routinized behavior. Habits were explained to be rather sticky and automatic (Dolan et al., 2012) and were reasoned to originate from past behavior in some studies (Gardner et al., 2012; Wood & Neal, 2009). There could also be a high threshold to forming new habits (Acland & Levy, 2015; Charness & Gneezy, 2009; Gardner et al., 2012; Sniehotta et al., 2005; Wood & Neal, 2009). Statements of this survey were developed to find out, whether physical activity was an established habit: "I practice physical activities according to a precise weekly schedule" (Q17), "I am physically active on a weekly basis" (Q25), and "I practice physical activities on a weekly basis" (Q31).

Intertemporal choice emphasizes the benefit of different times somewhat skewedly (Faralla et al., 2017)—there is an aim to change behavior, yet for some present-biased reason there is a failure in acting. Intertemporal choice was related with a want-should conflict (Milkman et al., 2008) and the intention-behavior gap (Sniehotta et al., 2005). In this setting, intertemporal choice was surveyed with four statements: "Being physically active now doesn't guarantee me health after 25 years" (Q19), "I should be more physically active" (Q21), "I tend to stop practicing physical activities after the first flush" (Q23), and "Being physically active wouldn't benefit my current life situation at all" (Q28). Lastly, licensing effect was the other measurement of time-based cognitive biases. The bias justifies the individual for letting go or committing a guilty decision, having executed any righteous deed (Khan & Dhar, 2006; Milkman et al., 2008; Monin & Miller, 2001; Prinsen et al., 2019). This bias was studied in the health and physical activity scene, too. A closer proximity of weight-loss goal licensed subjects to higher-calorie snacks (Prinsen et al., 2019), and a more vigorous exercise gave subjects permission for a higher calorie intake (Rosenkilde et al., 2012). Statements measuring licensing effect in this survey were: "Being physically active would require great amounts of food" (Q22), "Practicing physical activities as a hobby decreases my spontaneous and informal physical activity" (Q27), and "I tend to lie down on the couch after any form of physical activity" (Q31).

RESULTS

Even if theory and earlier studies supported risk and time preferences influencing physical activity behavior, this study could not find statistically significant connections through three different regression models. Nevertheless, interesting results were found throughout the research process, and these findings are elaborated in this section.

DESCRIPTIVE DATA

The study sample size was n = 144, leaving a response rate of 87% from a population of 165 from where 63% of respondents were male, 35% female, and 2% reported other gender (Table 1). The mean age was 25.96 (standard deviation, SD, 7.82), mean height 175.89 cm (SD 9.77), and mean weight 80.39 kg (SD 18.69). BMI of was calculated and grouped afterwards based on WHO (2010) guidelines. 50% of the subjects were classified as normal weight and 47% in the obesity groups. Also, the mean BMI of 25.93 (SD 5.66) exceeds 0.93 points above the normal weight class (WHO 2010). 9% reported comprehensive school, 68% higher secondary school or vocational school, 12% university of applied sciences, and 4% university as their highest level of educational attainment. Most respondents, 84%, reported sedentary behavior lasting between two and six hours daily. Moreover, 74% of respondents perceived their health to be rather or particularly good. Of the economic preferences, 35% were categorized risk-neutral, 38% risk-seeking, and 77% time-consistent. Preparation and Action stages were the most common PASC categories by totaling 58% of respondents. After excluding all the scale-typed background variables and sum variables, Cronbach's α for the survey was 0.69.

VARIABLE	CATEGORY	COUNT	%	MEAN	SD
Gender	Male	90	62.5%		
	Female	51	35.4%		
	Other	3	2.1%		
Highest level of educational attainment	Comprehensive school	13	9.0%		
	Higher secondary or vocational school	98	68.1%		
	University of Applied Sciences	17	11.8%		
	University	6	4.2%		
	Other	9	6.3%		
Age				25.958	7.815
Height				175.894	9.766
Weight				80.39	18.688
BMI				25.933	5.658

(Contd.)

VARIABLE	CATEGORY	COUNT	%	MEAN	SD
BMI (grouped)	Underweight	2	1.4%		
	Normal weight	72	50,0%		
	Pre-obesity	42	29.2%		
	Obesity class I	16	11.1%		
	Obesity class II	5	3.5%		
	Obesity class III	4	2.8%		
Sedentary behaviour	<2 hours	0	0.0%		
	2 hours < × < 4 hours	52	36.1%		
	4 hours < × < 6 hours	69	47.9%		
	6 hours < × < 8 hours	20	13.9%		
	>8 hours	2	1.4%		
Risk preference	Risk-aversive	37	25.7%		
	Risk-neutral	51	35.4%		
	Risk-seeking	55	38.2%		
Time preference	Present-biased	12	8.3%		
	Time-consistent	111	77.1%		
	Future-biased	20	13.9%		
Perceived health	Particularly poor	1	0.7%		
	Rather poor	10	6.9%		
	Neither poor nor good	23	16.0%		
	Rather good	69	47.9%		
	Particularly good	38	26.4%		
Physical	Precontemplation	3	2.08%		
Activity	Contemplation	33	22.92%		
Stages of	Preparation	45	31.25%		
Change	Action	39	27.08%		
	Maintenance	20	13.89%		

Table 1 Descriptive survey data.

Defining characteristics of the responders were male as gender, higher secondary or vocational school, normal weight, 4–6 hours of sedentary behavior daily, time-consistency as time preference, and rather good perceived health. BMI, Body Mass Index; SD, standard deviation.

FIRST REGRESSION MODEL: SIMPLE

Three OLR models were tested, the last one was complemented with EFA. The first model consisted of background and sum variables constructed from multiple questions: gender, educational attainment, age, BMI, sedentary, risk, time, health, SQ, H, LA, IC, and LE. For the economic risk and time variables, the Wald test values were too high to be kept in the model as significant factors. However, the stepwise deleting method under significance level of $p < 0.05$ showed positive effect for risk-related cognitive biases status quo bias and habit. In addition, background variables age and BMI had statistically significant explanatory power for advancing in the stages of physical activity (Table 2).

VARIABLE	β EST.	SE	WALD	DF	SIG.	95% CI		EXP(β)	95% CI (EXP)	
						LB	UB		EXP (LB)	EXP (UB)
PASC = 0	–0.832	0.952	0.764	1	0.382	–2.697	1.033	0.435	0.067	2.810
PASC = 1	2.868	0.845	11.530	1	<0.001	1.213	4.523	17.602	3.362	92.155
PASC = 2	5.541	0.962	33.142	1	<0.001	3.654	7.427	254.838	38.641	1680.670
PASC = 3	7.932	1.077	54.283	1	<0.001	5.822	10.042	2785.504	337.668	22978.261
Age	0.073	0.024	9.412	1	0.002	0.026	0.120	1.076	1.027	1.127
BMI	–0.344	0.171	4.026	1	0.045	–0.679	–0.008	0.709	0.507	0.992
SQ	0.634	0.232	7.472	1	0.006	0.179	1.089	1.886	1.197	2.972
H	1.233	0.236	27.335	1	<0.001	0.771	1.695	3.431	2.161	5.446

Table 2 The first final OLR model.

