# Probability and delay discounting behavior of pathological gamblers with and without a history of mental disorder

[www.foreconcontinent.com/wp-content/uploads/2014/12/Risk-Tolerance.jpg]

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http://propertyblogs.in/wp-content/uploads/2016/01/delay-claim-primavera-p6.jpg

## Rational & Introduction

Gambling addiction is strongly associated with mental disorders: Amongst others, major depression, anxiety disorders, and personality disorders show high comorbidity rates with pathological gambling. However, there is very little empirical evidence on how exactly the interaction of pathological gambling and mental disorders affects gamblers' risk behavior.

As a behavioral addiction, pathological gambling is characterized by repetitive maladaptive patterns of behavior connected to low impulse control - irrespective of potentially devastating long-term outcomes (Holden 2001, Bickel et al. 2014, Grant & Chamberlain 2014).

Among others, major depression, anxiety disorders, ADHD, and personality disorders show disproportionally high comorbidity rates with pathological gambling (Potenza et al. 2001, Black & Shaw 2008, Deisenhammer & Hausmann 2012, Bischof et al. 2013, Meyer et al. 2015). Still, we do not have clear evidence on to what extend the interaction of pathological gambling and mental disorders may accelerate behavioral biases and result in extreme and inconsistent delay and probability discounting behavior (Klein-Flügge et al. 2015).

Gambling addicts are more likely to exhibit systematic deviances from rational goal-oriented and consistent behavior (Redish 2010, Meyer et al. 2011, Braun et al. 2014). Studies on decision making under risk using experimental lab-based measures such as the Iowa Gambling Task or the Wisconsin Card Sorting Test found significant dissimilarities in economic choice behavior among addicts in general – not only in gambling addicts – compared with healthy control groups (Bellegarde & Potenza 2010, Bickel & Yi 2010, Redish 2010, Lai 2011). It is, therefore, likely that mental disorder should exert biases onto the behavior of gamblers. However, the exact interactive effect of pathological gambling and mental disorders is gravely understudied.

## Research objective

Based on an original sample of N=379 pathological gamblers raised with the Pathological Gambling and Epidemiology (PAGE) data set, we scrutinize the delay and probability discounting behaviors of pathological gamblers with and without mental disorders.

## Material: The PAGE Study

The empiricism of this paper is based on the data of the "Pathological Gambling and Epidemiology" (**PAGE**) research program initiated by the German federal states. The data were collected by an interdisciplinary research group (**EARLINT**) at the University Hospital of Lübeck and the University of Greifswald. The PAGE survey provides a rich epidemiological database on the prevalence of pathological gambling among the German population (Meyer et al. 2015).

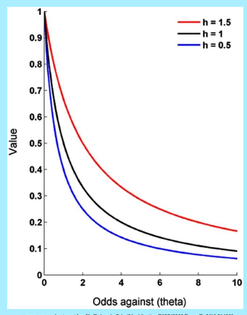
The sample was selected randomly through a dual sampling setup with guided telephone interviews for the general population and yielded N=15,023 test subjects (aged 14 to 64), as well as N=594 subjects through in-depth one-on-one clinical interviews with high-risk respondents recruited directly at gambling locations and in qualified addiction treatment facilities. EARLINT applied large parts of Wittchen and Pfister's standardized Composite International Diagnostic Interview (CIDI-X) codebook (Meyer et al. 2015, Wittchen & Pfister 2005), which allows for aggregation into parametric rating scale values with high test-retest reliability (α=.49-.83) and high evidential validity (α=.39-.82) (Essau et al. 1999, Stinchfield 2003, Wittchen & Pfister 2005).

Individual gambling behavior and gambling problems were classified by the criteria established in the American Psychiatric Association`s Diagnostic and Statistical Manual of Mental Disorders (4th ed.: DSM-IV). The DSM-IV criteria were standardized by translation into explicit questionnaire scale items. Socio-demographic measures were adapted from Abrams et al. (2000). In order to inhibit distortion effects due to cross-loadings, gamblers with substance-based disorders were excluded from this study. The data was collected pseudonymously in order to inhibit response distortion through social desirability.

