AUTOMATIC DETECTION OF CYBER SECURITY EVENTS FROM TURKISH TWITTER STREAM AND TURKISH NEWSPAPER DATA

A THESIS SUBMITTED TO

THE GRADUATE SCHOOL OF INFORMATICS

OF

THE MIDDLE EAST TECHNICAL UNIVERSITY

BY

ÖZGÜR URAL

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR

THE DEGREE OF MASTER OF SCIENCE

IN

CYBER SECURITY

MAY 2019

Approval of the thesis:

**AUTOMATIC DETECTION OF CYBER SECURITY EVENTS FROM TURKISH TWITTER STREAM AND TURKISH NEWSPAPER DATA**

Submitted by **ÖZGÜR URAL** in partial fulfillment of the requirements for the degree of **Master of Science in Cyber Security Department, Middle East Technical University** by,

Prof. Dr. Deniz Zeyrek Bozşahin

Dean, **Graduate School of Informatics**

Prof. Dr. Aysu Betin Can

Head of Department, **Cyber Security**

Assist. Prof. Dr. Cengiz Acartürk

Supervisor, **Cognitive Science Dept., METU**

Assoc. Prof. Dr. XXX

Co-Supervisor, **Computer Engineering Dept., METU**

**Examining Committee Members:**

Prof. Dr. XXX (\*)

Computer Engineering Dept., METU

Prof. Dr. XXX (\*\*)

Medical Informatics Dept., METU

Prof. Dr. XXX

Cognitive Science Dept., METU

Prof. Dr. XXX

Computer Engineering Dept., Boğaziçi University

Prof. Dr. XXX

Computer Engineering Dept., Bilkent University

**Date: \_***Write your defense date!*

*\*Write the name of the head of the examining committee in the first row.*

*\*\*Write ten name of the supervisor in the second row.*

**I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.**

**Name, Last name : ÖZGÜR URAL**

**Signature :**

# ABSTRACT

AUTOMATIC DETECTION OF CYBER SECURITY EVENTS FROM TURKISH TWITTER STREAM AND TURKISH NEWSPAPER DATA

Ural, Özgür

MSc., Department of Cyber Security

Supervisor: Assist. Prof. Dr. Cengiz Acartürk

May 2019, XX pages

Thesis Abstract – max 250 words

Keywords: xx, yy, zz… (max 5 keywords)

# ÖZ

TÜRKÇE TWITTER AKIŞI VE TÜRKÇE GAZETE VERİLERDEN SİBER GÜVENLİK OLAYLARININ OTOMATİK TESPİT EDİLMESİ

Soyisim, İsim

Yüksek Lisans, Siber Güvenlik Bölümü

Tez Yöneticisi: Yrd. Doç. Dr. XXX

Mayıs 2019, XX sayfa

Tez özeti – en fazla 250 kelime

Anahtar Sözcükler: xx, yy, zz… (en fazla 5 anahtar kelime)

# DEDICATION

To My Family

# ACKNOWLEDGMENTS

First of all, I would like to express …..

Besides my supervisor, I would like to thank …..

I would also like to thank all of colleagues from …..

To my wife, …..

# TABLE OF CONTENTS

[ABSTRACT iv](#_Toc487724816)

[DEDICATION vi](#_Toc487724818)

[ACKNOWLEDGMENTS vii](#_Toc487724819)

[TABLE OF CONTENTS viii](#_Toc487724820)

[LIST OF TABLES x](#_Toc487724821)

[LIST OF FIGURES xi](#_Toc487724822)

[LIST OF ABBREVIATIONS xii](#_Toc487724823)

CHAPTERS

1. [INTRODUCTION 1](#_Toc487724825)

[1.1. Title 2](#_Toc487724826)

[1.2. Title 2](#_Toc487724827)

[2. TITLE 5](#_Toc487724828)

[2.1. Title 5](#_Toc487724829)

[2.2. Title 5](#_Toc487724830)

[2.2.1. Title 5](#_Toc487724831)

[2.2.2. Title 5](#_Toc487724832)

[2.3. Summary 6](#_Toc487724833)

[3. TITLE 7](#_Toc487724834)

[3.1. Title 7](#_Toc487724835)

[3.2. Title 9](#_Toc487724836)

[REFERENCES 11](#_Toc487724837)

[APPENDICES 22](#_Toc487724838)

[APPENDIX A 22](#_Toc487724839)

[APPENDIX B 23](#_Toc487724840)

# LIST OF TABLES

[Table 1: Decision Making Terminology 1](#_Toc444263431)

[Table 2: xxxx 7](#_Toc444263432)

# LIST OF FIGURES

[Figure 1: Iris muscles and corresponding pupillary responses 5](file:///C:\Users\Enformatik\Desktop\tEZ%20öRNEK.docx#_Toc444263433)

[Figure 2:xxx 8](file:///C:\Users\Enformatik\Desktop\tEZ%20öRNEK.docx#_Toc444263434)