The first model recognized two background and two sum variables as significant factors in the model. BMI, Body Mass Index; CI, confidence interval; df, degrees of freedom; Est., estimate; Exp,. exponent; H, habit; LB, lower bound; OLR, Ordinal Logistic Regression; PASC, Physical Activity Stages of Change; SE, standard error; Sig., significance; SQ, status quo; UB, upper bound.

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Goodness-of-fit results tested 297.81 for the Pearson Chi-square test and 247.10 for Deviance Chi-square with non-significant test results (p = 1.000, degrees of freedom, df = 476). For these tests, a smaller p-value indicates a poor model fit (Fagerland & Hosmer, 2017). Even though the given values weren't exactly small, all the other models obtained a p-value of 1.000. The explanatory variable improved the model, since unexplained variation decreased from 375.02 in the model with only a constant to 261.20, with a statistically significant difference of 113.82 (p < 0.001, df = 4). Pseudo R-square resulted 0.56 for Cox and Snell, 0.60 for Nagelkerke, and 0.29 for McFadden. Considering the preceding tests, a value of 1 ought to be the expected direction (Hanneman, 2012; Metsämuuronen, 2008), even if they were considered as guidelines, not direct indicators (UCLAIDRE 2021). The test of parallel lines tested 261.20 for -2LL, whereas the general model was 250.71 with a subtraction of 10.49 (p = 0.573, df = 12). This type of p-value was considered a good indicator of a OLR model (UCLAIDRE 2021).

SECOND REGRESSION MODEL: COMPLEX

The second model consisted of individual data points instead of sum variables: gender, educational attainment, age, BMI, sitting still, standing still, lying down, risk, time, health, and all cognitive bias questions (Q16–31). This model would measure, if any of the individual statements have higher substantial value in comparison to others. Most of the variables did not show any statistically significant p < 0.05 value. Yet, as assumed from the larger number of variables, the final version of this model was slightly broader than the first one (Table 3).

VARIABLE	β EST.	SE	WALD	DF	SIG.	95% CI		EXP(β)	95% CI (EXP)	
						LB	UB		EXP(LB)	EXP(UB)
PASC = 0	4.009	1.642	5.965	1	0.015	0.792	7.227	55.112	2.207	1376.039
PASC = 1	8.332	1.664	25.077	1	<0.001	5.071	11.593	4154.515	159.317	108337.373
PASC = 2	11.824	1.855	40.622	1	<0.001	8.188	15.460	136433.328	3596.339	5175834.264
PASC = 3	14.564	2.003	52.892	1	<0.001	10.639	18.489	2113342.909	41726.571	107035352.885
Age	0.070	0.024	8.255	1	0.004	0.022	0.117	1.072	1.022	1.124
Q16_SQ	1.180	0.224	27.661	1	<0.001	0.740	1.620	3.254	2.096	5.051
Q22_LE	0.404	0.181	4.992	1	0.025	0.050	0.758	1.498	1.051	2.135
Q31_H	0.993	0.234	18.094	1	<0.001	0.536	1.451	2.701	1.709	4.268
Male	3.301	1.238	7.114	1	0.008	0.875	5.727	27.143	2.400	307.003
Female	3.337	1.262	6.986	1	0.008	0.862	5.811	28.129	2.369	334.005
Other	0[a]			0						

Table 3 Final model of the second OLR.

The second broader model showed significant results with three separate statements with age and gender as background variables. CI, confidence interval; df, degrees of freedom; Est., estimate; Exp., exponent; H, habit; LB, lower bound; LE, licensing effect; OLR, Ordinal Logistic Regression; PASC, Physical Activity Stages of Change; SE, standard error; Sig., significance; SQ, status quo; UB, upper bound.

For the second model, the goodness-of-fit results tested 268.97 for the Pearson Chi-square test and 232.33 for Deviance Chi-square with non-significant test results (p = 1.000, df = 514). The explanatory variable improved the model: unexplained variation decreased from 390.95 in the model with only a constant to 238.35, with a statistically significant difference of 152.6 (p < 0.001, df = 6). Pseudo R-square resulted 0.67 for Cox and Snell, 0.71 for Nagelkerke, and 0.38 for McFadden, which made them closer to the eligible value of 1. As with the test of parallel lines, the null hypothesis of -2LL was 238.35, whereas the general model was 206.73 with a subtraction of 31.62 (p = 0.024, df = 18). Age, gender, and statements Q16, Q22 and Q31 showed significance in the model. The second final model was broader, and gender had by far the greatest odds ratio. Next, the EFA was conducted to see how the 16 questions would cluster organically.

EXPLORATIVE FACTOR ANALYSIS FOR THE 16 QUESTIONS

The EFA extraction method used was Principal Component Analysis. Three principal components were distinguished from the 16 questions with an eigenvalue over 1. In the first run, none of the questions showed cross loadings, Q30 had no loading at all, and component three consisted only of one question (Q22). The Kaiser Normalization Varimax rotation stabilized the situation after four iterations and organized the statements into three principal components (Table 4).

ROTATED COMPONENT MATRIX	COMPONENT		
16. I engage in a sufficient amount of physical activity on a weekly basis (SQ).	0.892		
20. My current amount of practicing physical activities is good (SQ).	0.866		
25. I am physically active on a weekly basis (H).	0.842		
17. I practice physical activities according to a precise weekly schedule (H).	0.832		
31. I practice physical activities on a weekly basis (H).	0.827		
21. I should be more physically active (IC).	–0.763		
26. I wouldn't change anything in my weekly activity habits (SQ).	0.682		
23. I tend to stop practicing physical activities after the first flush (IC).	–0.673		
29. Being physically active doesn't guarantee me a better health (LA).		0.842	
28. Being physically active wouldn't benefit my current life situation at all (IC).		0.811	
19. Being physically active now doesn't guarantee me health after 25 years (IC).		0.690	
18. Practicing physical activities decreases my other activities (LA).		0.625	
22. Being physically active would require great amounts of food (LE).			0.804
27. Practicing physical activities as a hobby decreases my spontaneous and informal physical activity (LE).			0.518
24. Practicing physical activity on a weekly basis takes me energy and time (LA).			0.481
30. I tend to lie down on the couch after any form of physical activity (LE).			0.441

Table 4 The EFA Varimax analysis.

The EFA factored three components from the sixteen statements. EFA, explorative factor analysis; H, habit; IC, intertemporal choice; LA, loss aversion; LE, licensing effect; SQ, status quo.

The Kaiser-Meyer-Olkin measure resulted 0.84 and Bartlett's test of sphericity Chi-square 1129.74 ($p < 0.001$, df = 120) indicating a proper analysis. The first component had an eigenvalue of 5.33, explaining 33.3% of variance the second one 3.03, 18.92% of variance and the third one 1.14, 7.11% of variance. Based on the bias, new factors were named and recoded accordingly: prevailing physical activity habits and stability with a lesser intention-behavior gap (factor 1), a pessimistic attitude towards physical activity as a trade for other activities (factor 2), and self-licensing after physical activity with a great focus on energy consumption (factor 3). The factor variables summarized all the occurring biases from the theory. These new factors were constructed as new sum variables for the third OLR.