## Method

### Probability discounting questionnaire (Madden et al. 2009)

| Item No. | | Certain reward | Probability of Winning | Probabilistic reward | *h* |
|---|---|---|---|---|---|
| 01 | Part 1: $h_{medium}$ (medium amount of probabilistic reward, large margin of reward) | €20 | 0.1 | €80 | 0.33 |
| 02 | | €20 | 0.13 | €80 | 0.45 |
| 03 | | €20 | 0.17 | €80 | 0.61 |
| 04 | | €20 | 0.2 | €80 | 0.75 |
| 05 | | €20 | 0.25 | €80 | 1 |
| 06 | | €20 | 0.33 | €80 | 1.48 |
| 07 | | €20 | 0.5 | €80 | 3 |
| 08 | | €20 | 0.67 | €80 | 6.09 |
| 09 | | €20 | 0.75 | €80 | 9 |
| 10 | | €20 | 0.83 | €80 | 14.65 |
| 11 | Part 2: $h_{large}$ (large amount of probabilistic reward, large margin of reward) | €40 | 0.18 | €100 | 0.33 |
| 12 | | €40 | 0.22 | €100 | 0.42 |
| 13 | | €40 | 0.29 | €100 | 0.62 |
| 14 | | €40 | 0.33 | €100 | 0.74 |
| 15 | | €40 | 0.4 | €100 | 1 |
| 16 | | €40 | 0.5 | €100 | 1.5 |
| 17 | | €40 | 0.67 | €100 | 3.04 |
| 18 | | €40 | 0.8 | €100 | 6 |
| 19 | | €40 | 0.86 | €100 | 9.21 |
| 20 | | €40 | 0.91 | €100 | 15.17 |
| 21 | Part 3: $h_{small}$ (small amount of probabilistic reward, small margin of reward) | €40 | 0.4 | €60 | 0.33 |
| 22 | | €40 | 0.46 | €60 | 0.43 |
| 23 | | €40 | 0.55 | €60 | 0.61 |
| 24 | | €40 | 0.6 | €60 | 0.75 |
| 25 | | €40 | 0.67 | €60 | 1.01 |
| 26 | | €40 | 0.75 | €60 | 1.5 |
| 27 | | €40 | 0.86 | €60 | 3.07 |
| 28 | | €40 | 0.92 | €60 | 5.75 |
| 29 | | €40 | 0.95 | €60 | 9.5 |
| 30 | | €40 | 0.97 | €60 | 16.17 |



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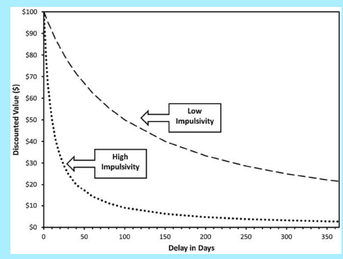
$$V = \frac{A}{1 + h * \theta}$$