# LIST OF ABBREVIATIONS

|  |  |
| --- | --- |
| **BART** | Balloon Analog Risk Task |
| **BIAS** | Behavioral Investment Allocation Strategy |
| **CCT** | Columbia Card Task |
| **CGT** | Cambridge Gambling Task |
| **DLPFC** | Dorso-Lateral Pre-Frontal Cortex |
| **DMPFC** | Dorso-medial Pre-Frontal Cortex |
| **DOSPERT** | Domain Specific Risk Taking |
| **EEG** | Electro-Encephalography |
| **EV** | Expected Value |
| **fMRI** | Functional Magnetic Resonance Imaging |
| **fNIRS** | Functional Near-Infrared Spectroscopy |
| **GLM** | General Linear Model |
| **GUI** | Graphical User Interface |
| **HCI** | Human-Computer Interaction |
| **HMM** | Hidden Markov Model |
| **IGT** | Iowa Gambling Task |
| **ISI** | Inter-Stimulus Interval |
| **LC** | Locus Coeruleus |
| **m-BART** | Modified Balloon Analog Risk Task |
| **NA** | Noradrenaline |
| **NAcc** | Nucleus Accumbens |
| **OFC** | Orbito-Frontal Cortex |
| **PET** | Positron Emission Tomography |
| **POG-VOG** | Photo-Video Oculography |
| **rTMS** | Repetitive Transcranial Magnetic Stimulation |
| **SCR** | Skin Conductance Response |
| **SDK** | Software Development Kit |
| **SMH** | Somatic Marker Hypothesis |
| **VMPFC** | Ventro-medial Pre-Frontal Cortex |
| **WCST** | Wisconsin Card Sorting Task |

**CHAPTER 1**

CHAPTER

# INTRODUCTION

Every day, …

Study of …

In the particular, … see (Fellows, 2004; Ernst & Paulus, 2005; Paulus, 2005)).

A subset of …(see Table 1 for definitions in decision making terminology that is referenced here). Several experimental paradigms (tasks) were proposed and used to study particular aspects of it (see (Schonberg, Fox, & Poldrack, 2011; Figner & Weber, 2011; Platt & Huettel, 2008) for …

Table 1: Decision Making Terminology

. This table comprises of some of the important terminology in the context of cognitive science, and their short definitions.

|  |  |
| --- | --- |
| Decision making | The mental process of … |
| Reward | Choices in … |
| Risk taking | When the …. |
| Uncertainty | If a …. |
| Learning | In a … |

The variation of … (risk taking for short[[1]](#footnote-1)).

Utilization of ….

However, ….

## Title

Decision,.

However,.

The aim of

In a decision making task under uncertainty;

## Title

Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

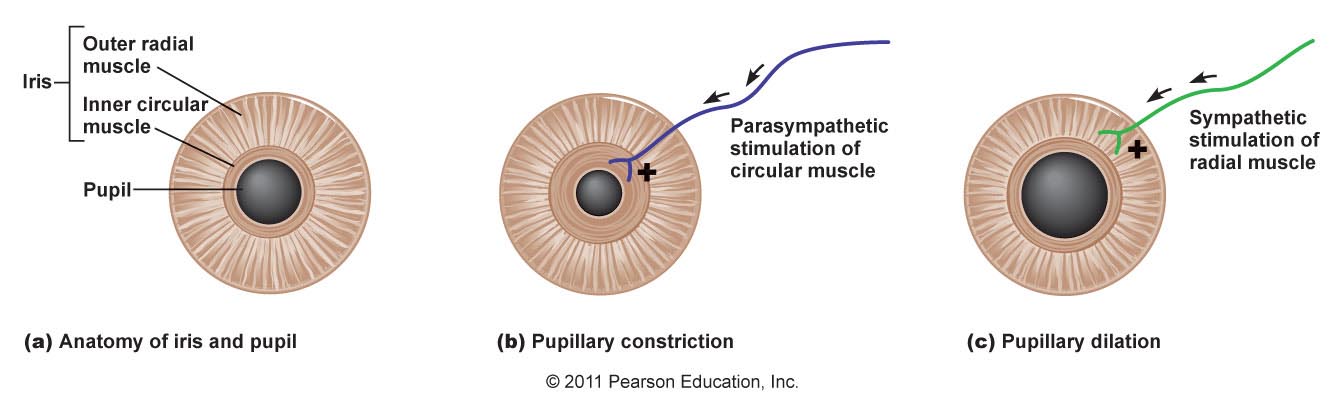
Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Figure 1: Iris muscles and corresponding pupillary responses

: Constriction and dilation.



**CHAPTER 2**

# TITLE

The results. …

## Title

xxxxxxxxxxxxxx (Figure 1). xxxxxxxx (Beatty & Lucero-Wagoner, 2000).

xxxxx...

## Title

* + 1. Title. xxxxxxxxxx.
    2. Title. xxxxx..