THIRD REGRESSION MODEL: NEW COMPONENTS

This model replaced the original bias sum variables with the newly created sum variables from the EFA: gender, educational attainment, age, BMI, sedentary, risk, time, health, and factors 1–3. Yet again, neither sedentary nor economic behavior had any significant effect in the model after stepwise deleting method (Table 5).

VARIABLE	β EST.	SE	WALD	DF	SIG.	95% CI		EXP(β)	95% CI (EXP)	
						LB	UB		EXP (LB)	EXP (UB)
PASC = 0	–4.312	0.927	21.651	1	<0.001	–6.129	–2.496	0.013	0.002	0.082
PASC = 1	–0.378	0.623	0.369	1	0.543	–1.598	0.842	0.685	0.202	2.321
PASC = 2	2.599	0.705	13.609	1	<0.001	1.218	3.980	13.450	3.380	53.517
PASC = 3	5.364	0.809	43.991	1	<0.001	3.779	6.949	213.578	43.772	1042.107
Age	0.076	0.024	10.299	1	0.001	0.030	0.123	1.079	1.030	1.131
Factor 1	2.500	0.291	73.652	1	<0.001	1.929	3.071	12.182	6.883	21.563
Factor 2	–0.558	0.184	9.233	1	0.002	–0.918	–0.198	0.572	0.399	0.820

Table 5 Third and final logistic regression model with new sum variables within.

From components of the factor analysis, two of them showed significance in the final OLR model along with age as a background variable. CI, confidence interval; df, degrees of freedom; Est., estimate; Exp., exponent; LB, lower bound; OLR, Ordinal Logistic Regression; PASC, Physical Activity Stages of Change; SE, standard error; Sig., significance; UB, upper bound.

For the third model, goodness-of-fit results tested 353.22 for Pearson Chi-square test and 246.54 for Deviance Chi-square with non-significant test results ($p = 1.000$, df = 521). The explanatory variable improved the model somewhat: unexplained variation decreased from 369.11 in the model with only a constant to 246.54, with a statistically significant difference of 122.57 ($p < 0.001$, df = 3). Pseudo R-square resulted in 0.61 for Cox and Snell, 0.64 for Nagelkerke, and 0.33 for McFadden. Lastly, in the results of the test of parallel lines: the null hypothesis of -2LL was 246.54, whereas the general model was 223.37 with a subtraction of 23.17 ($p = 0.006$, df = 9). Statistically significant explanatory power of two new factors, 1 and 2 (prevailing physical activity habits and stability with a lesser intention-behavior gap; pessimistic attitude towards physical activity as a trade for other activities), stayed throughout the elimination process, as did the age variable. Whereas factor 3 (self-licensing after physical activity with a great focus on energy consumption) was the weakest component already in the beginning of the initial model, and it was dropped out during the elimination process.

DISCUSSION

The aim for this study was to study the subjects' PASC by understanding their economic preferences and building behavioral profiles for neuromarketing. Risk-related cognitive biases SQ and H increased likelihood in advancing the PASC, as well as older age in all the OLR models. In addition, two behavioral factors derived from the data raised the PASC advancement likelihood, of which factor 1 ("people who are prevailing physical activity habits and stability with a lesser intention-behavior gap tended to engage higher in PASC") was over 12 times more likely. Gender and BMI also had statistical significance in individual models but not repeatedly. Economic preferences in the gambling setting did not have a significant effect in any of the OLR models, nor did other cognitive biases. All three OLR models and the EFA passed model fit tests indicating a good analysis method for the data.

Risk and time preferences could not be proven to significantly ($p < 0.05$) predict advancing in the PASC model, even though previous results (Leonard et al., 2013) indicated so. Other studies (Shuval et al., 2017; Shuval et al., 2015) too connected economic preferences with physical activity. Yet not all research (Conell-Price & Jamison, 2015; cf. van der Pol et al., 2017) verified these findings. A reason for the different result could be that this study focused on European subjects, mostly young men—the sample could have been too a different from the earlier studies' older, African American subjects with generational and/or cultural differences (Leonard et al., 2013; Shuval et al., 2017; Shuval et al., 2015). This difference in the results left leaves a space for replication or field testing in the European context.

Risk-related cognitive biases H and SQ showed significant results in advancing the PASC: 3.34 times and 1.88 times more likely respectively. Earlier studies found connections between H/SQ and physical activity/other health-promoting behavior (Gardner et al., 2011; Roberto & Kawachi, 2014; Tappe & Glanz, 2013), but the stages of change connection was missing until this study. The PASC model indicates a long-term, habit-building commitment to physical activity (Leonard et al., 2013; Marcus et al., 1992), and therefore, it would be important to continue studies on what type of cognitive biases might influence one's advancement in the model.

Older age showed consistency with more advanced stages of change in all the regression models: the likelihood for a more advanced stage of change was 1.07–1.08 higher per year. Earlier studies (e.g. Riebe et al. 2005; Dumith et al. 2007; Garber et al. 2008) would not support this finding, and further studies should be conducted to verify the results of this paper.

The second, statement level regression model was the only one where LE had any significance, and LA and IC showed significance only after the EFA. Why other cognitive biases could not pass the regression models as sum variables is most likely a two-way street: On the one hand, it might be that these biases don't have such a strong emphasis on engaging in and establishing physical activity behavior among young adults. On the other hand, the other cognitive bias statements had weaker correlations with each other and could therefore be re-evaluated for modification. Further studies for LA, LE, and IC with PASC should be considered.

Interestingly, two out of three new factors derived from the data were detected to predict their advancement in the PASC model: 1. people who are prevailing physical activity habits and stability with a lesser intention-behavior gap tended to engage higher in PASC with a likelihood of 12.18, holding constant all other variables and 2. people with a pessimistic attitude towards physical activity as a trade for other activities, with a negative likelihood of 0.57, holding constant all other variables. Since the factors derived from the bias statements were pioneered in this study, direct comparison to other studies would be indicative at best. However, the two factors could be used as a template for understanding subjects' behavior in the neuromarketing framework and nudging them towards a more physically active life.

As the research gap with physical activity and neuromarketing still exists, the results of this study could operate as a catalyst for encouraging such endeavors. These results could be further elaborated with targeted marketing messages compared with fMRI results, as it was already found that health activities such as weight gain and smoking habits but also consumer choice were better understood through neuromarketing (Hubert et al., 2018; Lichters et al., 2016; Masterson et al., 2019; Modica et al., 2018; Petit et al., 2016; Telpaz et al., 2015; Yokum et al., 2014). Moreover, nudges (Thaler et al., 2010) towards physical activity could be planned based on the behavioral profiles discovered in this study and following the fMRI understanding.

The first factor component included all the H and SQ and two LA statements confirming the effect of established habits as a prevailed state and describing people who do not juggle between the intention and behavior anymore but are continuously in the behavior stage. Most likely these individuals did not need any kind of extra push by promoting physical activity but needed to be encouraged to keep the healthy habits. The second factor consisted of two LA and IC statements with a rather pessimistic view towards physical activity. This could be a more difficult but also a more fruitful group to be nudged to a healthier lifestyle. Modern times are busy full of needs and activities that compete with each other, physical activities being only some of them. Moreover, for people who might not have any kind of activity history, the benefits of physical activity might not be clear. Physical activity may be seen rather uncomfortable and not likely to bring any immediate pleasure nor results. Or there might be assumptions that increasing physical activity in the daily life would be too much of a sacrifice and take too much time, even if as little as 25 minutes three times a week would have sufficient health benefits (UKKI 2021; WHO 2022). These speculations should be confirmed and field-tested in future studies.

