Only hyperbolic discounting and gifted experimental consumption work for happiness on spending: inferring directly correlating factors to happiness on money by causal discovery algorithm

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Keywords: subjective well-being, prosocial spending, behavioral economics, causal discovery algorithm

Purpose and background: This study is to infer factors directly correlating with subjective well-being on spending money using a causal discovery algorithm, named CS algorithm (Isozaki 2014). Three currents of studies have recently emerged on correlations between happiness and spending; the first focused upon income and other social attributes (e.g., Diener and Oishi 2000, Kahneman 2010, Frey and Stuzer 2006); the second from behavioral economics with concepts of mental accounting, risk aversion, experimental consumption and hyperbolic discounting (e.g., Tversky and Kahneman 1992, Thaler 1999, Boven and Gilovich 2003, Kahneman *et al.* on DRM 2004, Ikeda and Kang on hyperbolic discounting 2015); and the third with concepts of prosocial consumptions (e.g., Akin, Dunn and Norton 2011). However there has been few contributions to identify direct correlations by eliminating all spurious or indirect correlations among them.

Method: The authors collected all factors correlating happiness on spending money from more than fifty major previous studies above and identified 55 factors (green in the **Figure 1**) as reasons for spending and 6 social and economic attributions (gray in the **Figure 1**). They prepared 5 quantitative instruments with 13 factors (pink in the **Figure 1**) to weigh personal traits and subjective well-being; the Big five personality traits (Goldberg 1990), the Maeno's 4 factors (Maeno and Maeno 2015), PANAS (J-ver. Sato and Yasuda 2001), SHS (J-ver. Shimai *et al.* 2004) and SWLS (Diener *et al.* 1985). This study conducted 7-point numerical survey with 617 Japanese nationals on these 66 factors. Then it analyzed the data with the causal discovery algorithm (Isozaki 2014), which can statistically distinguish *direct* correlations from pseudo correlations using partial correlation like metrics and visualize all direct correlations among factors as a map and their relative distances in correlations among factors on it.

Results; The map induced by the causal discovery algorithm with the survey this time (see **Figure 1**) inferred four channels (red lines in **Figure 1**) of considerable and direct correlations from factors on spending money as well as social and economic attributions as gateways to factors of personal traits and subjective well-being, which are located at the center of the map (note: **p**: positive correlation, **n**:negative correlation);

Channel #1; strong hyperbolic discounting –**n**- conscientiousness –**p**- at-own-pace (Maeno F#4) -**p**- positivity (Maeno F#3) -**p**- SWLS -**p**- SHS.
Channel #2; spending for socializing -**p**- extraversion –**p**- openness –**p**- self-realization and growth (Maeno F#1) –**p**- positive affect -**p**- SHS -**p**- SWLS.
Channel #3; spending on watching TV -**p**- negative affect -**p**- neuroticism -**n**- positivity (Maeno F#3) -**p**- SWLS –**p**- SHS.
Channel #4; mental accounting -**p**- agreeableness -**p**- connected and appreciation (Maeno F#2) -**p**- SHS -**p**- SWLS.

The numbers in the **Figure 1** are indicators of mutual information according to the information theory and represent the strength of the correlation between two variables. They are different from the Pearson's linear correlation coefficient. They take >0 figures and are considered that weak correlation exists if they are above 0.01, moderate correlation if they around 0.1 to 0.4 and strong correlation if they are above 0.4.

Conclusion: this study showed with the CS algorithm that the spending for socializing and mental accounting have positive and direct correlation with indicators on subjective well-being while strong hyperbolic discounting and spending on watching TV has negative and direct correlation with them. There are no direct correlations observed between social and economic attributions (e.g., household income and debt) with them.

Figure 1. Map to visualize relative distances in correlations among factors on spending money, social and economic attributions and subjective well-being by the Causal Discovery Algorithm (n=617, Japanese, September 1 to January 27, 2019)