Neuroimaging Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

## Summary

Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

**CHAPTER 3**

# TITLE

## Title

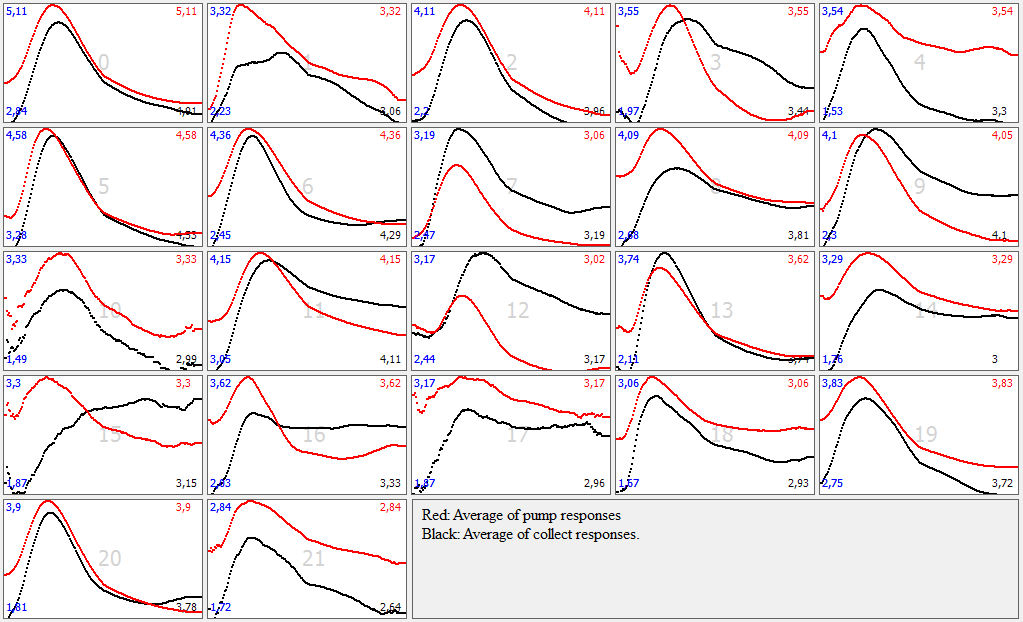
Table 2: xxxx

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|  | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | |
|  | Lower | Upper |
| Pair 1: Risk Aversive & Risk Taking | -61.24 | 263.00 | 75.92 | -228.35 | 105.86 | -.807 | 11 | .437 |

Figure 2:xxx

Yatay sayfalar, baskıya verildiğinde dik konuma geleceğinden, sayfa numarasının kısa kenarda olmasına dikkat edin.

In the horizontal pages, the page number should be put on the short edge.



8

## Title

In order ….

d.

# REFERENCES

Allais, M. (1953). Le Comportement de l'Homme Rationnel devant le Risque: Critique des Postulats et Axiomes de l'Ecole Americaine. *Econometrica, 21*(4), 503-546.

Anderson, S., Damasio, H., Jones, R., & Tranel, D. (1991). Wisconsin card sorting test performance as a measure of frontal lobe damage. *Journal of Clinical and Experimental Neuropsychology, 13*(6), 909-922.

Andreassi, J. L. (2006). Pupillary response and behavior. In J. L. Andreassi, *Psychophysiology: Human Behavior & Physiological Response* (5 ed., pp. 350-371). New Jersey: Lawrence Erlbaum Assoc.

Baron, J. (2005). Normative models of judgment and decision making. In D. Koehler, & N. Harvey (Eds.), *Blackwell Handbook of Judgment and Decision Making* (pp. 19-36). London: Wiley-Blackwell.

Beatty, J., & Lucero-Wagoner, B. (2000). The pupillary system. In J. T. Cacioppo, L. G. Tassinary, & G. G. Berntson (Eds.), *Handbook of Psychophysiology* (pp. 142-162). New York: Cambridge University Press.

Bechara, A. (2004). The role of emotion in decision-making: Evidence from neurological patients with orbitofrontal damage. *Brain and Cognition, 55*(1), 30-40.

Bechara, A., & Damasio, A. (2005). The somatic marker hypothesis: A neural theory of economic decision. *Games and Economic Behavior, 52*(2), 336-372.

Bechara, A., Damasio, A., Damasio, H., & Anderson, S. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition, 50*(1-3), 7-15.

Beer, R. (2000). Dynamical approaches to cognitive science. *Trends in Cognitive Sciences, 4*(3), 91-99.

Bernoulli, D. (1954). Exposition of a new theory on the measurement of risk - Originally published in 1738; translated by Dr. Louise Sommer. *Econometrica: Journal of the Econometric Society*, 23-36.

Blais, A. R., & Weber, E. U. (2006). A Domain-specific risk-taking (DOSPERT) scale for adult populations. *Judgment and Decision Making, 1*, 33-47.

Blakemore, S. J., & Robbins, T. W. (2012). Decision making in the adolescent brain. *Nature Neuroscience, 15*, 1184-1191.

Bradley, M. M., Miccoli, L., Escrig, M. A., & Lang, P. J. (2008). The pupil as a measure of emotional arousal and autonomic activation. *Psychophysiology, 45*(4), 602-607.

