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Rangel-Gomez, M.

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## References

- Albrecht, M. A., Martin-Iverson, M. T., Price, G., Lee, J., & Iyyalol, R. (2010). Dexamphetamine-induced reduction of P3a and P3b in healthy participants. *J Psychopharmacol*.
- Alho, K., Woods, D. L., & Algazi, A. (1994). Processing of auditory stimuli during auditory and visual attention as revealed by event-related potentials. *Psychophysiology*, *31*(5), 469-479.
- Apitz, T., & Bunzeck, N. (2013). Dopamine controls the neural dynamics of memory signals and retrieval accuracy. *Neuropsychopharmacology*, *38*(12), 2409-2417.
- Arbel, Y., Spencer, K. M., & Donchin, E. (2010). The N400 and the P300 are not all that independent. *Psychophysiology*, *48*(6), 861-875.
- Aston-Jones, G., & Cohen, J. D. (2005). An integrative theory of locus coeruleus-norepinephrine function: adaptive gain and optimal performance. *Annual review of neuroscience*, *28*, 403-450.
- Auerbach, J. G., Benjamin, J., Faroy, M., Geller, V., & Ebstein, R. (2001). DRD4 related to infant attention and information processing: a developmental link to ADHD? *Psychiatr Genet*, *11*(1), 31-35.
- Axmacher, N., Cohen, M. X., Fell, J., Haupt, S., Dumpelmann, M., Elger, C. E., . . . Ranganath, C. (2010). Intracranial EEG correlates of expectancy and memory formation in the human hippocampus and nucleus accumbens. *Neuron*, *65*(4), 541-549.
- Azmitia, E. C., Dolan, K., & Whitaker-Azmitia, P. M. (1990). S-100B but not NGF, EGF, insulin or calmodulin is a CNS serotonergic growth factor. *Brain Res*, *516*(2), 354-356.
- Barcelo, F., & Knight, R. T. (2007). An information-theoretical approach to contextual processing in the human brain: evidence from prefrontal lesions. *Cereb Cortex*, *17 Suppl 1*, i51-60.
- Bell, K., Shokrian, D., Potenzieri, C., & Whitaker-Azmitia, P. M. (2003). Harm avoidance, anxiety, and response to novelty in the adolescent S-100beta transgenic mouse: role of serotonin and relevance to Down syndrome. *Neuropsychopharmacology*, *28*(10), 1810-1816.
- Berlyne, D. E. (1958). The influence of complexity and novelty in visual figures on orienting responses. *J Exp Psychol*, *55*(3), 289-296.
- Bilder, R. M., Volavka, J., Lachman, H. M., & Grace, A. A. (2004). The catechol-O-methyltransferase polymorphism: relations to the tonic-phasic dopamine hypothesis and neuropsychiatric phenotypes. *Neuropsychopharmacology*, *29*(11), 1943-1961.
- Bireta, T. J., Surprenant, A. M., & Neath, I. (2008). Age-related differences in the von restorff isolation effect. *Q J Exp Psychol (Colchester)*, *61*(3), 345-352.
- Birkas, E., Horvath, J., Lakatos, K., Nemoda, Z., Sasvari-Szekely, M., Winkler, I., & Gervai, J. (2006). Association between dopamine D4 receptor (DRD4) gene polymorphisms and novelty-elicited auditory event-related potentials in preschool children. *Brain Res*, *1103*(1), 150-158.
- Bozzali, M., MacPherson, S. E., Dolan, R. J., & Shallice, T. (2006). Left prefrontal cortex control of novel occurrences during recollection: a psychopharmacological study using scopolamine and event-related fMRI. *Neuroimage*, *33*(1), 286-295.
- Breitenstein, C., Korsukewitz, C., Floel, A., Kretzschmar, T., Diederich, K., & Knecht, S. (2006). Tonic dopaminergic stimulation impairs associative learning in healthy subjects. *Neuropsychopharmacology*, *31*(11), 2552-2564.
- Bunzeck, N., & Düzel, E. (2006). Absolute coding of stimulus novelty in the human Substantia Nigra/VTA. *Neuron*, *51*, 369-379.
- Bunzeck, N., Guitart-Masip, M., Dolan, R. J., & Düzel, E. (2013). Pharmacological Dissociation of Novelty Responses in the Human Brain. *Cereb Cortex*.