CONCLUSION

This was the first study to scrutinize both economic behaviors and physical activity stages of change model, and to discover behavioral profiles towards physical activity for neuromarketing. Based on the three regression models and the explorative factor analysis, perceiving physical activity as a habit and a status quo, as well as older age, increased advancement in the PASC model, whereas an intertemporal, pessimistic attitude towards physical activity decreased. This kind of attitude could focus on the current benefits overriding the future ones, i.e., not seeing the future health benefits of physical activity, and could be the target profile for neuromarketing studies and further field testing for encouraging in more physical activity.

LIMITATIONS

As a hypothetical online survey in the organization context, further lab or field experiment settings should be conducted for broader conclusions. Considering the numerus, a cluster sample permitted only a certain number of subjects, and broader samplings should be gathered in future studies. Also, a North European organization consisting mainly young men might differ greatly from African American households and communities as a sample. Therefore, one should not make too strict comparisons between earlier results (Leonard et al., 2013; Shuval et al., 2015) and the results of this paper. A replication study in Central Europe could better validate findings of this study.

DATA ACCESSIBILITY STATEMENT

The data are available on request from the corresponding author.

ABBREVIATIONS

BMI, Body Mass Index; CI, confidence interval; df, degrees of freedom; EFA, Explorative Factor Analysis; Est., estimate; Exp., exponent; fMRI, functional Magnetic Resonance Imaging; H, habit; IC, intertemporal choice; LA, loss aversion; LB, lower bound; LE, licensing effect; OLR, Ordinal Logistic Regression; PASC, Physical Activity Stages of Change; SD, standard deviation; SE, standard error; Sig., significance; SQ, Status Quo; UB, upper bound.

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COMPETING INTERESTS

The authors have no competing interests to declare.

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REFERENCES

Acland, D., & **Levy, M. R.** (2015). Naivete, Projection Bias, and Habit Formation in Gym Attendance. *Management Science* [Online], *61*(1), pp. 146–160. DOI: https://doi.org/10.1287/mnsc.2014.2091

Anderson, L. R., & **Mellor, J. M.** (2008). Predicting Health Behaviors with an Experimental Measure of Risk Preference. *Journal of health economics* [Online], *27*(5) September, pp. 1260–1274. DOI: https://doi.org/10.1016/j.jhealeco.2008.05.011

Baker, H. K., Kumar, S., Goyal, N., & **Gaur, V.** (2019). How Financial Literacy and Demographic Variables Relate to Behavioral Biases. *Managerial Finance*, *45*(1), pp. 124–146. DOI: https://doi.org/10.1108/MF-01-2018-0003

Baklouti, I. (2015). On the Role of Loan Officers' Psychological Traits in Predicting Microcredit Default Accuracy. *Qualitative Research in Financial Markets*, *7*(3), pp. 264–289. DOI: https://doi.org/10.1108/QRFM-04-2014-0011

Bayer, Y. M., Shtudiner, Z., Suhorukov, O., & **Grisaru, N.** (2019). Time and Risk Preferences, and Consumption Decisions of Patients with Clinical Depression. *Journal of Behavioral and Experimental Economics* [Online], *78*(January), pp. 138–145. DOI: https://doi.org/10.1016/j.socec.2019.01.003

Bezyak, J. L., Berven, N. L., & **Chan, F.** (2011). Stages of Change and Physical Activity Among Individuals With Severe Mental Illness. *Rehabilitation Psychology*, *56*(3), pp. 182–190. DOI: https://doi.org/10.1037/a0024207

Biddle, S. J. H., Ciaccioni, S., Thomas, G., & **Vergeer, I.** (2019). Physical Activity and Mental Health in Children and Adolescents: An Updated Review of Reviews and an Analysis of Causality. *Psychology of Sport and Exercise* [Online], *42*(May 2018), pp. 146–155. DOI: https://doi.org/10.1016/j.psychsport.2018.08.011

Camerer, C., Babcock, L., Loewenstein, G., & **Thaler, R.** (1997). Labor Supply of New York City Cabdrivers: One Day at a Time. *Source: The Quarterly Journal of Economics*, *112*(2), pp. 407–441. DOI: https://doi.org/10.1162/003355397555244

Centers for Disease Control and Prevention. (2023). *Adults Meeting Aerobic and Muscle Strengthening Guidelines in 2019* [Online]. Available from: <https://nccd.cdc.gov/dnpao_dtm/rdPage.aspx?rdReport=DNPAO_DTM.ExploreByTopic&islClass=PA&islTopic=PA1&go=GO>

Charness, G., & **Gneezy, U.** (2009). Incentives to Exercise. *Econometrica* [Online], *77*(3), pp. 909–931. DOI: https://doi.org/10.3982/ECTA7416

Chekroud, S. R., Gueorguieva, R., Zheutlin, A. B., Paulus, M., Krumholz, H. M., Krystal, J. H., & **Chekroud, A. M.** (2018). Association between Physical Exercise and Mental Health in 1·2 Million Individuals in the USA between 2011 and 2015: A Cross-Sectional Study. *The Lancet Psychiatry* [Online], *0366*(18), pp. 1–7. DOI: https://doi.org/10.1016/S2215-0366(18)30227-X

Concina, L. (2014). *Risk Attitude & Economics* [Online]. 2014–01. Toulouse: Foundation for an industrial safety culture (Foncsi). Available from: <https://www.foncsi.org/fr/publications/collections/regards/risk-attitude-and-economics/Viewpoint-risk-attitude-economics.pdf>

Conell-Price, L., & **Jamison, J.** (2015). Predicting Health Behaviors with Economic Preferences & Locus of Control. *Journal of Behavioral and Experimental Economics* [Online], *54*, pp. 1–9. DOI: https://doi.org/10.1016/j.socec.2014.10.003

Coppola, M. (2014). Eliciting Risk-Preferences in Socio-Economic Surveys: How Do Different Measures Perform? *Journal of Socio-Economics* [Online], *48*, pp. 1–10. DOI: https://doi.org/10.1016/j.socec.2013.08.010

Dearden, J. S., & **Sheahan, S. L.** (2002). Counseling Middle-Aged Women about Physical Activity Using the Stages of Change. *Journal of the American Academy of Nurse Practitioners* [Online], *14*(11), pp. 492–497. Available from: <http://search.ebscohost.com/login.aspx?direct=true&AuthType=sso&db=ccm&AN=106802225&site=ehost-live&scope=site&custid=ns206789>. DOI: https://doi.org/10.1111/j.1745-7599.2002.tb00081.x

DiClemente, C. C., Prochaska, J. O., Fairhurst, S. K., Velicer, W. F., Velasquez, M. M., & **Rossi, J. S.** (1991). The Process of Smoking Cessation: An Analysis of Precontemplation, Contemplation, and Preparation Stages of Change. *Journal of Consulting and Clinical Psychology*, *59*(2), pp. 295–304. DOI: https://doi.org/10.1037/0022-006X.59.2.295