Breiter, H. C., Aharon, I., Kahneman, D., Dale, A., & Shizgal, P. (2001). Functional imaging of neural responses to expectancy and experience of monetary gains and losses. *Neuron, 30*(2), 619-639.

Buelow, M. T., & Suhr, J. A. (2013). Personality characteristics and state mood influence individual deck selections on the Iowa Gambling Task. *Personality and Individual Differences, 54*(5), 593-597.

Busemeyer, J. R., & Johnson, J. G. (2005). Computational models of decision making. In D. Koehler, & N. Harvey (Eds.), *Blackwell Handbook of Judgment and Decision Making* (pp. 133-154). London: Wiley-Blackwell.

Camerer, C. (1999). Behavioral economics: Reunifying psychology and economics. *Proceedings of the National Academy of Sciences of the United States of America, 96*(19), 10575-10577.

Camerer, C. F., & Loewenstein, G. (2004). Behavioral economics: past, present, future. In C. F. Camerer, G. Loewenstein, & M. Rabin (Eds.), *Advances in Behavioral Economics* (pp. 3-51). New York: Princeton University Press.

Caplin, A., & Dean, M. (2009). Dopamine, reward prediction error, and economics. *Quarterly Journal of Economics, 123*(2), 663-701.

Cavanagh, J. F., Wiecki, T. V., Kochar, A., & Frank, M. J. (2014). Eye tracking and pupillometry are indicators of dissociable latent decision processes. *Journal of Experimental Psychology: General, 143*(4), 1476-1488.

Cessac, B. (2010). A view of neural networks as dynamical systems. *International Journal of Bifurcation and Chaos, 20*(6), 1585-1629.

Chiu, Y. C., Lin, C. H., T, H. J., Lin, S., Lee, P. L., & Hsieh, J. C. (2008). Immediate gain is long-term loss: Are there foresighted decision makers in the Iowa Gambling Task? *Behavioral and Brain Functions, 4*(1), 13-22.

Clark, L., Lawrence, A., Astley-Jones, F., & Gray, N. (2009). Gambling near-misses enhance motivation to gamble and recruit win-related brain circuitry. *Neuron, 61*(3), 481-490.

Critchley, H., Mathias, C., & Dolan, R. (2001). Neural Activity in the Human Brain Relating to Uncertainty and Arousal during Anticipation. *Neuron, 29*(2), 537-545.

Damasio, A., Everitt, B., & Bishop, D. (1996). The somatic marker hypothesis and the possible functions of the prefrontal cortex. *Philosophical Transactions of the Royal Society B: Biological Sciences, 351*(1346), 1413-1420.

de Gee, J. W., Knapen, T., & Donner, T. H. (2014). Decision-related pupil dilation reflects upcoming choice and individual bias. *Procedings of the National Academy of Sciences of USA, 111*(5), 618-625.

de Vries, M., Holland, R. W., & Witteman, C. L. (2008). Fitting decisions: Mood and intuitive versus deliberative decision strategies. *Cognition and Emotion, 22*(5), 931-943.

Duchowski, A. (2007). *Eye Tracking Methodology: Theory and Practice* (2 ed.). Springer.

Edwards, W., & Fasolo, B. (2001). Decision technology. *Annual Review of Psychology, 52*, 581-606.

Einhäuser, W., Koch, C., & Carter, L. O. (2010). Pupil dilation betrays the timing of decisions. *Frontiers Human Neuroscience*, 4:18.

Einhäuser, W., Stout, J., Koch, C., & Carter, O. (2008). Pupil dilation reflects perceptual selection and predicts subsequent stability in perceptual rivalry. *Proceedings of the National Academy of Sciences of the United States of America, 105*(5), 1704-1709.

Ellsberg, D. (1961). Risk, ambiguity, and the savage axioms. *Quarterly Journal of Economics, 75*(4), 643-669.

Ernst, M., & Paulus, M. P. (2005). Neurobiology of Decision Making: A Selective Review from a Neurocognitive and Clinical Perspective. *Biological Psychiatry, 58*(8), 597–604.

Eshel, N., Nelson, E. E., Blair, R. J., Pine, D. S., & Ernst, M. (2007). Neural substrates of choice selection in adults and adolescents: development of the ventrolateral prefrontal and anterior cingulate cortices. *Neuropsychologia, 45*(6), 1270-1279.

Evans, J. S., Barston, J. L., & Pollard, P. (1983). On the conflict between logic and belief in syllogistic reasoning. *Memory & Cognition, 11*(3), 295-306.

Eysenck, S. B., Pearson, P. R., G, E., & Allsopp, J. F. (1985). Age norms for impulsiveness, venturesomeness and empathy in adults. *Personality and Individual Differences, 6*(5), 613-619.

Fecteau, S., Knoch, D., Fregni, F., Sultani, N., Boggio, P., & Pascual-Leone, A. (2007). Diminishing Risk-Taking Behavior by Modulating Activity in the Prefrontal Cortex: A Direct Current Stimulation Study. *The Journal of Neuroscience, 27*(46), 12500-12505.