### Delay discounting questionnaire (Kirby et al. 1999)

| Item No. | Smaller immediate reward | Larger delayed reward | Delay | k (indiff.) | Larger delayed reward size |
|---|---|---|---|---|---|
| 13 | €34 | €35 | 186 | .00016 | S |
| 1 | €54 | €55 | 117 | .00016 | M |
| 9 | €78 | €80 | 162 | .00016 | L |
| 20 | €28 | €30 | 179 | .00040 | S |
| 6 | €47 | €50 | 160 | .00040 | M |
| 17 | €80 | €85 | 157 | .00040 | L |
| 26 | €22 | €25 | 136 | .0010 | S |
| 24 | €54 | €60 | 111 | .0010 | M |
| 12 | €67 | €75 | 119 | .0010 | L |
| 22 | €25 | €30 | 80 | .0025 | S |
| 16 | €49 | €60 | 89 | .0025 | M |
| 15 | €69 | €85 | 91 | .0025 | L |
| 3 | €19 | €25 | 53 | .0060 | S |
| 10 | €40 | €55 | 62 | .0060 | M |
| 2 | €55 | €75 | 61 | .0060 | L |
| 18 | €24 | €35 | 29 | .016 | S |
| 21 | €34 | €50 | 30 | .016 | M |
| 25 | €54 | €80 | 30 | .016 | L |
| 5 | €14 | €25 | 19 | .041 | S |
| 14 | €27 | €50 | 21 | .041 | M |
| 23 | €41 | €70 | 20 | .041 | L |
| 7 | €15 | €35 | 13 | .10 | S |
| 8 | €25 | €60 | 14 | .10 | M |
| 19 | €33 | €80 | 14 | .10 | L |
| 11 | €11 | €30 | 7 | .25 | S |
| 27 | €20 | €55 | 7 | .25 | M |
| 4 | €31 | €85 | 7 | .25 | L |



Gray & MacKillop (2015) http://journal.frontiersin.org/article/10.3389/fpsyg.2015.01104/full

$$V = \frac{A}{1 + k * D}$$

## Results

The results of the Wilcoxon rank-sum (Mann-Whitney) tests indicate that, in this sample, there are only statistically reliable differences in the discounting behavior of pathological gamblers with and without mental disorders **for large, probabilistic rewards** (z=-2.328, p=.020): Pathological gamblers with mental disorders discount large probabilistic rewards **more steeply** than pathologic gamblers without mental disorder. There are no statistically reliable differences for delayed rewards, irrespective of magnitude of delayed reward. Table 1 displays the mean estimated results of the probability ($h_{large}$, $h_{medium}$, and $h_{small}$) and of the delay discounting parameters by magnitude of reward ($k_{large}$, $k_{medium}$, and $k_{small}$) for pathological gamblers with and without a history of mental disorders.

However, as shown in table 2, **different mental disorders affect discounting behavior very dissimilarly**:

| Magnitude of reward | Subsample (DSM>4) | N | Mean | SD | Wilcoxon | | |
|---|---|---|---|---|---|---|---|
| | | | | | z | Prob > \|z\| | Sign. |
| $h_{large}$ | with mental disorder | 256 | 1.473 | .3560 | -2.328 | .020 | * |
| | without mental disorder | 113 | 1.386 | .3128 | | | |
| $h_{medium}$ | with mental disorder | 214 | 1.471 | .2946 | -1.290 | .197 | n.s. |
| | without mental disorder | 93 | 1.424 | .3303 | | | |
| $h_{small}$ | with mental disorder | 259 | 1.439 | .3186 | -1.456 | .145 | n.s. |
| | without mental disorder | 114 | 1.401 | .3520 | | | |
| $k_{large}$ | with mental disorder | 262 | 1.307 | .1907 | 1.291 | .197 | n.s. |
| | without mental disorder | 117 | 1.345 | .2286 | | | |
| $k_{medium}$ | with mental disorder | 262 | 1.266 | .1838 | 1.195 | .232 | n.s. |
| | without mental disorder | 116 | 1.301 | .2173 | | | |
| $k_{small}$ | with mental disorder | 263 | 1.206 | .1682 | 1.740 | .082 | n.s. |
| | without mental disorder | 116 | 1.242 | .1850 | | | |

**Table 1:** Inter-group comparison of results of the estimated probability and delay discounting parameters (*h*-values by magnitude of reward, *k*-values by margins of reward) between pathological gamblers with and without mental disorders. Tested for statistical significance with Wilcoxon rank-sum (Mann-Whitney) test; level of significance p<.05. *p < .05.