## REFERENCES

- Ceponiene, R., Alku, P., Westerfield, M., Torki, M., & Townsend, J. (2005). ERPs differentiate syllable and nonphonetic sound processing in children and adults. *Psychophysiology*, *42*(4), 391-406.
- Ceponiene, R., Shestakova, A., Balan, P., Alku, P., Yianguchi, K., & Naatanen, R. (2001). Children's auditory event-related potentials index sound complexity and "speechness". *The International journal of neuroscience*, *109*(3-4), 245-260.
- Chwilla, D. J., Brown, C. M., & Hagoort, P. (1995). The N400 as a function of the level of processing. *Psychophysiology*, *32*(3), 274-285.
- Chwilla, D. J., Kolk, H. H., & Vissers, C. T. (2007). Immediate integration of novel meanings: N400 support for an embodied view of language comprehension. *Brain Res*, *1183*, 109-123.
- Cimbalo, R. S., Nowak, B. I., & Soderstrom, J. A. (1981). The Isolation Effect in Children's Short-Term-Memory. *Journal of General Psychology*, *105*(2), 215-223.
- Cloninger, C. R. (1987). A systematic method for clinical description and classification of personality variants. A proposal. *Arch Gen Psychiatry*, *44*(6), 573-588.
- Cools, R., & D'Esposito, M. (2011). Inverted-U-shaped dopamine actions on human working memory and cognitive control. *Biol Psychiatry*, *69*(12), e113-125.
- Costa, A., Peppe, A., Dell'Agnello, G., Carlesimo, G. A., Murri, L., Bonuccelli, U., & Caltagirone, C. (2003). Dopaminergic modulation of visual-spatial working memory in Parkinson's disease. *Dement Geriatr Cogn Disord*, *15*(2), 55-66.
- Courchesne, E., Hillyard, S. A., & Galambos, R. (1975). Stimulus novelty, task relevance and the visual evoked potential in man. *Electroencephalogr Clin Neurophysiol*, *39*(2), 131-143.
- Crottaz-Herbette, S., & Menon, V. (2006). Where and when the anterior cingulate cortex modulates attentional response: combined fMRI and ERP evidence. *J Cogn Neurosci*, *18*(5), 766-780.
- Crowley, K. E., & Colrain, I. M. (2004). A review of the evidence for P2 being an independent component process: age, sleep and modality. *Clin Neurophysiol*, *115*(4), 732-744.
- Csibra, G., & Czigler, I. (1991). Event-related potentials to irrelevant deviant motion of visual shapes. *Int J Psychophysiol*, *11*(2), 155-159.
- Cycowicz, Y. M., & Friedman, D. (1998). Effect of sound familiarity on the event-related potentials elicited by novel environmental sounds. *Brain Cogn*, *36*(1), 30-51.
- Czigler, I., & Csibra, G. (1992). Event-related potentials and the identification of deviant visual stimuli. *Psychophysiology*, *29*(4), 471-485.
- Daffner, K. R., Mesulam, M. M., Scinto, L. F., Calvo, V., Faust, R., & Holcomb, P. J. (2000). An electrophysiological index of stimulus unfamiliarity. *Psychophysiology*, *37*(6), 737-747.
- Delorme, A., & Makeig, S. (2004). EEGLAB: an open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. *J Neurosci Methods*, *134*(1), 9-21.
- Delorme, A., Sejnowski, T., & Makeig, S. (2007). Enhanced detection of artifacts in EEG data using higher-order statistics and independent component analysis. *Neuroimage*, *34*(4), 1443-1449.
- Dien, J. (2010a). The ERP PCA Toolkit: an open source program for advanced statistical analysis of event-related potential data. *J Neurosci Methods*, *187*(1), 138-145.
- Dien, J. (2010b). Evaluating two-step PCA of ERP data with Geomin, Infomax, Oblimin, Promax, and Varimax rotations. *Psychophysiology*, *47*(1), 170-183.
- Djamshidian, A., O'Sullivan, S. S., Wittmann, B. C., Lees, A. J., & Averbach, B. B. (2011). Novelty seeking behaviour in Parkinson's disease. *Neuropsychologia*, *49*(9), 2483-2488.
- Donchin, E. (1981). Presidential address, 1980. Surprise!...Surprise? *Psychophysiology*, *18*(5), 493-513.
- Dong, Z., Gong, B., Li, H., Bai, Y., Wu, X., Huang, Y., . . . Wang, Y. T. (2012). Mechanisms of hippocampal long-term depression are required for memory enhancement by novelty exploration. *J Neurosci*, *32*(35), 11980-11990.
- Dunlosky, J., Hunt, R. R., & Clark, E. (2000). Is perceptual salience needed in explanations of the isolation effect? *J Exp Psychol Learn Mem Cogn*, *26*(3), 649-657.