Fellows, L. K. (2004). The cognitive neuroscience of human decision making: a review and conceptual framework. *Behav Cogn Neurosci Rev, 3*(3), 159-172.

Fiedler, S., & Glöckner, A. (2012). The dynamics of decision making in risky choice: An eye-tracking analysis. *Frontiers in Psychology, 3*(335).

Figner, B., & Weber, E. (2011). Who takes risks when and why? Determinants of risk taking. *Current Directions in Psychological Science, 20*(4), 211-216.

Figner, B., Knoch, D., Johnson, E., Krosch, A., Lisanby, S., Fehr, E., & Weber, E. (2010). Lateral prefrontal cortex and self-control in intertemporal choice. *Nature Neuroscience, 13*(5), 538-539.

Figner, B., MacKinlay, R., Wilkening, F., & Weber, E. (2009). Affective and deliberative processes in risky choice: Age differences in risk taking in the Columbia Card Task. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 35*(3), 709-730.

Finucane, M. L., Mertz, C. K., Slovic, P., & Schmidt, E. S. (2005). Task complexity and older adults’ decision-making competence. *Psychology and Aging, 20*(1), 71-84.

Geangu, E., Hauf, P., Bhardwaj, R., & Bentz, W. (2011). Infant pupil diameter changes in response to others' positive and negative emotions. *PLoS ONE, 6*(11), 1-10.

Glimcher, P. W., & Fehr, E. (2013). *Neuroeconomics: Decision Making and the Brain* (2 ed.). Academic Press.

Glimcher, P. W., & Rustichini, A. (2004). Neuroeconomics: the consilience of brain and decision. *Science, 306*(5695), 447-452.

Glöckner, A., & Herbold, A. (2011). An eye‐tracking study on information processing in risky decisions: Evidence for compensatory strategies based on automatic processes. *Journal of Behavioral Decision Making, 24*(1), 71-98.

Gupta, R., Koscik, T., Bechara, A., & Tranel, D. (2011). The amygdala and decision-making. *Neuropsychologia, 49*(4), 760-766.

Haken, H., Kelso, J., & Bunz, H. (1985). A theoretical model of phase transitions in human hand movements. *Biological Cybernetics, 51*(5), 347-356.

Hakerem, G. (1967). Pupillography. In P. H. Venables, & I. Martin (Eds.), *A Manual of Psychophysiological Methods* (pp. 335-349). Amsterdam: North-Holland Publishing Co.

Harlé, K. M., Chang, L. J., van 't Wout, M., & Sanfey, A. G. (2012). The neural mechanisms of affect infusion in social economic decision-making: A mediating role of the anterior insula. *NeuroImage, 61*(1), 32-40.

Hooper, C. J., Luciana, M., & Conklin, H. M. (2004). Adolescents' performance on the Iowa Gambling Task: implications for the development of decision making and ventromedial prefrontal cortex. *Developmental Psychology, 40*(6), 1148-1158.

Hsu, M., Bhatt, M., Adolphs, R., Tranel, D., & Camerer, C. F. (2005). Neural systems responding to degrees of uncertainty in human decision-making. *Science, 310*(5754), 1680-1683.

Huettel, S. A., Stowe, C. J., Gordon, E. M., Warner, B. T., & Platt, M. L. (2006). Neural signatures of economic preferences for risk and ambiguity. *Neuron, 49*(5), 765-775.

Jepma, M., & Nieuwenhuis, S. (2011). Pupil diameter predicts changes in the exploration-exploitation trade-off: Evidence for the adaptive gain theory. *Journal of Cognitive Neuroscience, 23*(7), 1587-1596.

Jones, C., & Sutherland, J. (2008). Acoustic emotion recognition for affective computer gaming. In C. Peter, & R. Beale (Eds.), *Affect and Emotion in Human-Computer Interaction* (Vol. 4868). Heidelberg, Germany: Springer.

Juliusson, E. A., Karlsson, N., & Garling, T. (2005). Weighing the past and the future in decision making. *European Journal of Cognitive Psychology, 17*(4), 561-575.

Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica, 47*(2), 263-291.

Kang, O., & Wheatley, T. (2015). Pupil dilation patterns reflect the contents of consciousness. *Consciousness and Cognition, 35*, 128-135.

Kelso, J., & Zanone, P. (2002). Coordination dynamics of learning and transfer across different effector systems. *Journal of Experimental Psychology: Human Perception and Performance, 28*(4), 776-797.

Klinger, J., Kumar, R., & Hanrahan, P. (2008). Measuring the task-evoked pupillary response with a remote eye tracker. *Proceedings of the 2008 symposium on Eye tracking research & applications*, 69-72.

Kloosterman, N. A., Meindertsma, T., Loon, A. M., Lamme, V. A., Bonneh, Y. S., & Donner, T. H. (2015). Pupil size tracks perceptual content and surprise. *European Journal of Neuroscience, 41*(8), 1068-1078.

