White paper on Leveraging Neuroscientific and Neurotechnological (NeuroS&T) Developments with Focus on Influence and Deterrence in a Networked World

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Contributing Authors: Brig Gen Tim Fay (Joint Staff), Dr. Jorge Barraza (Claremont Graduate University), Dr. Roland Benedikter (University of California, Santa Barbara), Dr. William Casebeer (DARPA), Dr. Jeffrey Collmann (Georgetown), Dr. Nicole Cooper (Univ. of Penn), Dr. Diane DiEuliis (HHS), Dr. Emily Falk (Univ. of Penn), Dr. Kevin FitzGerald (Georgetown), Dr. James Giordano (Georgetown), Dr. Scott Heuttel (Duke), Mr. Hunter Hustus (USAF), Dr. Clark McCauley (Bryn Mawr), Dr. Rose McDermott (Brown), Dr. Ed Robbins (USAF), Dr. Victoria Romero (Charles River Analytics), Maj Jason Spitaletta (JHU/APL), Dr. Rochelle E. Tractenberg (Georgetown), Dr. Nicholas D Wright (Carnegie Endowment)

Editors: Dr. Hriar Cabayan (Joint Staff), Dr. William Casebeer (DARPA), Dr. Diane DiEuliis (HHS), Dr. James Giordano (Georgetown), Dr. Nicholas D Wright (Carnegie),

Copy Editor: Mr. Sam Rhem (Joint Staff)

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Neuroscientific Considerations of Trust and Influence

Dr. Jorge A. Barraza
Claremont Graduate University
jorge.barraza@cgu.edu

Abstract. Influence is a social process. Social cues dictate how an *influence target* attributes trust or truthiness to an *influence source*. As such, influence is not purely calculative (or "rational") as a myriad of both cognitive (thought) and affective (emotion) factors are involved in the process. The neuroscience of trust provides a framework for examining how emotions, pre-existing beliefs, and individual differences can impact influence at individual and group levels. In particular, the hormone oxytocin illustrates that influence can have ancient roots in our evolutionary development as a social species. Some highlights of this research are provided with a discussion of their implications to deterrence.

Introduction

Whether an influence strategy utilizes force, coercion, or more "diplomatic" means, these decisions rely on valuation processes operating under conscious awareness. The neurobiology of trust provides an opportunity to illuminate this hidden process. Trust is generally viewed as a *behavior* that makes one party (influence target) *vulnerable* to another party (influence source). Trust occurs when the other party is deemed to be credible or trustworthy. An influence target will ascribe trustworthiness if he or she believes the influence source is 1) competent and consistent (*ability*); 2) caring, empathetic, or sharing a common goal (*benevolence*); or 3) objective, fair, and honest (*integrity*; Mayer, Davis, & Schoorman, 1995).

Neuroscience research has generally used social dilemma games to study trust (e.g., investment/trust game), whereby an individual can place him or herself at risk of financial loss in order to cooperate with another party. In these studies it is assumed that all parties are fully informed about the rules of the games. As such, this body of work can inform us about trust in settings where *benevolence* and *integrity* are important, but not when *ability* is a driver of trust (for instance, the ability of the influence source to carry out an agreement).

The Neuroscience of Trust

Biological events, primarily occurring in the brain, have been shown to be involved in the formation of trust. Key in this body of research is the relationship between oxytocin and trust. Oxytocin is an evolutionarily ancient hormone produced in the brain. It is implicated in a wide range of positive social behaviors (e.g., trust, reciprocity) and emotions (e.g., empathy) among strangers (for review see Barraza & Zak, 2013). The link between oxytocin and trust has been examined using multiple methods including direct modification of levels in the brain (e.g., Kosfeld et al., 2005), via changes in circulating oxytocin in blood (e.g., Zak et al., 2005), with brain imaging technology (Baumgartner, et al. 2008), and through genetic studies (e.g., Reuter et

al., 2009). Our understanding of this relationship began with a landmark study indicating a direct causal relationship: experimentally increasing oxytocin in the human brain increased trust toward strangers (Kosfeld et al., 2005). Research to date now indicates that oxytocin influences the perception of social information below conscious awareness (lower order processes), particularly by increasing attention given to social information (thinking about the "other") and by lowering social threat. The proceeding highlights some of the key findings and conclusions related to influence.

First Impressions Bias Future Interactions

Aggression is a useful but costly strategy. This effective short-term strategy can ultimately be costly for future cooperation. A priori social knowledge can heavily impact the subjective (and neural) assessments of trust in others (Delgado, Frank, & Phelps, 2005). Oxytocin will not increase trust when past history leads to an initial evaluation of the partner as untrustworthy (Mikolajczak et al., 2010). The reverse also appears to be accurate: when trust initially exists, it takes much longer to "spot" an untrustworthy partner (Delgado, Frank, & Phelps, 2005; Baumgartner, et al. 2008). As such, ensuring that first encounters create positive evaluations will be beneficial to future influence attempts.