- Duzel, E., Bunzeck, N., Guitart-Masip, M., & Duzel, S. (2010). Novelty-related motivation of anticipation and exploration by dopamine (NOMAD): implications for healthy aging. *Neurosci Biobehav Rev*, *34*(5), 660-669.
- Eckart, C., & Bunzeck, N. (2012). Dopamine modulates processing speed in the human mesolimbic system. *Neuroimage*, *66C*, 293-300.
- Enge, S., Fleischhauer, M., Lesch, K. P., & Strobel, A. (2011). On the role of serotonin and effort in voluntary attention: evidence of genetic variation in N1 modulation. *Behav Brain Res*, *216*(1), 122-128.
- Fabiani, M., & Donchin, E. (1995). Encoding processes and memory organization: a model of the von Restorff effect. *J Exp Psychol Learn Mem Cogn*, *21*(1), 224-240.
- Fabiani, M., Karis, D., & Donchin, E. (1982). P300 and Memory - Individual-Differences in the Vonrestorff Effect. *Psychophysiology*, *19*(5), 558-559.
- Fabiani, M., Karis, D., & Donchin, E. (1985). Effects of Strategy Manipulation on P300 Amplitude in a Vonrestorff Paradigm. *Psychophysiology*, *22*(5), 588-589.
- Fabiani, M., Karis, D., & Donchin, E. (1990). Effects of mnemonic strategy manipulation in a Von Restorff paradigm. *Electroencephalogr Clin Neurophysiol*, *75*(2), 22-35.
- Farrell, S., & Lewandowsky, S. (2002). An endogenous distributed model of ordering in serial recall. *Psychon Bull Rev*, *9*(1), 59-79.
- Fenker, D. B., Frey, J. U., Schuetze, H., Heipertz, D., Heinze, H. J., & Duzel, E. (2008). Novel scenes improve recollection and recall of words. *J Cogn Neurosci*, *20*(7), 1250-1265.
- Ferrari, V., Bradley, M. M., Codispoti, M., & Lang, P. J. (2010). Detecting novelty and significance. *J Cogn Neurosci*, *22*(2), 404-411.
- Folstein, J. R., & Van Petten, C. (2008). Influence of cognitive control and mismatch on the N2 component of the ERP: a review. *Psychophysiology*, *45*(1), 152-170.
- Friedman, D., Cycowicz, Y. M., & Gaeta, H. (2001). The novelty P3: an event-related brain potential (ERP) sign of the brain's evaluation of novelty. *Neurosci Biobehav Rev*, *25*(4), 355-373.
- Gabbay, F. H., Duncan, C. C., & McDonald, C. G. (2010). Brain potential indices of novelty processing are associated with preference for amphetamine. *Experimental and clinical psychopharmacology*, *18*(6), 470-488.
- Garcia-Garcia, M., Barcelo, F., Clemente, I. C., & Escera, C. (2010a). The role of DAT1 gene on the rapid detection of task novelty. *Neuropsychologia*, *48*(14), 4136-4141.
- Garcia-Garcia, M., Barcelo, F., Clemente, I. C., & Escera, C. (2010b). The role of the dopamine transporter DAT1 genotype on the neural correlates of cognitive flexibility. *Eur J Neurosci*, *31*(4), 754-760.
- Garcia-Garcia, M., Barcelo, F., Clemente, I. C., & Escera, C. (2011). COMT and ANKK1 gene-gene interaction modulates contextual updating of mental representations. *Neuroimage*, *56*(3), 1641-1647.
- Garcia-Garcia, M., Clemente, I., Dominguez-Borras, J., & Escera, C. (2010a). Dopamine transporter regulates the enhancement of novelty processing by a negative emotional context. *Neuropsychologia*, *48*(5), 1483-1488.
- Garcia-Garcia, M., Clemente, I. C., Dominguez-Borras, J., & Escera, C. (2010b). Dopamine transporter regulates the enhancement of novelty processing by a negative emotional context. *Neuropsychologia*, *48*(5), 1483-1488.
- Geraci, L., & Manzano, I. (2010). Distinctive items are salient during encoding: Delayed judgements of learning predict the isolation effect. *The quarterly journal of experimental psychology*, *63*(1), 50-64.
- Giovannini, M. G., Rakovska, A., Benton, R. S., Pazzagli, M., Bianchi, L., & Pepeu, G. (2001). Effects of novelty and habituation on acetylcholine, GABA, and glutamate release from the frontal cortex and hippocampus of freely moving rats. *Neuroscience*, *106*(1), 43-53.
- Goldstein, A., Spencer, K. M., & Donchin, E. (2002). The influence of stimulus deviance and novelty on the P300 and novelty P3. *Psychophysiology*, *39*(6), 781-790.

## REFERENCES

- Greenhouse, S. W., & Geisser, S. (1959). On methods in the analysis of profile data. *Psychometrika*, *24*, 95-112.
- Grzella, I., Muller, B. W., Oades, R. D., Bender, S., Schall, U., Zerbin, D., . . . Sartory, G. (2001). Novelty-elicited mismatch negativity in patients with schizophrenia on admission and discharge. *Journal of psychiatry & neuroscience : JPN*, *26*(3), 235-246.
- Hakymez, H. S., Dagher, A., Smith, S. D., & Zald, D. H. (2008). Striatal dopamine transmission in healthy humans during a passive monetary reward task. *Neuroimage*, *39*(4), 2058-2065.
- Halgren, E., Baudena, P., Clarke, J. M., Heit, G., Liegeois, C., Chauvel, P., & Musolino, A. (1995). Intracerebral potentials to rare target and distractor auditory and visual stimuli. I. Superior temporal plane and parietal lobe. *Electroencephalogr Clin Neurophysiol*, *94*(3), 191-220.
- Halgren, E., Baudena, P., Clarke, J. M., Heit, G., Marinkovic, K., Devaux, B., . . . Biraben, A. (1995). Intracerebral potentials to rare target and distractor auditory and visual stimuli. II. Medial, lateral and posterior temporal lobe. *Electroencephalogr Clin Neurophysiol*, *94*(4), 229-250.
- Hansenne, M., Pinto, E., Scantamburlo, G., Couvreur, A., Reggers, J., Fuchs, S., . . . Ansseau, M. (2003). Mismatch negativity is not correlated with neuroendocrine indicators of catecholaminergic activity in healthy subjects. *Human Psychopharmacology-Clinical and Experimental*, *18*(3), 201-205.
- Hasselmo, M. E. (1999). Neuromodulation: Acetylcholine and memory consolidation. *Trends Cogn Sci*, *3*, 351-359.
- Hasselmo, M. E., Bradley, P., Wyble, B. P., & Wallenstein, G. V. (1996). Encoding and retrieval of episodic memories: Role of cholinergic and GABAergic modulation in the hippocampus. *Hippocampus*, *6*(6), 693-708.
- Hasselmo, M. E., & Stern, C. E. (2006). Mechanisms underlying working memory for novel information. *Trends Cogn Sci*, *10*(11), 487-493.
- Hasselmo, M. E., Wyble, B. P., & Wallenstein, G. V. (1996). Encoding and retrieval of episodic memories: Role of cholinergic and GABAergic modulation in the hippocampus. *Hippocampus*, *6*, 693-708.
- Hazy, T. E., Frank, M. J., & O'Reilly, R. C. (2010). Neural mechanisms of acquired phasic dopamine responses in learning. *Neurosci Biobehav Rev*, *34*(5), 701-720.
- He, B., Lian, J., Spencer, K. M., Dien, J., & Donchin, E. (2001). A cortical potential imaging analysis of the P300 and novelty P3 components. *Hum Brain Mapp*, *12*(2), 120-130.
- Heils, A., Teufel, A., Petri, S., Stober, G., Riederer, P., Bengel, D., & Lesch, K. P. (1996). Allelic variation of human serotonin transporter gene expression. *J Neurochem*, *66*(6), 2621-2624.
- Heitland, I., Kenemans, J. L., Oosting, R. S., Baas, J. M., & Bocker, K. B. (2013). Auditory event-related potentials (P3a, P3b) and genetic variants within the dopamine and serotonin system in healthy females. *Behav Brain Res*, *249*, 55-64.
- Heslenfeld, D. J. (2002). Visual mismatch negativity. In J. Polich (Ed.), *Detection of Change: Event-related Potential and fMRI findings*. Dordrecht: Kluwer.
- Hoormann, J., Falkenstein, M., Schwarzenau, P., & Hohnsbein, J. (1998). Methods for the quantification and statistical testing of ERP differences across conditions. *Behavior Research Methods Instruments & Computers*, *30*(1), 103-109.
- Hunt, R. R. (1995). The subtlety of distinctiveness: What von Restorff really did. *Psychon Bull Rev*, *2*(1), 105-112.
- Hunt, R. R., & Lamb, C. A. (2001). What causes the isolation effect? *J Exp Psychol Learn Mem Cogn*, *27*(6), 1359-1366.
- Johansson, B. S. (1970). Attention and the von Restorff Effect. *Br J Psychology*, *61*(2), 163-170.
- Jung, T. P., Makeig, S., Humphries, C., Lee, T. W., McKeown, M. J., Iragui, V., & Sejnowski, T. J. (2000). Removing electroencephalographic artifacts by blind source separation. *Psychophysiology*, *37*(2), 163-178.