Knoch, D., Gianotti, L. R., Pascual-Leone, A., Treyer, V., Regard, M., Hohmann, M., & Brugger, P. (2006). Disruption of Right Prefrontal Cortex by Low-Frequency Repetitive Transcranial Magnetic Stimulation Induces Risk-Taking Behavior. *The Journal of neuroscience: the official journal of the Society for Neuroscience, 26*(24), 6469-6472.

Kovalchik, S., Camerer, C. F., Grether, D. M., Plott, C. R., & Allman, J. M. (2005). Aging and decision making: a comparison between neurologically healthy elderly and young individuals. *Journal of Economic Behavior & Organization, 58*(1), 79–94.

Kuhnen, C., & Knutson, B. (2005). The neural basis of financial risk taking. *Neuron, 47*, 763-770.

Lauriola, M., Panno, A., Levin, I. P., & Lejuez, C. W. (2014). Individual differences in risky decision making: A meta-analysis of sensation seeking and impulsivity with the Balloon Analogue Risk Task. *Journal of Behavioral Decision Making, 27*(1), 20-36.

Lejuez, C. W., Aklin, W. M., Zvolensky, M. J., & Pedulla, C. M. (2003). Evaluation of the Balloon Analogue Risk Task (BART) as a predictor of adolescent real-world risk-taking behaviours. *Journal of Adolescence, 26*(4), 475-479.

Lejuez, C., Read, P. J., Kahler, W. C., Richards, J. B., Ramsey, E. S., Stuart, L. G., . . . Brown, A. R. (2002). Evaluation of a behavioral measure of risk taking: The Balloon Analogue Risk Task (BART). *Journal of Experimental Psychology: Applied, 8*(2), 75-84.

Lerner, J. S., Li, Y., Valdesolo, P., & Kassam, K. S. (2015). Emotion and decision making. *Annual Review of Psychology, 66*, 799-823.

Lighthall, N. R., Sakaki, M., Vasunilashorn, S., Nga, L., Somayajula, S., Chen, E. Y., . . . Mather, M. (2012). Gender differences in reward-related decision processing under stress. *Social Cognitive and Affective Neuroscience, 7*(4), 476-484.

Lin, C. H., Chiu, Y. C., Lee, P. L., & Hsieh, J. C. (2007). Is deck B a disadvantageous deck in the Iowa gambling task? *Behavioral and Brain Functions, 3*(1), 16-25.

Loewenstein, G., & Lerner, J. S. (2003). The role of affect in decision making. In R. J. Davidson, K. R. Sherer, & H. H. Goldsmith (Eds.), *Handbook of Affective Sciences* (pp. 619-642). Oxford: Oxford University Press.

Loewenstein, G., Rick, S., & Cohen, J. D. (2008). Neuroeconomics. *Annual Review of Psychology, 59*, 647-672.

Loewenstein, G., Weber, E., Hsee, C., & Welch, N. (2001). Risk as feelings. *Psychological Bulletin, 127*(2), 267-286.

Macmillan, M. (2000). Restoring Phineas Gage: A 150th retrospective. *Journal of the History of the Neurosciences, 9*(1), 46-66.

Maia, T., & McClelland, J. (2004). A reexamination of the evidence for the somatic marker hypothesis: What participants really know in the Iowa gambling task. *Proceedings of the National Academy of Sciences of the United States of America, 101*(45), 16075-16080.

Maia, T., & McClelland, J. (2005). The somatic marker hypothesis: Still many questions but no answers. *Trends in Cognitive Sciences, 9*(4), 162-164.

Marcus, B. (2003). An empirical examination of the construct validity of two alternative self-control measures. *Educational and Psychological Measurement, 63*(4), 674-706.

Marx, S., & Einhäuser, W. (2015). Reward modulates perception in binocular rivalry. *Journal of Vision, 15*(1), 1-13.

Marx, S., Gruenhage, G., Walper, D., Rutishauser, U., & Einhäuser, W. (2015). Competition with and without priority control: Iinking rivalry to attention through winner-take-all networks with memory. *Annals of the New York Academy of Sciences, 1339*(1), 138-153.

Moretto, G., Làdavas, E., Mattioli, F., & di Pellegrino, G. (2010). A psychophysiological investigation of moral judgment after ventromedial prefrontal damage. *Journal of Cognitive Neuroscience, 22*(8), 1888-1899.

Morris, G., Nevet, A., Arkadir, D., Vaadia, E., & Bergman, H. (2006). Midbrain dopamine neurons encode decisions for future action. *Nature Neuroscience, 9*(8), 1057-1063.

Murphy, P. R., O'Connell, R. G., O'Sullivan, M., Robertson, I. H., & Balsters, J. H. (2014). Pupil diameter covaries with BOLD activity in human locus coeruleus. *Human Brain Mapping, 35*(8), 4140-4154.