Dolan, P., Hallsworth, M., Halpern, D., King, D., Metcalfe, R., & **Vlaev, I.** (2012). Influencing Behaviour: The Mindspace Way. *Journal of Economic Psychology*, *33*(1), pp. 264–277. DOI: https://doi.org/10.1016/j.joep.2011.10.009

Dumith, S. C., Gigante, D. P., & **Domingues, M. R.** (2007). Stages of Change for Physical Activity in Adults from Southern Brazil: A Population-Based Survey. *Notes*, 4(25), pp. 1–10. DOI: https://doi.org/10.1186/1479-5868-4-25

Ert, E., & **Haruvy, E.** (2017). Revisiting Risk Aversion: Can Risk Preferences Change with Experience? *Economics Letters* [Online], *151*, pp. 91–95. DOI: https://doi.org/10.1016/j.econlet.2016.12.008

European Institute for Gender Equality. (2022). *Time Spent on Health-Enhancing (Non-Work-Related) Aerobic Physical Activity by Sex, Age and Educational Attainment Level* [Online]. Available from: <https://eige.europa.eu/it/gender-statistics/dgs/indicator/ta_timeuse_soclesact_sport__hlth_ehis_pe2e/bar/year:2019/geo:EU28,EU27_2020/duration:MN0/unit:PC/isced11:TOTAL/sex:T,M,W/age:TOTAL>

Fagerland, M. W., & **Hosmer, D. W.** (2017). How to Test for Goodness of Fit in Ordinal Logistic Regression Models. *Stata Journal*, *17*(3), pp. 668–686. DOI: https://doi.org/10.1177/1536867X1701700308

Falk, E., & **Scholz, C.** (2018). Persuasion, Influence, and Value: Perspectives from Communication and Social Neuroscience. *Annual Review of Psychology*, *69*(1), pp. 329–356. DOI: https://doi.org/10.1146/annurev-psych-122216-011821

Faralla, V., Novarese, M., & **Ardizzone, A.** (2017). Framing Effects in Intertemporal Choice: A Nudge Experiment. *Journal of Behavioral and Experimental Economics* [Online], *71*, pp. 13–25. Available from: <http://linkinghub.elsevier.com/retrieve/pii/S2214804317301003>. DOI: https://doi.org/10.1016/j.socec.2017.09.002

Fugate, D. L. (2007). Neuromarketing: A Layman's Look at Neuroscience and Its Potential Application to Marketing Practice. *Journal of Consumer Marketing*, *24*(7), pp. 385–394. DOI: https://doi.org/10.1108/07363760710834807

Garber, C. E., Allsworth, J. E., Marcus, B. H., Hesser, J., & **Lapane, K. L.** (2008). Correlates of the Stages of Change for Physical Activity in a Population Survey. *American Journal of Public Health*, *98*(5), pp. 897–904. DOI: https://doi.org/10.2105/AJPH.2007.123075

Gardner, B., Bruijn, G. J. De., & **Lally, P.** (2011). A Systematic Review and Meta-Analysis of Applications of the Self-Report Habit Index to Nutrition and Physical Activity Behaviours. *Annals of Behavioral Medicine*, *42*(2), pp. 174–187. DOI: https://doi.org/10.1007/s12160-011-9282-0

Gardner, B., Lally, P., & **Wardle, J.** (2012). Making Health Habitual: The Psychology of 'habit Formation' and General Practice. *British Journal of General Practice*, *62*(605), pp. 664–666. DOI: https://doi.org/10.3399/bjgp12X659466

Gifford, R. D., & **Chen, A. K. S.** (2017). Why Aren't We Taking Action? Psychological Barriers to Climate-Positive Food Choices. *Climatic Change* [Online], *140*(2), pp. 165–178. DOI: https://doi.org/10.1007/s10584-016-1830-y

Golsteyn, B. H. H., Grönqvist, H., & **Lindahl, L.** (2014). Adolescent Time Preferences Predict Lifetime Outcomes. *Economic Journal*, *124*(580), pp. F739–F761. DOI: https://doi.org/10.1111/ecoj.12095

Gurgu, E., Gurgu, I.-A., & **Tonis, R. B. M.** (2020). Neuromarketing for a Better Understanding of Consumer Needs and Emotions. *Independent Journal of Management & Production*, *11*(1), p. 208. DOI: https://doi.org/10.14807/ijmp.v11i1.993

Guthold, R., Stevens, G. A., Riley, L. M., & **Bull, F. C.** (2018). Worldwide Trends in Insufficient Physical Activity from 2001 to 2016: A Pooled Analysis of 358 Population-Based Surveys with 1·9 Million Participants. *The Lancet Global Health* [Online], *6*(10), pp. e1077–e1086. DOI: https://doi.org/10.1016/S2214-109X(18)30357-7

Haas, S., & **Nigg, C. R.** (2009). Construct Validation of the Stages of Change with Strenuous, Moderate, and Mild Physical Activity and Sedentary Behaviour among Children. *Journal of Science and Medicine in Sport*, *12*(5), pp. 586–591. DOI: https://doi.org/10.1016/j.jsams.2008.11.001

Hanneman. (2012). Logistic Regression Analysis.

Harris, J. M., Ciorciari, J., & **Gountas, J.** (2018). Public Health Social Media Communications and Consumer Neuroscience. *Cogent Psychology* [Online], *5*(1). DOI: https://doi.org/10.1080/23311908.2018.1434058

Holopainen, M., & **Pulkkinen, P.** (2013). *Tilastolliset Menetelmät*. 5th–8th ed. Helsinki: Sanoma PRO.

Holt, C., & **Laury, S.** (2002). Risk Aversion and Incentive Effects. *The American Economic Review*, *92*(5), pp. 1644–1655. DOI: https://doi.org/10.1257/000282802762024700

Howard, G. (2016). On Linking Risk Preferences and Time Preferences When Estimating Incentive Effects. *Economics Letters* [Online], *143*, pp. 87–89. DOI: https://doi.org/10.1016/j.econlet.2016.04.001

Hubert, M., Hubert, M., Linzmajer, M., Riedl, R., & **Kenning, P.** (2018). Trust Me If You Can – Neurophysiological Insights on the Influence of Consumer Impulsiveness on Trustworthiness Evaluations in Online Settings. *European Journal of Marketing*, *52*(1–2), pp. 118–146. DOI: https://doi.org/10.1108/EJM-12-2016-0870

Husu, P., Sievänen, H., Tokola, K., Suni, J., Vähä-Ypyä, H., Mänttäri, A., & **Vasankari, T.** (2018). *Suomalaisten objektiivisesti mitattu fyysinen aktiivisuus, paikallaanolo ja fyysinen kunto* [Online]. Helsinki: Finnish Ministry of Education and Culture. Available from: <http://urn.fi/URN:ISBN:978-952-263-585-3>.