- Jung, T. P., Makeig, S., Westerfield, M., Townsend, J., Courchesne, E., & Sejnowski, T. J. (2000). Removal of eye activity artifacts from visual event-related potentials in normal and clinical subjects. *Clin Neurophysiol*, *111*(10), 1745-1758.
- Karis, D., Fabiani, M., & Donchin, E. (1984). P300 and Memory - Individual-Differences in the Vonrestorff Effect. *Cognitive Psychology*, *16*(2), 177-216.
- Karson, C. N. (1983). Spontaneous eye-blink rates and dopaminergic systems. *Brain*, *106* (Pt 3), 643-653.
- Katayama, J., & Polich, J. (1998). Stimulus context determines P3a and P3b. *Psychophysiology*, *35*(1), 23-33.
- Kellendonk, C., Simpson, E. H., Polan, H. J., Malleret, G., Vronskaya, S., Winiger, V., . . . Kandel, E. R. (2006). Transient and selective overexpression of dopamine D2 receptors in the striatum causes persistent abnormalities in prefrontal cortex functioning. *Neuron*, *49*(4), 603-615.
- Kenemans, J. L., & Kahkonen, S. (2011). How Human Electrophysiology Informs Psychopharmacology: from Bottom-up Driven Processing to Top-Down Control. *Neuropsychopharmacology*, *36*(1), 26-51.
- Kiesel, A., Miller, J., Jolicoeur, P., & Brisson, B. (2008). Measurement of ERP latency differences: a comparison of single-participant and jackknife-based scoring methods. *Psychophysiology*, *45*(2), 250-274.
- Kihara, M., Hogan, A. M., Newton, C. R., Garrashi, H. H., Neville, B. R., & de Haan, M. (2010). Auditory and visual novelty processing in normally-developing Kenyan children. *Clinical Neurophysiology*, *121*(4), 564-576.
- Kimura, M., Schroger, E., & Czigler, I. (2011). Visual mismatch negativity and its importance in visual cognitive sciences. *Neuroreport*, *22*(14), 669-673.
- Kishiyama, M. M., Yonelinas, A. P., & Knight, R. T. (2009). Novelty enhancements in memory are dependent on lateral prefrontal cortex. *J Neurosci*, *29*(25), 8114-8118.
- Kishiyama, M. M., Yonelinas, A. P., & Lazzara, M. M. (2004). The von Restorff effect in amnesia: the contribution of the hippocampal system to novelty-related memory enhancements. *J Cogn Neurosci*, *16*(1), 15-23.
- Klinkenberg, I., Blokland, A., Riedel, W. J., & Sambeth, A. (2013). Cholinergic modulation of auditory processing, sensory gating and novelty detection in human participants. *Psychopharmacology (Berl)*, *225*(4), 903-921.
- Knight, R. T., & Scabini, D. (1998). Anatomic bases of event-related potentials and their relationship to novelty detection in humans. *J Clin Neurophysiol*, *15*(1), 3-13.
- Kopp, B., & Wessel, K. (2010). Event-related brain potentials and cognitive processes related to perceptual-motor information transmission. *Cognitive, affective & behavioral neuroscience*, *10*(2), 316-327.
- Kujala, T., Kallio, J., Tervaniemi, M., & Naatanen, R. (2001). The mismatch negativity as an index of temporal processing in audition. *Clin Neurophysiol*, *112*(9), 1712-1719.
- Kutas, M., & Federmeier, K. D. (2011). Thirty years and counting: finding meaning in the N400 component of the event-related brain potential (ERP). *Annu Rev Psychol*, *62*, 621-647.
- Kutas, M., & Hillyard, S. A. (1980). Event-related brain potentials to semantically inappropriate and surprisingly large words. *Biol Psychol*, *11*(2), 99-116.
- Kutas, M., & Hillyard, S. A. (1983). Event-related brain potentials to grammatical errors and semantic anomalies. *Mem Cognit*, *11*(5), 539-550.
- Kutas, M., & Hillyard, S. A. (1984a). Brain potentials during reading reflect word expectancy and semantic association. *Nature*, *307*(5947), 161-163.
- Kutas, M., & Hillyard, S. A. (1984b). Event-related brain potentials (ERPs) elicited by novel stimuli during sentence processing. *Ann N Y Acad Sci*, *425*, 236-241.
- Lakatos, K., Nemoda, Z., Birkas, E., Ronai, Z., Kovacs, E., Ney, K., . . . Gervai, J. (2003). Association of D4 dopamine receptor gene and serotonin transporter promoter polymorphisms with infants' response to novelty. *Mol Psychiatry*, *8*(1), 90-97.