Nicholson, N., Soane, E., Fenton-O'Creevy, M., & Willman, P. (2005). Personality and domain-specific risk taking. *Journal of Risk Research, 8*(2), 157-176.

Orquin, J. L., & Mueller Loose, S. (2013). Attention and choice: a review on eye movements in decision making. *Acta Psychologica, 144*(1), 190-206.

Orquin, J. L., Bagger, M. P., & Mueller Loose, S. (2013). Learning affects top down and bottom up modulation of eye movements in decision making. *Judgment and Decision Making, 8*(6), 700-716.

Panno, A., Lauriola, M., & Figner, B. (2013). Emotion regulation and risk taking: Predicting risky choice in deliberative decision making. *Cognition and Emotion, 27*(2), 326-334.

Partala, T., & Surakka, V. (2003). Pupil size variation as an indication of affective processing. *International Journal of Human-Computer Studies, 59*(1), 185-198.

Paulus, M. P. (2005). Neurobiology of decision-making: quo vadis? *Cognitive Brain Research, 23*(1), 2-10.

Payzan-LeNestour, E., Dunne, S., Bossaerts, P., & O'Doherty, J. P. (2013). The neural representation of unexpected uncertainty during value-based decision making. *Neuron, 79*(1), 191-201.

Peter, C., & Beale, R. (2008). *Affect and Emotion in Human-Computer Interaction.* Heidelberg: Springer.

Phelps, E. A., Lempert, K. M., & Sokol-Hessner, P. (2014). Emotion and decision making: multiple modulatory neural circuits. *Annual Review of Neuroscience, 37*, 263-287.

Platt, M. L., & Huettel, S. A. (2008). Risky business: the neuroeconomics of decision making under uncertainty. *Nature Neuroscience, 11*, 398-403.

Plous, S. (1993). *The Psychology of Judgment and Decision Making. McGraw-Hill series in social psychology.* McGraw-Hill.

Preuschoff, K., Hart, B. M., & Einhäuser, W. (2011). Pupil dilation signals surprise: evidence for noradrenaline's role in decision making. *Front. Neuroscience, 5*(115). doi:10.3389/fnins.2011.00115

Privitera, C. M., Carney, T., Klein, S., & Aguilar, M. (2014). Analysis of microsaccades and pupil dilation reveals a common decisional origin during visual search. *Vision Research, 95*, 43-50.

Rabiner, L., & Juang, B. H. (1986). An introduction to hidden Markov models. *ASSP Magazine, IEEE, 3*(1), 4-16.

Rao, H., Korczykowski, M., Pluta, J., Hoang, A., & Detre, J. (2008). Neural correlates of voluntary and involuntary risk taking in the human brain: An fMRI Study of the Balloon Analog Risk Task (BART). *Neuroimage, 42*(2), 902-910.

Ratcliff, R. (1978). A theory of memory retrieval. *Psychological Review, 85*(2), 59-108.

Ratcliff, R., & McKoon, G. (2008). The diffusion decision model: theory and data for two-choice decision tasks. *Neural Computation, 20*(4), 873-922.

Rayner, K., Pollatsek, A., Ashby, J., & Clifton, C. (2011). *Psychology of Reading* (2 ed.). Psychology Press.

Reid, R. (1986). The psychology of the near miss. *Journal of Gambling Behavior, 2*(1), 32-39.

Reimann, M., & Bechara, A. (2010). The somatic marker framework as a neurological theory of decision-making: Review, conceptual comparisons, and future neuroeconomics research. *Journal of Economic Psychology, 31*(5), 767-776.

Rogers, R. D., Owen, A. M., Middleton, H. C., Williams, E. J., Pickard, J. D., Sahakian, B. J., & Robbins, T. W. (1999). Choosing between small, likely rewards and large, unlikely rewards activates inferior and orbital prefrontal cortex. *The Journal of neuroscience: the official journal of the Society for Neuroscience, 19*(20), 9029-9038.

Rolfs, M. (2009). Microsaccades: Small steps on a long way. *Vision Research, 49*(20), 2415-2441.

Ruff, C. C., & Huettel, S. A. (2013). Experimental Methods in Cognitive Neuroscience. In P. W. Glimcher, & E. Fehr (Eds.), *Neuroeconomics: Decision Making and the Brain* (2 ed., pp. 77-108). Academic Press.

Rustichini, A. (2009). Neuroeconomics: what have we found, and what should we search for. *Current Opinion in Neurobiology, 19*(6), 672-677.

Sanfey, A. G., & Chang, L. J. (2008). Multiple systems in decision making. *Annals of the New York Academy of Sciences, 1128*, 53-62.

Schonberg, T., Fox, C., & Poldrack, R. (2011). Mind the gap: bridging economic and naturalistic risk-taking with cognitive neuroscience. *Trends in Cognitive Sciences, 15*(1), 11-19.

Shah, A. K., & Oppenheimer, D. M. (2008). Heuristics made easy: An effort-reduction framework. *Psychological Bulletin, 134*(2), 207-222.