Husu, P., Suni, J., Vähä-Ypyä, H., Sievänen, H., Tokola, K., Valkeinen, H., Mäki-Opas, T., & **Vasankari, T.** (2016). Objectively Measured Sedentary Behavior and Physical Activity in a Sample of Finnish Adults: A Cross-Sectional Study. *BMC Public Health* [Online], *16*(1), pp. 1–11. DOI: https://doi.org/10.1186/s12889-016-3591-y

Israel, A., Rosenboim, M., & **Shavit, T.** (2014). Using Priming Manipulations to Affect Time Preferences and Risk Aversion: An Experimental Study. *Journal of Behavioral and Experimental Economics* [Online], *53*, pp. 36–43. DOI: https://doi.org/10.1016/j.socec.2014.08.006

Kahneman, D., & **Tversky, A.** (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, *47*(2), pp. 263-. DOI: https://doi.org/10.2307/1914185

Kang, M. Il., & **Ikeda, S.** (2016). Time Discounting, Present Biases, and Health-Related Behaviors: Evidence from Japan. *Economics and Human Biology* [Online], *21*, pp. 122–136. DOI: https://doi.org/10.1016/j.ehb.2015.09.005

Khan, U., & **Dhar, R.** (2006). Licensing Effect in Consumer Choice. *Journal of Marketing Research*, *43*(2), pp. 259–266. DOI: https://doi.org/10.1509/jmkr.43.2.259

Kokko, S., Mehtälä, A., Villberg, J., Ng, K., & **Hämylä, R.** (2016). Itsearvioitu liikunta-aktiivisuus, istuminen ja ruutuaika sekä liikkumisen seurantalaitteet ja -sovellukset [Online]. In: S. Kokko, & A. Mehtälä (Eds.), *Lasten ja nuorten liikuntakäyttäytyminen Suomessa. LIITU-tutkimuksen tuloksia*. Helsinki: Finnish National Sports Council, pp. 10–15. Available from: <https://www.liikuntaneuvosto.fi/wp-content/uploads/2019/09/LIITU_2016.pdf>

Komlos, J., Smith, P. K., & **Bogin, B.** (2004). Obesity and the Rate of Time Preference: Is There a Connection? *Journal of Biosocial Science* [Online], *36*(2), pp. 209–219. Available from: <https://www.cambridge.org/core/product/identifier/S0021932003006205/type/journal_article>. DOI: https://doi.org/10.1017/S0021932003006205

Kosteas, V. D. (2015). Physical Activity and Time Preference. *International Journal of Health Economics and Management*, *15*(4), pp. 361–386. DOI: https://doi.org/10.1007/s10754-015-9173-1

LeComte, R. S., Sofis, M. J., & **Jarmolowicz, D. P.** (2020). Independent Effects of Ideal Body Image Valuation and Delay Discounting on Proximal and Typical Levels of Physical Activity. *Psychological Record*, *70*(1), pp. 75–82. DOI: https://doi.org/10.1007/s40732-019-00369-y

Lee, N., Chamberlain, L., & **Brandes, L.** (2018). Welcome to the Jungle! The Neuromarketing Literature through the Eyes of a Newcomer. *European Journal of Marketing*, *52*(1–2), pp. 4–38. DOI: https://doi.org/10.1108/EJM-02-2017-0122

Leonard, T., & **Shuval, K.** (2017). Behavioral Economics: Tools for Promotion of Physical Activity. In: Y. Hanoch, A. Barnes, & T. Rice (Eds.), *Behavioral Economics and Healthy Behaviors. Key Concepts and Current Research*. 1st ed. New York: Routledge, pp. 70–89. DOI: https://doi.org/10.4324/9781315637938-5

Leonard, T., Shuval, K., Oliveira, A. de, Skinner, C. S., Eckel, C., & **Murdoch, J.** (2013). Health Behavior and Behavioral Economics: Economic Preferences and Physical Activity Stages of Change in a Low-Income African American Community. *American Journal of Health promotion*, *27*(4), pp. 211–221. DOI: https://doi.org/10.4278/ajhp.110624-QUAN-264

Lichters, M., Brunnlieb, C., Nave, G., Sarstedt, M., & **Vogt, B.** (2016). The Influence Serotonin Deficiency on Choice Deferral and the Compromise. *Journal of Marketing Research*, *53*(2), pp. 183–198. DOI: https://doi.org/10.1509/jmr.14.0482

Lim, M. S. M., & **Rogers, R. D.** (2017). Chinese Beliefs in Luck Are Linked to Gambling Problems via Strengthened Cognitive Biases: A Mediation Test. *Journal of Gambling Studies*, *33*(4), pp. 1325–1336. DOI: https://doi.org/10.1007/s10899-017-9690-6

Marcus, B. H., Rossi, Joseph, S., Selby, V. C., Niaura, R. S., & **Abrams, D. B.** (1992). The Stages and Processes of Exercise Adoption and Maintenance in a Worksite Sample. *Health Psychology* [Online], *11*(6), pp. 386–395. Available from: <http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed2&NEWS=N&AN=1286658>. DOI: https://doi.org/10.1037/0278-6133.11.6.386

Masterson, T. D., Stein, W. M., Beidler, E., Bermudez, M., English, L. K., & **Keller, K. L.** (2019). Brain Response to Food Brands Correlates with Increased Intake from Branded Meals in Children: An FMRI Study. *Brain Imaging and Behavior*, *13*(4), pp. 1035–1048. DOI: https://doi.org/10.1007/s11682-018-9919-8

Metsämuuronen, J. (2008). *Monimuuttujamenetelmien Perusteet*. Helsinki: International Methelp.

Milkman, K. L., Rogers, T., & **Bazerman, M. H.** (2008). Harnessing Our Inner Angels and Demons. *Perspectives on Psychological Science*, *3*(4), pp. 324–338. DOI: https://doi.org/10.1111/j.1745-6924.2008.00083.x

Miura, T. (2019). Does Time Preference Affect Smoking Behavior. A Dynamic Panel Analysis. *Journal of Behavioral and Experimental Economics*, *78*(C), pp. 170–180. DOI: https://doi.org/10.1016/j.socec.2018.11.001

Modica, E., Rossi, D., Cartocci, G., Perrotta, D., Feo, P. di, Mancini, M., Aricò, P., Inguscio, B. M. S., & **Babiloni, F.** (2018). Neurophysiological Profile of Antismoking Campaigns. *Computational Intelligence and Neuroscience*, 2018. DOI: https://doi.org/10.1155/2018/9721561

Monin, B., & **Miller, D. T.** (2001). Moral Credentials and the Expression of Prejudice. *Journal of Personality and Social Psychology*, *81*(1), pp. 33–43. DOI: https://doi.org/10.1037/0022-3514.81.1.33

Mostafa, M. M. (2014). Functional Neuroimaging Applications in Marketing: Some Methodological and Statistical Considerations: *Qualitative Market Research*, *17*(4), pp. 343–372. DOI: https://doi.org/10.1108/QMR-06-2011-0003

National Advisory Board on Research Ethics. (2009). *Ethical Principles of Research in the Humanities and Social and Behavioural Sciences and Proposals for Ethical Review* [Online]. Available from: <https://tenk.fi/sites/tenk.fi/files/ethicalprinciples.pdf>

Ng, K., Sainio, P., & **Sit, C.** (2019). Physical Activity of Adolescents with and without Disabilities from a Complete Enumeration Study (N = 128,803): School Health Promotion Study 2017. *International Journal of Environmental Research and Public Health*, *16*(17), pp. 1–13. DOI: https://doi.org/10.3390/ijerph16173156

Nummenmaa, L. (2009). *Käyttäytymistieteiden Tilastolliset Menetelmät*. Helsinki: Tammi.