## REFERENCES

- Li, S., Cullen, W. K., Anwyl, R., & Rowan, M. J. (2003). Dopamine-dependent facilitation of LTP induction in hippocampal CA1 by exposure to spatial novelty. *Nat Neurosci*, *6*(5), 526-531.
- Li, Y. C., Kellendonk, C., Simpson, E. H., Kandel, E. R., & Gao, W. J. (2011). D2 receptor overexpression in the striatum leads to a deficit in inhibitory transmission and dopamine sensitivity in mouse prefrontal cortex. *Proc Natl Acad Sci U S A*, *108*(29), 12107-12112.
- Lins, O. G., Picton, T. W., Berg, P., & Scherg, M. (1993). Ocular artifacts in EEG and event-related potentials. I: Scalp topography. *Brain Topogr*, *6*(1), 51-63.
- Lisman, J. E., & Grace, A. A. (2005). The hippocampal-VTA loop: controlling the entry of information into long-term memory. *Neuron*, *46*(5), 703-713.
- Luck, S. J. (2014). *An Introduction to the Event-Related Potential Technique* (2nd Edition ed.). Cambridge, Massachusetts: The MIT Press.
- Luthringer, R., Rinaudo, G., Toussaint, M., Bailey, P., Muller, G., Muzet, A., & Macher, J. (1999). Electroencephalographic characterization of brain dopaminergic stimulation by apomorphine in healthy volunteers. *Neuropsychobiology*, *39*(1), 49-56.
- Makeig, S., Bell, A. J., Jung, T., & Sejnowski, T. J. (1996). *Independent component analysis of electroencephalographic data*. Paper presented at the Advances in Neural Information Processing Systems.
- May, P. J., & Tiitinen, H. (2010). Mismatch negativity (MMN), the deviance-elicited auditory deflection, explained. *Psychophysiology*, *47*(1), 66-122.
- McDaniel, M. A., Dornburg, C. C., & Guynn, M. J. (2005). Disentangling encoding versus retrieval explanations of the bizarreness effect: implications for distinctiveness. *Mem Cognit*, *33*(2), 270-279.
- Meeter, M., Murre, J. M., & Talamini, L. M. (2004). Mode shifting between storage and recall based on novelty detection in oscillating hippocampal circuits. *Hippocampus*, *14*(6), 722-741.
- Meeter, M., Talamini, L. M., & Murre, J. M. J. (2004). Mode shifting between storage and recall based on novelty detection in oscillating hippocampal circuits. *Hippocampus*, *14*, 722-741.
- Naatanen, R., & Alho, K. (1995). Mismatch negativity--a unique measure of sensory processing in audition. *Int J Neurosci*, *80*(1-4), 317-337.
- Naatanen, R., Gaillard, A. W., & Mäntysalo, S. (1978). Early selective-attention effect on evoked potential reinterpreted. *Acta Psychol (Amst)*, *42*(4), 313-329.
- Naatanen, R., Gaillard, A. W., & Mäntysalo, S. (1980). Brain potential correlates of voluntary and involuntary attention. *Prog Brain Res*, *54*, 343-348.
- Näätänen, R., Gaillard, A. W. K., & Mäntysalo, S. (1978). Early selective-attention effect on evoked potential reinterpreted. *Acta Psychol (Amst)*, *42*, 313-329.
- Naatanen, R., & Picton, T. (1987). The N1 wave of the human electric and magnetic response to sound: a review and an analysis of the component structure. *Psychophysiology*, *24*(4), 375-425.
- Nakamura, K., Kurasawa, M., & Tanaka, Y. (1998). Apomorphine-induced hypoattention in rats and reversal of the choice performance impairment by aniracetam. *Eur J Pharmacol*, *342*(2-3), 127-138.
- Nieuwenhuis, S., Aston-Jones, G., & Cohen, J. D. (2005). Decision making, the P3, and the locus coeruleus-norepinephrine system. *Psychol Bull*, *131*(4), 510-532.
- Nigam, A., Hoffman, J. E., & Simons, R. F. (1992). N400 to semantically anomalous pictures and words. *J Cogn Neurosci*, *4*(1), 15-22.
- Nyman, G., Alho, K., Laurinen, P., Paavilainen, P., Radil, T., Reinikainen, K., . . . Naatanen, R. (1990). Mismatch negativity (MMN) for sequences of auditory and visual stimuli: evidence for a mechanism specific to the auditory modality. *Electroencephalogr Clin Neurophysiol*, *77*(6), 436-444.
- Oades, R. D., & Dittmann-Balcar, A. (1995). Mismatch negativity (MMN) is altered by directing attention. *Neuroreport*, *6*(8), 1187-1190.