Trust is Socially Risky (and Rewarding)

Influence operations involve both uncertainty and risk for the influence target. The neurobiology underlying trust may promote risk behavior by shifting attention to positive social outcomes. This has been shown to be entirely different from non-social risk decisions, like gambling (Kosfeld et al., 2005). It appears that trust is different from engaging in risky choice itself, but is an action based on considerations about the social uncertainty involved. Why? Brain imaging studies suggest that humans experience trusting others as rewarding, which may act to reinforce future trust/cooperation (e.g., King-Casas et al., 2005; Krueger et al., 2007; Rilling et al., 2002). Indeed, the "reward" neurochemical dopamine has a strong positive relationship with oxytocin in the brain (Baskerville & Douglas, 2010). Thus, people make themselves vulnerable not just because the outcome is potentially rewarding, but the act of trust is intrinsically rewarding.

Trust has Ingroup/Outgroup Distinctions

Trust involves both coordination with and a preference to affiliate with group members. Oxytocin appears to increase preference for one's ingroup (see De Dreu, 2012). However, there is no consistent support for oxytocin promoting antisocial behavior toward an outgroup (see van IJzendoorn & Bakermans-Kranenburg, 2012). Oxytocin may promote ingroup bias when there are zero-sum relationships between groups, specifically where cooperation with the ingroup would be a detriment to the outgroup. Support for this interpretation is found by other scientists (Israel et al., 2012) who find that oxytocin can promote outgroup cooperation in tasks that allow for the mutual benefit of groups. It appears that trust is sensitive to ingroup/similarity cues, but only when the framing of the conflict is zero-sum.

Trusting in Mass Communication

The pace by which social information is shared by known and unknown others is dramatically accelerated by new technologies and social platforms. The process by which this information is ignored, counter-argued, or influential to actors may include countless factors. Influence may occur under conscious awareness, or may occur over an extended period of time, and thus may not always be amenable to traditional observation tools. There is evidence to suggest that the amount of emotional engagement with a message (public service announcement: PSA) can

indicate message effectiveness (sacrificing personal money to the "cause" communicated by the PSA). Both subjective engagement with the message and the costly action (viewed as message influence) are associated with greater oxytocin in the brain (Lin et al., 2013). Similar effects for oxytocin are found for donating to charities after being presented with a persuasive appeal (Barraza et al., 2011; van IJzendoorn et al., 2011). As such, the neurobiology of trust is also involved at a more macro-level with mass communication techniques.

Individual Differences can Impact Trust

Trust occurs at an individual level, varying by situation. However, the propensity to trust varies from person to person and from culture to culture (Cesarini et al., 2008; Fukuyama, 1995; Johnson & Cullen, 2002). Trust also varies at a national level, with lower GDP countries showing lower levels of interpersonal trust for government and neighbors alike (Zak & Knack, 2001). We should be cognizant of personality (or group predispositions) affecting the dynamic between influence target and source. For instance, oxytocin appears to be involved in trust in leadership and organizations. Oxytocin leads certain individuals (Democrats) to be more trusting of politicians from both parties, and the federal government in general, when compared to those on placebo (Merolla et al., 2013). It is possible that individual differences more prevalent in this group (e.g., openness to divergent opinions) provide wiggle room to influence their attitudes toward political figures. If this is the case, there may be "soft targets" of influence that could be identified by certain psychological predispositions.

Conclusion

No single hormone, no single neural or autonomic state can be expected to align perfectly with abstract multi-faceted concepts like trust. Nevertheless, our understanding of the neurobiology of trust has been greatly informed by oxytocin. The neurobiology of trust can provide insight into a fundamental human capacity with real world implications.

References

Barraza, J. A., McCullough, M. E., Ahmadi S., & Zak, P. J. (2011). Oxytocin infusion increases charitable donations regardless of monetary resources. *Hormones and Behavior, 60,* 148-151. doi:10.1016/j.yhbeh.2011.04.008

Barraza, J. A., & Zak P. J. (2013). Oxytocin instantiates empathy and promotes prosocial behavior. In E. Choleris, D. Pfaff, and Dr M. Kavaliers (Eds.), Oxytocin, Vasopressin and Related Peptides in the Regulation of Behavior.