Nummenmaa, L., Holopainen, M., & **Pulkkinen, P.** (2019). *Tilastollisten Menetelmien Perusteet*. 1st–5th ed. Helsinki: Sanoma PRO.

Obrien, K., Agostino, J., Ciszek, K., & **Douglas, K. A.** (2020). Physical Activity and Risk of Behavioural and Mental Health Disorders in Kindergarten Children: Analysis of a Series of Cross-Sectional Complete Enumeration (Census) Surveys. *BMJ Open*, *10*(3). DOI: https://doi.org/10.1136/bmjopen-2019-034847

Patterson, E., McGeough, D., Cannon, E., Hagströmer, M., Bergman, P., Kearney, J., & **Sjöström, M.** (2006). Self-Efficacy, Stages of Change and Physical Activity in Irish College Students. *Journal of Public Health*, *14*(2), pp. 81–86. DOI: https://doi.org/10.1007/s10389-006-0028-6

Petit, O., Merunka, D., Anton, J. L., Nazarian, B., Spence, C., Cheok, A. D., Raccah, D., & **Oullier, O.** (2016). Health and Pleasure in Consumers' Dietary Food Choices: Individual Differences in the Brain's Value System. *PLoS ONE*, *11*(7), pp. 1–15. DOI: https://doi.org/10.1371/journal.pone.0156333

Plotnikoff, R. C., Lippke, S., Johnson, S. T., & **Courneya, K. S.** (2010). Physical Activity and Stages of Change: A Longitudinal Test in Types 1 and 2 Diabetes Samples. *Annals of Behavioral Medicine*, *40*(2), pp. 138–149. DOI: https://doi.org/10.1007/s12160-010-9193-5

Pol, M. van der, Hennessy, D., & **Manns, B.** (2017). The Role of Time and Risk Preferences in Adherence to Physician Advice on Health Behavior Change. *European Journal of Health Economics*, *18*(3), pp. 373–386. DOI: https://doi.org/10.1007/s10198-016-0800-7

Post, T., Assem, M. van den, Baltussen, G., & **Thaler, R. H.** (2008). Deal or No Deal? Decision Making under Risk in a Large-Stake TV Game Show and Related Experiments. *American Economic Review* [Online], *98*(1), pp. 38–71. DOI: https://doi.org/10.1257/aer.98.1.38

Prinsen, S., Evers, C., & **Ridder, D. T. D. de.** (2019). Justified Indulgence: Self-Licensing Effects on Caloric Consumption. *Psychology and Health* [Online], *34*(1), pp. 24–43. DOI: https://doi.org/10.1080/08870446.2018.1508683

Prochaska, J. O., & **DiClemente, C. C.** (1983). Stages and Processes of Self-Change of Smoking: Toward an Integrative Model of Change. *Journal of Consulting and Clinical Psychology*, *51*(3), pp. 390–395. DOI: https://doi.org/10.1037/0022-006X.51.3.390

Rabin, M., & **O'Donoghue, T.** (1999). Doing It Now or Later. *American Economic Review* [Online], *89*(1), pp. 103–124. Available from: <http://ideas.repec.org/a/aea/aecrev/v89y1999i1p103-124.html>. DOI: https://doi.org/10.1257/aer.89.1.103

Reimann, M., Castaño, R., Zaichkowsky, J., & **Bechara, A.** (2012). How We Relate to Brands: Psychological and Neurophysiological Insights into Consumer-Brand Relationships. *Journal of Consumer Psychology* [Online], *22*(1), pp. 128–142. DOI: https://doi.org/10.1016/j.jcps.2011.11.003

Rhodes, S. D., Bowie, D. A., & **Hergenrather, K. C.** (2003). Collecting Behavioural Data Using the World Wide Web: Considerations for Researchers. *Journal of Epidemiology and Community Health*, *57*(1), pp. 68–73. DOI: https://doi.org/10.1136/jech.57.1.68

Riebe, D., Garber, C. E., Rossi, J. S., Greaney, M. L., Nigg, C. R., Lees, F. D., Burbank, P. M., & **Clark, P. G.** (2005). Physical Activity, Physical Function, and Stages of Change in Older Adults. *American Journal of*

Health Behavior [Online], *29*(1), pp. 70–80. Available from: <http://search.ebscohost.com/login.aspx?direct=true&db=rzh&AN=106633732&site=ehost-live>. DOI: https://doi.org/10.5993/AJHB.29.1.6

Roberto, C. A., & **Kawachi, I.** (2014). Use of Psychology and Behavioral Economics to Promote Healthy Eating. *American Journal of Preventive Medicine* [Online], *47*(6), pp. 832–837. DOI: https://doi.org/10.1016/j.amepre.2014.08.002

Rosenkilde, M., Auerbach, P., Reichkendler, M. H., Ploug, T., Stallknecht, B. M., & **Sjödin, A.** (2012). Body Fat Loss and Compensatory Mechanisms in Response to Different Doses of Aerobic Exercise—a Randomized Controlled Trial in Overweight Sedentary Males. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, *303*(6), pp. R571–R579. DOI: https://doi.org/10.1152/ajpregu.00141.2012

Sahi, S. K. (2017). Psychological Biases of Individual Investors and Financial Satisfaction. *Journal of Consumer Behaviour*, *16*(6), pp. 511–535. DOI: https://doi.org/10.1002/cb.1644

Samuelson, A., & **Zeckhouser, R.** (1988). Status Quo Bias in Decision Making. pp. 7–59. DOI: https://doi.org/10.1007/BF00055564

Scopelliti, I., Morewedge, C. K., Mccormick, E., Min, H. L., Lebrecht, S., & **Kassam, K. S.** (2015). Bias Blind Spot: Structure, Measurement, and Consequences. *Management Science*, *61*(10), pp. 2468–2486. DOI: https://doi.org/10.1287/mnsc.2014.2096

Shiv, B., Bechara, A., Levin, I., Alba, J. W., Bettman, J. R., Dube, L., Isen, A., Mellers, B., Smidts, A., Grant, S. J., & **McGraw, A. P.** (2005). Decision Neuroscience. *Marketing Letters* [Online], *16*(3/4), pp. 375–386. Available from: <https://faculty.fuqua.duke.edu/~jrb12/bio/Jim/shivetalchoiceconf.pdf>. DOI: https://doi.org/10.1007/s11002-005-5899-8

Shuval, K., Drope, J., Stoklosa, M., Yaroch, A. L., Pachucki, M. C., & **Harding, M.** (2017). Time Preferences and Physical Activity: Insights from Behavioral Economics. *Health Behavior and Policy Review* [Online], 4(1), pp. 53–59. Available from: <http://www.ingentaconnect.com/content/10.14485/HBPR.4.1.6>. DOI: https://doi.org/10.14485/HBPR.4.1.6

Shuval, K., Si, X., Nguyen, B., & **Leonard, T.** (2015). Utilizing Behavioral Economics to Understand Adherence to Physical Activity Guidelines Among a Low-Income Urban Community. *Journal of Physical Activity and Health* [Online], *12*(7), pp. 947–953. DOI: https://doi.org/10.1123/jpah.2014-0203