- Otten, L. J., & Donchin, E. (2000). Relationship between P300 amplitude and subsequent recall for distinctive events: dependence on type of distinctiveness attribute. *Psychophysiology*, 37(5), 644-661.
- Ozaki, N., Manji, H., Lubierman, V., Lu, S. J., Lappalainen, J., Rosenthal, N. E., & Goldman, D. (1997). A naturally occurring amino acid substitution of the human serotonin 5-HT<sub>2A</sub> receptor influences amplitude and timing of intracellular calcium mobilization. *J Neurochem*, 68(5), 2186-2193.
- Parker, A., Wilding, E., & Akerman, C. (1998). The von Restorff effect in visual object recognition memory in humans and monkeys: The role of frontal/perirhinal interaction. *J Cogn Neurosci*, 10(6), 691-703.
- Pavlov, I. P. (1927). *Conditioned reflexes*. London: Oxford University Press.
- Pegado, F., Bekinschtein, T., Chausson, N., Dehaene, S., Cohen, L., & Naccache, L. (2010). Probing the lifetimes of auditory novelty detection processes. *Neuropsychologia*, 48(10), 3145-3154.
- Perrault, N., & Picton, T. W. (1984a). Event-related potentials recorded from the scalp and nasopharynx. I. N1 and P2. *Electroencephalography and Clinical Neurophysiology*, 59(3), 177-194.
- Perrault, N., & Picton, T. W. (1984b). Event-related potentials recorded from the scalp and nasopharynx. II. N2, P3 and slow wave. *Electroencephalography and Clinical Neurophysiology*, 59(4), 261-278.
- Pirtosek, Z. (2009). 'Bad guys' among the antiparkinsonian drugs. *Psychiatr Danub*, 21(1), 114-118.
- Plancher, G., & Barrouillet, P. (2013). Forgetting from working memory: does novelty encoding matter? *J Exp Psychol Learn Mem Cogn*, 39(1), 110-125.
- Polich, J. (1987). Task difficulty, probability, and inter-stimulus interval as determinants of P300 from auditory stimuli. *Electroencephalogr Clin Neurophysiol*, 68(4), 311-320.
- Polich, J. (2007). Updating P300: an integrative theory of P3a and P3b. *Clin Neurophysiol*, 118(10), 2128-2148.
- Polich, J., & Comerchero, M. D. (2003). P3a from visual stimuli: typicality, task, and topography. *Brain Topogr*, 15(3), 141-152.
- Polich, J., & Criado, J. R. (2006). Neuropsychology and neuropharmacology of P3a and P3b. *Int J Psychophysiol*, 60(2), 172-185.
- Posner, M. I., & Dehaene, S. (1994). Attentional networks. *Trends Neurosci*, 17(2), 75-79.
- Potts, G. F., Liotti, M., Tucker, D. M., & Posner, M. I. (1996). Frontal and inferior temporal cortical activity in visual target detection: Evidence from high spatially sampled event-related potentials. *Brain Topogr*, 9(1), 3-14.
- Potts, G. F., Patel, S. H., & Azzam, P. N. (2004). Impact of instructed relevance on the visual ERP. *Int J Psychophysiol*, 52(2), 197-209.
- Prasher, D., & Findley, L. (1991). Dopaminergic induced changes in cognitive and motor processing in Parkinson's disease: an electrophysiological investigation. *Journal of neurology, neurosurgery, and psychiatry*, 54(7), 603-609.
- Pritchard, W., Shappell, S., & Brandt, M. (1991). Psychophysiology of N200/N400: A review and classification scheme. In J. Jennings & P. Ackles (Eds.), *Advances in psychophysiology: A research annual* (Vol. 4, pp. 43-106). London: Jessica Kingsley.
- Ranganath, C., & Rainer, G. (2003). Neural mechanisms for detecting and remembering novel events. *Nat Rev Neurosci*, 4(3), 193-202.
- Rangel-Gomez, M., Hickey, C., van Amelsvoort, T., Bet, P., & Meeter, M. (2013). The detection of novelty relies on dopaminergic signaling: evidence from apomorphine's impact on the novelty N2. *PLoS One*, 8(6), e66469.
- Rangel-Gomez, M., & Meeter, M. (2013). Electrophysiological analysis of the role of novelty in the von Restorff effect. *Brain Behav*, 3(2), 159-170.
- Redgrave, P., & Gurney, K. (2006). The short-latency dopamine signal: a role in discovering novel actions? *Nat Rev Neurosci*, 7(12), 967-975.