Baskerville, T. A., & Douglas, A. J. (2010). Dopamine and oxytocin interactions underlying behaviors: Potential contributions to behavioral disorders. *CNS Neuroscience & Therapeutics, 16*, e92–e123. doi:10.1111/j.1755-5949.2010.00154.x

Baumgartner, T., Heinrichs, M., Vonlanthen, A., Fischbacher, U., & Fehr, E. (2008). Oxytocin shapes the neural circuitry of trust and trust adaptation in humans. *Neuron, 58*, 639-650.

Cesarini, D., Dawes, C. T., Fowler, J. H., Johannesson, M., Lichtenstein, P., & Wallace, B. (2008). Heritability of cooperative behavior in the trust game. *Proceedings of the National Academy of Sciences, 105*, 3721–3726. doi:10.1073/pnas.0710069105

De Dreu, C. K. (2012). Oxytocin modulates cooperation within and competition between groups: an integrative review and research agenda. *Hormones and Behavior, 61*, 419-28.

Delgado, M. R., Frank, R. H., & Phelps, E. A. (2005). Perceptions of moral character modulate the neural systems of reward during the trust game. *Nature Neuroscience, 8*, 1611–1618. doi:10.1038/nn1575

Fukuyama, F. (1995). Social capital and the global economy. *Foreign Affairs, 74,* 89-103.

Israel, S., Weisel, O., Ebstein, R. P., & Bornstein, G. (2012). Oxytocin, but not vasopressin, increases both parochial and universal altruism. *Psychoneuroendocrinology*, *37*, 1341-1344.

Johnson, J.L. & Cullen, J.B. (2002). Trust in cross-cultural relationships, in M. Gannon & K. Newman (eds.), *The Blackwell Handbook of Cross-Cultural Management* (pp. 335-360) Oxford: Blackwell.

King-Casas, B., Tomlin, D., Anen, C., Camerer, C. F., Quartz, S. R., & Montague, P. R. (2005). Getting to know you: Reputation and trust in a two-person economic exchange. *Science, 308*, 78– 83. doi:10.1126/science.1108062

Kosfeld, M., Heinrichs, M., Zak, P. J., Fischbacher, U., & Fehr, E. (2005). Oxytocin increases trust in humans. *Nature, 435*, 673-676.

Krueger, F., McCabe, K., Moll, J., Kriegeskorte, N., Zahn, R., Strenziok, M., . . . Grafman, J. (2007). Neural correlates of trust. *Proceedings of the National Academy of Sciences, 104*, 20084–20089. doi:10.1073/pnas.0710103104

Lin, P.-Y., Grewal, N. S., Morin, C., Johnson, W. D., & Zak, P. J. (2013). Oxytocin increases the influence of public service advertisements. *PLoS ONE*, *8*(2), e56934.

Mayer, R. C., Davis, J. H., & Schoorman, F. D. (1995). An integrative model of organizational trust. *Academy of Management Review, 20*, 709–734.

Merolla, J. L, Burnett, G., Pyle, K., Ahmadi, S., & Zak, P. J. (2013). Oxytocin and the biological basis for interpersonal and political trust. *Political Behavior, 34,* 1-24.

Mikolajczak, M., Gross, J. J., Lane, A., Corneille, O., de Timary, P., & Luminet, O. (2010). Oxytocin makes people trusting, not gullible. *Psychological Science, 21*, 1072-1074.

Reuter, M., Montag, C., Altmann, S., Bendlow, F., Elger, C., Kirsch, P., . . . Falk, A. (2009). Genetically determined differences in human trust behavior: The role of the oxytocin receptor gene. NeuroPsychoEconomics Conference Proceedings, 21.

Rilling, J. K., Gutman, D. A., Zeh, T. R., Pagnoni, G., Berns, G. S., & Kilts, C. D. (2002). A neural basis for social cooperation. *Neuron, 35*, 395–405. doi: 10.1016/S0896-6273(02)00755-9

van IJzendoorn, M.H., Huffmeijer, R., Alink, L.R.A, Bakermans-Kranenburg, M.J., Tops, M.T., 2011. The impact of oxytocin administration on charitable giving is moderated by experiences of parental love-withdrawal. *Frontiers in Psychology, 2*, 1-8.

van IJzendoorn, M. H., & Bakermans-Kranenburg, M. J. (2012). A sniff of trust: Meta-analysis of the effects of intranasal oxytocin administration on face recognition, trust to in-group, and trust to out-group. *Psychoneuroendocrinology, 37*, 438—443.

Zak, P. J., Kurzban, R., & Matzner, W. T. (2005b). Oxytocin is associated with human trustworthiness. *Hormones and Behavior, 48*, 522–527. doi:10.1016/j.yhbeh.2005.07.009

Zak, P. J., & Knack, S. (2001). Trust and growth. *The Economic Journal, 111*, 295–321. doi:10.1111/1468-0297.00609