Smith, P. K., Bogin, B., & **Bishai, D.** (2005). Are Time Preference and Body Mass Index Associated? Evidence from the National Longitudinal Survey of Youth. *Economics and Human Biology*, *3*(2 SPEC. ISS.), pp. 259–270. DOI: https://doi.org/10.1016/j.ehb.2005.05.001

Sniehotta, F. F., Scholz, U., & **Schwarzer, R.** (2005). Bridging the Intention-Behaviour Gap: Planning, Self-Efficacy, and Action Control in the Adoption and Maintenance of Physical Exercise. *Psychology and Health*, *20*(2), pp. 143–160. DOI: https://doi.org/10.1080/08870440512331317670

Steenbergh, T. A., Meyers, A. W., May, R. K., & **Whelan, J. P.** (2002). Development and Validation of the Gamblers' Beliefs Questionnaire. *Psychology of Addictive Behaviors*, *16*(2), pp. 143–149. DOI: https://doi.org/10.1037/0893-164X.16.2.143

Stoklosa, M., Shuval, K., Drope, J., Tchernis, R., Pachucki, M., Yaroch, A., & **Harding, M.** (2018). The Intergenerational Transmission of Obesity: The Role of Time Preferences and Self-Control. *Economics and Human Biology* [Online], *28*, pp. 92–106. DOI: https://doi.org/10.1016/j.ehb.2017.12.004

Suomen Telecenter Oy. (2017). *Financial Statement and Audit Report.*

Tappe, K. A., & **Glanz, K.** (2013). Measurement of Exercise Habits and Prediction of Leisure-Time Activity in Established Exercise. *Psychology, Health and Medicine*, *18*(5), pp. 601–611. DOI: https://doi.org/10.1080/13548506.2013.764458

Telpaz, A., Webb, R., & **Levy, D. J.** (2015). Using EEG to Predict Consumers' Future Choices. *Journal of Marketing Research*, *52*(4), pp. 511–529. DOI: https://doi.org/10.1509/jmr.13.0564

Thaler, R. H., Sunstein, C. R., & **Balz, J. P.** (2010). Choice Architecture. *Social Science Research Network* [Online]. DOI: https://doi.org/10.2139/ssrn.1583509

Thorgeirsson, T., & **Kawachi, I.** (2013). Behavioral Economics: Merging Psychology and Economics for Lifestyle Interventions. *American Journal of Preventive Medicine* [Online], 44(2), pp. 185–189. DOI: https://doi.org/10.1016/j.amepre.2012.10.008

Tversky, A., & **Kahneman, D.** (1991). Loss Aversion in Riskless Choice. A Reference-Dependent Mod. *The Quarterly Journal of Economics*, pp. 1039–1061. DOI: https://doi.org/10.2307/2937956

Tversky, A., & **Kahneman, D.** (1992). Advances in Prospect-Theory – Cumulative Representation of Uncertainty. *Journal of Risk and Uncertainty*, *5*(4), pp. 297–323. DOI: https://doi.org/10.1007/BF00122574

UCLA Institute for Digital Research and Education. (2021). *Statistical Consulting. Ordered Logistic Regression.* [Online]. Available from: <https://stats.idre.ucla.edu/spss/output/ordered-logistic-regression/> [Accessed 15 August 2021].

UKK Institute. (2021). *Physical Activity Pie 2021* [Online]. UKK Institute Products & Services. Available from: <https://ukkinstituutti.fi/en/products-services/physical-activity-pie/> [Accessed 13 May 2021].

U. S. Department of Health and Human Services. (2018). *Physical Activity Guidelines for Americans.* [Online]. Available from: <https://health.gov/sites/default/files/2019-09/Physical_Activity_Guidelines_2nd_edition.pdf>

Volpp, K. G., & **Asch, D. A.** (2017). Make the Healthy Choice the Easy Choice: Using Behavioral Economics to Advance a Culture of Health. *Qjm*, *110*(5), pp. 271–275. DOI: https://doi.org/10.1093/qjmed/hcw190

Walton, J. A., Hoerr, S. M., & **Heine, L. D.** (1999). Stages of Change and Physical Activity Following After-School Intervention in Fifth and Sixth Graders. *Medicine & Science in Sports & Exercise*, *31*(Supplement), p. S91. DOI: https://doi.org/10.1097/00005768-199905001-00300

Webb, T. L., & **Sheeran, P.** (2006). Does Changing Behavioral Intentions Engender Behavior Change? A Meta-Analysis of the Experimental Evidence. *Psychological Bulletin*, *132*(2), pp. 249–268. DOI: https://doi.org/10.1037/0033-2909.132.2.249

Wood, W., & **Neal, D. T.** (2009). The Habitual Consumer. *Journal of Consumer Psychology* [Online], *19*(4), pp. 579–592. DOI: https://doi.org/10.1016/j.jcps.2009.08.003

World Health Organization. (2010). *Body Mass Index – BMI* [Online]. Available from: <https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations> [Accessed 1 August 2023].

World Health Organization. (2022). *Physical Activity*. [Online]. Available from: <https://www.who.int/news-room/fact-sheets/detail/physical-activity> [Accessed 20 January 2023].

Xiao, J. J., & **Porto, N.** (2019). Present Bias and Financial Behavior. *Financial Planning Review*, *2*(2), pp. 1–14. DOI: https://doi.org/10.1002/cfp2.1048

Yokum, S., Gearhardt, A. N., Harris, J. L., Brownell, K. D., & **Stice, E.** (2014). Individual Differences in Striatum Activity to Food Commercials Predict Weight Gain in Adolescents. *Obesity*, *22*(12), pp. 2544–2551. DOI: https://doi.org/10.1002/oby.20882

YTJ – The Business Information System. (2020). Suomen Telecenter Oy (Soldem) [Online]. Available from: <https://tietopalvelu.ytj.fi/yritys/2264755-0> [Accessed 1 August 2023].

Zhang, L., & **Rashad, I.** (2008). Obesity and Time Preference: The Health Consequences of Discounting the Future. *Journal of Biosocial Science*, *40*(1), pp. 97–113. DOI: https://doi.org/10.1017/S0021932007002039

Zhang, W., Zhao, W., Gao, Y., & **Xiao, Z.** (2020). How Do Managerial Ties Influence the Effectuation and Causation of Entrepreneurship in China? The Role of Entrepreneurs' Cognitive Bias. *Asia Pacific Business Review* [Online], *26*(5), pp. 613–641. DOI: https://doi.org/10.1080/13602381.2020.1765537

Zhang, Y., Cui, L., Zhang, G., Sarasvathy, S., & **Anusha, R.** (2019). An Exploratory Study of Antecedents of Entrepreneurial Decision-Making Logics: The Role of Self-Efficacy, Optimism, and Perspective Taking. *Emerging Markets Finance and Trade* [Online], *55*(4), pp. 781–794. DOI: https://doi.org/10.1080/1540496X.2018.1478283

Zimmerman, F. J. (2009). Using Behavioral Economics to Promote Physical Activity. *Preventive Medicine* [Online], *49*(4), pp. 289–291. DOI: https://doi.org/10.1016/j.ypmed.2009.07.008

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