## REFERENCES

- Rouder, J. N., & Morey, R. D. (2012). Default bayes factors for model selection in regression. *Multivariate Behavioral Research*, *47*(6), 877-903.
- Rouder, J. N., Morey, R. D., Speckman, P. L., & Province, J. M. (2012). Default bayes factors for ANOVA designs. *Journal of Mathematical Psychology*, *56*(6), 356-374.
- Rouder, J. N., Speckman, P. L., Sun, D., Morey, R. D., & Iverson, G. (2009). Bayesian t tests for accepting and rejecting the null hypothesis. *Psychon Bull Rev*, *16*(2), 225-237.
- Rundus, D. (1971). Analysis of Rehearsal Processes in Free Recall. *Journal of Experimental Psychology*, *89*(1), 63-77.
- Ruzicka, E., Roth, J., Spackova, N., Mecir, P., & Jech, R. (1994). Apomorphine induced cognitive changes in Parkinson's disease. *J Neurol Neurosurg Psychiatry*, *57*(8), 998-1001.
- Ryan, B., Joilin, G., & Williams, J. M. (2015). Plasticity-related microRNA and their potential contribution to the maintenance of long-term potentiation. *Front Mol Neurosci*, *8*, 4.
- Salveti, B., Morris, R. G., & Wang, S. H. (2014). The role of rewarding and novel events in facilitating memory persistence in a separate spatial memory task. *Learn Mem*, *21*(2), 61-72.
- Sambeth, A., Huottilainen, M., Kushnerenko, E., Fellman, V., & Pihko, E. (2006). Newborns discriminate novel from harmonic sounds: a study using magnetoencephalography. *Clinical Neurophysiology*, *117*(3), 496-503.
- SanMiguel, I., Morgan, H. M., Klein, C., Linden, D., & Escera, C. (2010). On the functional significance of Novelty-P3: facilitation by unexpected novel sounds. *Biol Psychol*, *83*(2), 143-152.
- Schellekens, A. F., Grootens, K. P., Neef, C., Movig, K. L., Buitelaar, J. K., Ellenbroek, B., & Verkes, R. J. (2010). Effect of apomorphine on cognitive performance and sensorimotor gating in humans. *Psychopharmacology (Berl)*, *207*(4), 559-569.
- Schellekens, A. F., van Oosterwijk, A. W., Ellenbroek, B., de Jong, C. A., Buitelaar, J. K., Cools, L., & Verkes, R. J. (2009). The dopamine agonist apomorphine differentially affects cognitive performance in alcohol dependent patients and healthy controls. *Eur Neuropsychopharmacol*, *19*(1), 68-73.
- Schomaker, J., & Meeter, M. (2012). Novelty enhances visual perception. *PLoS One*, *7*(12), e50599.
- Schomaker, J., & Meeter, M. (2014a). Facilitation of responses by task-irrelevant complex deviant stimuli. *Acta Psychol (Amst)*, *148*, 74-80.
- Schomaker, J., & Meeter, M. (2014b). Novelty detection is enhanced when attention is otherwise engaged: an event-related potential study. *Exp Brain Res*, *232*(3), 995-1011.
- Schomaker, J., & Meeter, M. (in press). Exploring a novel environment promotes recall of words. *Front Psychol*.
- Schomaker, J., Roos, R., & Meeter, M. (2014). Expecting the unexpected: the effects of deviance on novelty processing. *Behav Neurosci*, *128*(2), 146-160.
- Schott, B. H., Seidenbecher, C. I., Richter, S., Wustenberg, T., Debska-Vielhaber, G., Schubert, H., . . . Duzel, E. (2011). Genetic variation of the serotonin 2a receptor affects hippocampal novelty processing in humans. *PLoS One*, *6*(1), e15984.
- Schroger, E., & Wolff, C. (1998). Attentional orienting and reorienting is indicated by human event-related brain potentials. *Neuroreport*, *9*(15), 3355-3358.
- Schultz, W. (1998). Predictive reward signal of dopamine neurons. *J Neurophysiol*, *80*, 1-27.
- Sechenov, I. M. I. (1866). *Refleksy golovnago mozga*.
- Simons, R. F., Graham, F. K., Miles, M. A., & Chen, X. (2001). On the relationship of P3a and the Novelty-P3. *Biol Psychol*, *56*(3), 207-218.
- Sokolov, E. N. (1963). Higher nervous functions; the orienting reflex. *Annual Review of Physiology*, *25*, 545-580.
- Soltani, M., & Knight, R. T. (2000). Neural origins of the P300. *Critical reviews in neurobiology*, *14*(3-4), 199-224.
- Spencer, K. M., Dien, J., & Donchin, E. (1999). A componential analysis of the ERP elicited by novel events using a dense electrode array. *Psychophysiology*, *36*(3), 409-414.

