

# Tryptophan Promotes Interpersonal Trust

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“Every kind of peaceful cooperation among men is primarily based on mutual trust and only secondarily on institutions such as courts of justice and police,” Albert Einstein (1950) once said. Indeed, interpersonal trust is an essential element of social life in general and an important determinant of cooperative behavior in particular (Pruitt & Kimmel, 1977; Yamagishi, 1986). After all, most people will cooperate only if they expect others to do so as well, which makes mutual trust an important precondition for establishing mutual cooperation.

Pharmacological studies in rats and humans suggest that the neurotransmitter serotonin (5-HT) plays a crucial role in promoting cooperative behavior (Crockett, 2009), which can be enhanced by increasing the 5-HT level through administration of selective serotonin reuptake inhibitors (Knutson et al., 1998; Tse & Bond, 2002) and can be reduced by lowering the 5-HT level through tryptophan depletion (Crockett, Clark, & Robbins, 2009; Crockett, Clark, Tabibnia, Lieberman, & Robbins, 2008; Wood, Rilling, Sanfey, Bhagwagar, & Rogers, 2006). In the experiment reported here, for the first time, we focused on the link between 5-HT and the key precursor to cooperation: interpersonal trust.

We tested whether mutual trust can be promoted by administering the food supplement L-tryptophan (TRP), the biochemical precursor of 5-HT. TRP is an essential amino acid contained in food such as fish, soybeans, eggs, and spinach. TRP supplementation is known to increase plasma TRP levels and to influence brain 5-HT synthesis (Markus, Firk, Gerhardt, Kloek, & Smolders, 2008). We expected to find an effect of TRP on interpersonal trust because the medial prefrontal cortex, the brain region associated with trust-related decisions (Delgado, Frank, & Phelps, 2005; McCabe, Houser, Ryan, Smith, & Trouard, 2001), receives serotonergic projections from neurons in the raphe nuclei, the principal source of 5-HT release in the brain. It is thus plausible, if not likely, that the activation of the medial prefrontal cortex is modulated through serotonergic projections—which we aimed to target by supplementation with TRP.

## Method

We investigated the link between TRP supplementation and interpersonal trust in 40 healthy adults exposed to an oral dose of either TRP or a neutral placebo ( $n = 20$  in each condition; for details on the method, see the Supplemental Material available online). Participants arrived at the laboratory in pairs, took their dose of TRP or placebo, and about an hour later performed an unrelated joint-action task.

We then measured interpersonal trust by having each pair perform the Trust Game (Camerer & Weigelt, 1988)—a task that measures the extent to which one person (the truster) trusts another person (the trustee), as indicated by money units transferred from truster to trustee. Members of each pair were seated in two separate cubicles and led to believe that one of them would play the role of truster and the other the role of trustee (in reality, both of them were trusters). Trusters were endowed with €5 and could decide how much of this amount to transfer to the trustee. Transferred money would be multiplied by 3, and the trustee could reciprocate by giving part of this tripled amount back to the truster. Thus, by transferring money to the trustee (in a single trial), the truster could gain extra endowments, but only if the trustee would give enough money back—which made the amount transferred by the truster an indicator of interpersonal trust (Meijnders et al., 2009).

## Results and Discussion

As expected, participants transferred significantly more euros to their partners (whom they thought were trustees) in the TRP condition ( $M = €3.57$ ,  $SD = €1.33$ ) than in

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the placebo condition ( $M = \text{€}2.61$ ,  $SD = \text{€}1.26$ ),  $t(38) = 2.35$ ,  $p = .024$  (for further analyses, including analyses of how the condition manipulation affected mood and heart rate, see the Supplemental Material).

This study is the first to demonstrate that TRP supplementation promotes interpersonal trust. One may wonder how this novel finding relates to Kosfeld, Heinrichs, Zak, Fischbacher, and Fehr's (2005) observation that the neuropeptide oxytocin (OT) also increases trust and cooperation. Such similarities between the social effects of TRP and OT are plausible if one considers the functional and anatomical interactions between serotonergic and oxytocinergic systems. Serotonergic terminals, originating mainly from the dorsal and median raphe nuclei of the brainstem, project to the paraventricular nuclei (Larsen, Hay-Schmidt, Vrang, & Mikkelsen, 1996), the neurons of which synthesize OT. Further, the administration of the serotonergic agonist fenfluramine to healthy subjects increases plasma OT levels (Lee, Garcia, van de Kar, Hauger, & Coccaro, 2003). One may thus speculate that interpersonal trust is mediated by the effect that 5-HT exerts on OT levels.

More research is needed to replicate, clarify, and extend our preliminary findings. For instance, it is possible that TRP makes people more trusting by making them more inclined to take social risks. Indeed, the decision to trust another party involves risk for the truster (Kosfeld et al., 2005), and TRP does induce people to take more risks (Doya, 2008; Murphy et al., 2009). To disentangle the relationships among 5-HT, risk taking, and trust, future research might explore the impact of individual differences in risk aversion (cf. Kosfeld et al., 2005; Mikolajczak et al., 2010). Another issue worth noting is that all of our participants played the role of the truster and were led to believe that their partners were the trustees. The reason we used this procedure was that we were primarily interested in the effect of TRP on trust, and not on trustworthiness (which is measured by trustees' decisions). However, future research might investigate the effect of TRP on trustees' decisions as well, and thereby generate new insights on the effect of TRP on trustworthiness and reciprocity. Finally, we cannot exclude the possibility that trust and cooperation in our study were enhanced by the earlier interaction between the participants, which perhaps made the participant pairings particularly salient.

This article is the first to show that TRP facilitates interpersonal trust, a fundamental precursor of social cooperation. Thus, our findings shed an interesting new light on the social functions of 5-HT. In a sense, our results support the materialist approach that "you are what you eat" (Feuerbach, 1862/1960)—the idea that the food one eats has a bearing on one's state of mind. Food may thus act as a cognitive enhancer that modulates the way one thinks and perceives the physical and social world.

In particular, TRP supplements, or TRP-containing diets, may promote interpersonal trust in inexpensive, efficient, and healthy ways, thus supporting the "peaceful cooperation among men" that Einstein was concerned about.

### Author Contributions

L. S. Colzato developed the study concept. All authors contributed to the study design. Testing and data collection were performed by L. Steenbergen. R. Sellaro performed the data analysis and interpretation under the supervision of B. Hommel and L. S. Colzato. L. S. Colzato drafted the manuscript, and E. W. de Kwaadsteniet, R. Liepelt, and B. Hommel provided critical revisions. All authors approved the final version of the manuscript for submission.

### Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

### Supplemental Material

Additional supporting information may be found at <http://pss.sagepub.com/content/by/supplemental-data>

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