| | Probability Discounting | | | | | | | | | Delay Discounting | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | small rewards Wilcoxon[a] | | | medium rewards Wilcoxon[a] | | | large rewards Wilcoxon[a] | | | small rewards Wilcoxon[a] | | | medium rewards Wilcoxon[a] | | | large rewards Wilcoxon[a] | | |
| Mental Disorder | z | Prob > \|z\| | Sign. | z | Prob > \|z\| | Sign. | z | Prob > \|z\| | Sign. | z | Prob > \|z\| | Sign. | z | Prob > \|z\| | Sign. | z | Prob > \|z\| | Sign. |
| Major depression | -1.374 | .1695 | n.s. | **-2.547** | **.0109** | ** | -1.473 | .1408 | n.s. | 1.842 | .0654 | n.s. | 1.120 | .2626 | n.s. | 1.317 | .1879 | n.s. |
| Major depression (single episodes) | -.091 | .9274 | n.s. | -1.220 | 0.2224 | n.s. | -.073 | .9418 | n.s. | .062 | .9504 | n.s. | .562 | .5762 | n.s. | -.208 | .8354 | n.s. |
| Major depression (recurent) | -1.440 | .1500 | n.s. | -1.781 | .0749 | n.s. | -1.551 | .1209 | n.s. | **1.980** | **.0477** | * | .761 | .4467 | n.s. | 1.637 | .1016 | n.s. |
| Dysthyme disorder | -1.718 | .0858 | n.s. | -1.751 | .0799 | n.s. | -.951 | .3415 | n.s. | **2.612** | **.0090** | ** | **2.240** | **.0251** | * | **3.202** | **.0014** | ** |
| **Depressive disorders (combined)** | **-2.197** | **.0280** | * | **-3.006** | **.0026** | ** | **-2.004** | **.0451** | * | **2.173** | **.0298** | * | 1.774 | .0760 | n.s. | **2.150** | **.0316** | * |
| Hypomania | .559 | .5760 | n.s. | 1.070 | .2847 | n.s. | .906 | .3649 | n.s. | 1.650 | .0990 | n.s. | .682 | .4954 | n.s. | -.166 | .8680 | n.s. |
| Bipolar disorder type I | .179 | .8675 | n.s. | 1.261 | .2074 | n.s. | 1.335 | .1819 | n.s. | -.457 | .6475 | n.s. | -.313 | .7544 | n.s. | -.541 | .5886 | n.s. |
| Bipolar disorder type II | -1.286 | .1985 | n.s. | -1.667 | .0954 | n.s. | -1.734 | .0828 | n.s. | **2.034** | **.0419** | * | **2.036** | **.0418** | * | .399 | .6896 | n.s. |
| **Bipolar disorders (combined)** | -.354 | .7234 | n.s. | .577 | .5638 | n.s. | .523 | .6008 | n.s. | .534 | .5936 | n.s. | -.083 | .9338 | n.s. | -.083 | .9338 | n.s. |
| Affektive disorder based on medical condition | 1.318 | .1875 | n.s. | .[b] | | | 1.477 | .1396 | n.s. | -1.482 | .1383 | n.s. | -1.278 | .2013 | n.s. | -1.026 | .3049 | n.s. |
| **Affektive disorders (combined)** | -1.782 | .0747 | n.s. | **-2.457** | **.0140** | * | -1.151 | .2496 | n.s. | **2.576** | **.0100** | * | **2.066** | **.0388** | * | **2.006** | **.0449** | * |
| Panic attacks without agoraphobia | -1.567 | .1172 | n.s. | **-2.201** | **.0277** | * | -1.348 | .1778 | n.s. | -.533 | .5941 | n.s. | -.651 | .5151 | n.s. | -.653 | .5136 | n.s. |
| Panic attacks | -.541 | .5883 | n.s. | -1.753 | .0796 | n.s. | -.718 | .4729 | n.s. | 1.141 | .2539 | n.s. | .756 | .4494 | n.s. | 1.062 | .2883 | n.s. |
| Anxiety with agoraphobia | .197 | .8437 | n.s. | -.866 | .3865 | n.s. | -1.780 | .0750 | n.s. | -1.348 | .1778 | n.s. | -1.687 | .0916 | n.s. | -1.135 | .2563 | n.s. |
| Agoraphobia without history of panic attacks | .799 | .4245 | n.s. | .529 | .5968 | n.s. | .447 | .6549 | n.s. | -1.617 | .1059 | n.s. | -.805 | .4210 | n.s. | **-2.031** | **.0422** | * |
| Anxiety without specification | .742 | .4579 | n.s. | 1.525 | .1273 | n.s. | 1.696 | .0899 | n.s. | 1.129 | .2589 | n.s. | .566 | .5717 | n.s. | 1.194 | .2327 | n.s. |
| Social anxiety | -.550 | .5820 | n.s. | -.429 | .6680 | n.s. | -.961 | .3366 | n.s. | **2.211** | **.0270** | * | **2.267** | **.0234** | * | **2.142** | **.0322** | * |
| General anxiety disorder | -.647 | .5176 | n.s. | -.471 | .6378 | n.s. | -.581 | .5613 | n.s. | -.846 | .3977 | n.s. | -.534 | .5933 | n.s. | -.570 | .5689 | n.s. |
| Posttraumatic stress disorder | -.327 | .7439 | n.s. | -1.263 | .2068 | n.s. | -.971 | .3315 | n.s. | 2.129 | .0333 | n.s. | 1.264 | .2064 | n.s. | 1.706 | .0880 | n.s. |
| Anxiety disorder based on medical conditions | -.567 | .5707 | n.s. | -1.090 | .2757 | n.s. | -1.086 | .2773 | n.s. | -.671 | .5022 | n.s. | -.014 | .9888 | n.s. | -.319 | .7495 | n.s. |
| **Anxiety disorder (combined)** | -.449 | .6533 | n.s. | -1.928 | .0538 | n.s. | -1.328 | .1843 | n.s. | .931 | .3517 | n.s. | .330 | .7416 | n.s. | .952 | .3413 | n.s. |
| Mental disorder without tobacco addiction | **-2.352** | **.0187** | * | **-2.870** | **.0041** | ** | -1.339 | .1805 | n.s. | .952 | .3413 | n.s. | .014 | .9884 | n.s. | .642 | .5208 | n.s. |
| Mental disorder without substance addiction | -1.456 | .1454 | n.s. | **-2.328** | **.0199** | * | -1.290 | .1972 | n.s. | 1.740 | .0819 | n.s. | 1.195 | .2320 | n.s. | 1.291 | .1968 | n.s. |
| **Mental disorders (combined)** | -.826 | .4086 | n.s. | -1.631 | .1029 | n.s. | -.701 | .4832 | n.s. | .650 | .5156 | n.s. | -.127 | .8988 | n.s. | .100 | 9207 | n.s. |