- Squires, N. K., Squires, K. C., & Hillyard, S. A. (1975). Two varieties of long-latency positive waves evoked by unpredictable auditory stimuli in man. *Electroencephalogr Clin Neurophysiol*, *38*(4), 387-401.
- Stoppel, C. M., Boehler, C. N., Strumpf, H., Heinze, H. J., Hopf, J. M., Duzel, E., & Schoenfeld, M. A. (2009). Neural correlates of exemplar novelty processing under different spatial attention conditions. *Hum Brain Mapp*, *30*(11), 3759-3771.
- Strobel, A., Debener, S., Anacker, K., Muller, J., Lesch, K. P., & Brocke, B. (2004). Dopamine D4 receptor exon III genotype influence on the auditory evoked novelty P3. *Neuroreport*, *15*(15), 2411-2415.
- Suri, R. E., Bargas, J., & Arbib, M. A. (2001). Modeling functions of striatal dopamine modulation in learning and planning. *Neuroscience*, *103*(1), 65-85.
- Sussman, E., Winkler, I., & Wang, W. (2003). MMN and attention: competition for deviance detection. *Psychophysiology*, *40*(3), 430-435.
- Szucs, D., Soltész, F., Czigler, I., & Csepe, V. (2007). Electroencephalography effects to semantic and non-semantic mismatch in properties of visually presented single-characters: the N2b and the N400. *Neurosci Lett*, *412*(1), 18-23.
- Takeshita, S., & Ogura, C. (1994). Effect of the dopamine D2 antagonist sulpiride on event-related potentials and its relation to the law of initial value. *International journal of psychophysiology*, *16*(1), 99-106.
- Talamini, L. M., de Haan, L., Nieman, D. H., Linszen, D. H., & Meeter, M. (2010). Reduced context effects on retrieval in first-episode schizophrenia. *PLoS One*, *5*(4), e10356.
- Tarbi, E. C., Sun, X., Holcomb, P. J., & Daffner, K. R. (2010). Surprise? Early visual novelty processing is not modulated by attention. *Psychophysiology*, *48*(5), 624-632.
- Tielemans, N. S., Hendriks, M. P., Talamini, L., Wester, A. J., Meeter, M., & Kessels, R. P. (2012). Facilitation of memory by contextual cues in patients with diencephalic or medial temporal lobe dysfunction. *Neuropsychologia*, *50*(7), 1603-1608.
- Tiitinen, H., May, P., Reinikainen, K., & Naatanen, R. (1994). Attentive novelty detection in humans is governed by pre-attentive sensory memory. *Nature*, *372*(6501), 90-92.
- Tome, D., Barbosa, F., Nowak, K., & Marques-Teixeira, J. (2015). The development of the N1 and N2 components in auditory oddball paradigms: a systematic review with narrative analysis and suggested normative values. *J Neural Transm*, *122*(3), 375-391.
- Tulving, E., Markowitsch, H. J., Craik, F. E., Habib, R., & Houle, S. (1996). Novelty and familiarity activations in PET studies of memory encoding and retrieval. *Cereb Cortex*, *6*(1), 71-79.
- Tulving, E., & Pearlstone, Z. (1966). Availability Versus Accessibility of Information in Memory for Words. *Journal of Verbal Learning and Verbal Behavior*, *5*, 381-391.
- van Ast, V. A., Cornelisse, S., Meeter, M., Joels, M., & Kindt, M. (2013). Time-dependent effects of cortisol on the contextualization of emotional memories. *Biol Psychiatry*, *74*(11), 809-816.
- Van Overschelde, J. P., Rawson, K. A., & Dunlosky, J. (2004). Category norms: An updated and expanded version of the Battig and Montague (1969) norms. *Journal of Memory and Language*, *50*(3), 289-335.
- Vankov, A., Herve-Minvielle, A., & Sara, S. J. (1995). Response to novelty and its rapid habituation in locus coeruleus neurons of the freely exploring rat. *Eur J Neurosci*, *7*(6), 1180-1187.
- Vogel, E. K., & Luck, S. J. (2000). The visual N1 component as an index of a discrimination process. *Psychophysiology*, *37*(2), 190-203.
- Von Restorff, H. (1933). Über die Wirkung von Bereichsbildungen im Spurenfeld [The effects of field formation in the trace field]. *Psychologie Forschung*, *18*, 299-342.
- Waddill, P. J., & McDaniel, M. A. (1998). Distinctiveness effects in recall: differential processing or privileged retrieval? *Mem Cognit*, *26*(1), 108-120.
- Welch, M. J. (1974). Infants' visual attention to varying degrees of novelty. *Child Dev*, *45*(2), 344-350.

## REFERENCES

- Wilson, F. A., & Rolls, E. T. (1990). Neuronal responses related to the novelty and familiarity of visual stimuli in the substantia innominata, diagonal band of Broca and periventricular region of the primate basal forebrain. *Exp Brain Res*, *80*(1), 104-120.
- Wiswede, D., Russeler, J., Hasselbach, S., & Munte, T. F. (2006). Memory recall in arousing situations - an emotional von Restorff effect? *BMC Neurosci*, *7*, 57.
- Wittmann, B. C., Bunzeck, N., Dolan, R. J., & Duzel, E. (2007). Anticipation of novelty recruits reward system and hippocampus while promoting recollection. *Neuroimage*, *38*(1), 194-202.
- Wronka, E., Kaiser, J., & Coenen, A. M. (2012). Neural generators of the auditory evoked potential components P3a and P3b. *Acta Neurobiol Exp (Wars)*, *72*(1), 51-64.
- Xiang, J. Z., & Brown, M. W. (1998). Differential neuronal encoding of novelty, familiarity, and recency in regions of the anterior temporal lobe. *Neuropharmacology*, *37*, 657-676.
- Yamaguchi, S., & Knight, R. T. (1991). P300 generation by novel somatosensory stimuli. *Electroencephalography and Clinical Neurophysiology*, *78*(1), 50-55.
- Yuan, J., He, Y., Qinglin, Z., Chen, A., & Li, H. (2008). Gender differences in behavioral inhibitory control: ERP evidence from a two-choice oddball task. *Psychophysiology*, *45*(6), 986-993.
- Yucel, G., Petty, C., McCarthy, G., & Belger, A. (2005). Visual task complexity modulates the brain's response to unattended auditory novelty. *Neuroreport*, *16*(10), 1031-1036.