Shen, L., Wang, M., & Shen, R. (2009). Affective e-Learning: Using "emotional" data to improve learning in pervasive learning environment. *Journal of Educational Technology & Society, 12*(2), 176-189.

Simpson, H. M., & Hale, S. M. (1969). Pupillary changes during a decision making task. *Perceptual and Motor Skills, 29*, 495-498.

Sitkin, S. B., & Weingart, L. R. (1995). Determinants of risky decision-making behavior: A test of the mediating role of risk perceptions and propensity. *Academy of Management Journal, 38*(6), 1573-1592.

Smith, D. G., Xiao, L., & Bechara, A. (2012). Decision making in children and adolescents: impaired Iowa Gambling Task performance in early adolescence. *Developmental Psychology, 48*(4), 1180-1187.

Sykes, J. (2010). Affective games: How iOpiates elicit an emotional fix. In D. Gökçay, & G. Yıldırım (Eds.), *Affective Computing and Interaction: Psychological, Cognitive and Neuroscientific Perspectives* (pp. 344-358). New York: IGI Global.

Taskin, K., & Gokcay, D. (2015). Investigation of Risk Taking Behavior and Outcomes in Decision Making with Modified BART (m-BART). *Affective Computing and Intelligent Interaction.* Xi'an: The Association for the Advancement of Affective Computing.

Taskin, K., & Gokcay, D. (2016). Temporal aspects of decision making: Pupillary responses reveal alternating levels of arousal related to dynamic risk-taking states. *International Journal of Human Computer Interactions*.

Tobler, P., Christopoulos, G., O'Doherty, J., Dolan, R., & Schultz, W. (2009). Risk-dependent reward value signal in human prefrontal cortex. *Proceedings of the National Academy of Sciences, 106*(17), 7185-7190.

Tversky, A., & Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty, 5*(4), 297-323.

van Gelder, T. (1998). The dynamical hypothesis in cognitive science. *Behavioral and Brain Sciences, 21*(5), 615-665.

von Neumann, J., Morgenstern, O., Kuhn, H. W., & Rubinstein, A. (2007). *Theory of Games and Economic Behavior* (60th Anniversary Commemorative ed.). Princeton University Press.

Wakker, P. (2010). *Prospect Theory: For Risk and Ambiguity.* Cambridge University Press.

Wakker, P., & Fennema, H. (1997). Original and cumulative prospect theory: a discussion of empirical differences. *Journal of behavioral decision making, 10*(10), 53-64.

Wallsten, T. S., Pleskac, T. C., & Lejuez, C. W. (2005). Modeling behavior in a clinically diagnostic sequential risk-taking task. *Psychological Review, 112*(4), 862-880.

Weber, E. U., Blais, A. R., & Betz, N. (2002). A domain-specific risk-attitude scale: Measuring risk perceptions and risk behaviors. *Journal of Behavioral Decision Making, 15*, 263-290.

Weber, E., & Johnson, E. (2008). Decisions under Uncertainty: Psychological, Economic, and Neuroeconomic Explanations of Risk Preference. In P. Glimcher, E. Fehr, C. Camerer, & A. Poldrack (Eds.), *Neuroeconomics: Decision Making and the Brain* (pp. 127-144). London: Academic Press.

Weller, J. A., Levin, I. P., Shiv, B., & Bechara, A. (2007). Neural correlates of adaptive decision making for risky gains and losses. *Psychological science: a journal of the American Psychological Society, 18*(11), 958-964.

West, R. F., Toplak, M. E., & Stanovich, K. E. (2008). Heuristics and biases as measures of critical thinking: Associations with cognitive ability and thinking dispositions. *Journal of Educational Psychology, 100*(4), 930-941.

White, T. L., Lejuez, C. W., & de Wit, H. (2008). Test-retest characteristics of the Balloon Analogue Risk Task (BART). *Experimental and Clinical Psychopharmacology, 16*(6), 565-570.

Wu, G., Zhang, J., & Gonzalez, R. (2005). Decision under risk. In D. Koehler, & N. Harvey (Eds.), *Blackwell Handbook of Judgment and Decision Making* (pp. 299-423). London: Wiley-Blackwell.

Yu, A. J., & Dayan, P. (2005). Uncertainty, neuromodulation, and attention. *Neuron, 46*(4), 681-692.

Zak, P. J. (2004). Neuroeconomics. *Philosophical Transactions of the Royal Society B: Biological Sciences, 359*(1451), 1737-1748.

Zeelenberg, M. (1999). Anticipated regret, expected feedback and behavioral decision making. *Journal of Behavioral Decision Making, 12*(2), 93-106.

Zuckerman, M. (1994). *Behavioral expressions and biosocial bases of sensation seeking.* Cambridge: Cambridge University Press.

# APPENDICES

# APPENDIX A

**TITLE**

xxx

# APPENDIX B

**TITLE**

xxx

1. Risk taking is, in common sense, independent of uncertainty. Even though everything about the selection criteria is known, one can claim that the person is taking a risk in every choice. However, [↑](#footnote-ref-1)