**Table 2:** Results for differences in Probability Discounting and Delay Discounting (*h*-values and *k*-values by absolute magnitude of rewards) between pathological gamblers with and without prevalence of mental disorder by different kinds of mental disorders. Tested for significance of findings with two-sample Wilcoxon rank-sum (Mann-Whitney) test. [a] *p < .05; ** p < .01. [b] no testing because of insufficient subsample size.

## Discussion & further directions

Our study is evidence on how mental health problems have the potential to seriously confound goal-oriented discounting behavior, posing a profound threat to the success of both programs for the prevention and for the treatment of pathologic gambling behavior if these effects are not taken into account. However, the findings need further scrutinizing, especially in respect to

1. the origin of the magnitude bias in probability discounting,
2. the effect of individual factors as predictors of discounting behavior, e.g. risk propensity, impulsiveness, & socio-demographic factors, as well as
3. interaction effects due to potential multi-morbidity.
4. How well do these findings correspond to real-life risk behavior of pathological gamblers – especially with a focus on treatment success, (gambling) consumption, and relapse?
5. Future studies might want to research the long-term interaction effects of substance-abuse, pathological gambling, and mental disorder using larger sample sizes.
6. Deviant probability discounting behavior: Cause or Consequence of gambling addiction and what are the neuroeconomic correlates?

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## This research is work in progress.

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