

Sigrid Schmitz and Grit Höppner, editors

## Gendered Neurocultures

Feminist and Queer Perspectives  
on Current Brain Discourses



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### **Oxytocin as Proximal Cause of 'Maternal Instinct': Weak Science, Post-Feminism, and the Hormones Mystique**

During the first decade of the 2000s, a seemingly scientific theory supporting the notion that 'maternal instinct' is not a myth became widespread in French public space. According to this theory, the hormone oxytocin (OT) activates cerebral circuits that promote affective bonding, and since parturition and nipple stimulation cause a rise in OT levels in women, delivery and breastfeeding have the physiological effect of priming their attachment and care giving toward their infant. In this chapter I will first show that the empirical research related to that theory, hereinafter referred to as the OT-theory, offers it very little support. Second, I will sketch out the context and key players of the dissemination of the OT-theory in French public space, and propose some hypotheses about the determinants of its success despite its lack of scientific support.

#### **State of Knowledge Regarding Oxytocin Release in Mothers and its Possible Effects on Their Attitudes toward Their Infants**

OT is mainly synthesized in magnocellular hypothalamic neurons which project to the posterior pituitary, where it is stored in vesicles at axon terminals. Their content is released into the peripheral circulation in response to some physiological stimuli, typically

cervical stretching by the fetus at the end of the pregnancy or suckling by an infant. After travelling via the bloodstream, OT binds to specific receptors on smooth muscles in the uterus and in the mammary gland, which facilitates fetal, placental, and milk ejection.

### *Oxytocin in the Brain*

Because of its poor ability to cross the blood–brain barrier, most researchers think that the OT secreted into the blood from the pituitary does not re-enter the brain in significant amounts. More categorically, Mike Ludwig and Gareth Leng (2006: 128) stated that OT is “prevented from re-entering the brain” by the blood–brain barrier. The only study they cite here has actually led its authors to state that in rats, OT crosses this barrier “in amounts obviously sufficient to induce central actions” (Mens et al. 1983: 143), but their data in fact suggested that less than 0.003% of peripherally administered OT reaches the cerebrospinal fluid (CSF). In any case, Frédéric Lévy and Alison Fleming (2006) noted that in women, as opposed to other mammals, OT levels in the CSF seem not to significantly increase at parturition (even when plasma OT levels are increased more than sixfold during labor, as seen in a sub-group of women of the study they cite), and Margaret Altemus et al. (2004) consistently found that in pregnant women at term but not in labor, OT levels in the CSF were not significantly elevated relative to non-pregnant women although plasma levels were.

Nonetheless, central effects of an OT release specifically linked to parturition or breastfeeding may exist if peripheral and central release patterns are partly coordinated. As considered by Heather Ross and Larry Young (2009), collaterals from magnocellular neurons projecting to other brain sites may simultaneously release OT, or the activity of magnocellular neurons may be partly coordinated with the one of parvocellular neurons, which also synthesize OT and project to various brain sites. Alternatively, there

may be a partly dependent dendritic release of OT in the CSF by magnocellular neurons, as some studies in rats suggest (Leng et al. 2008). However, these three scenarios were highly hypothetical in 2009, and they still were as of the end of 2012. Moreover, the pathways by which OT might modulate human behavior or cognition by acting on the CNS remained to be discovered. It is noteworthy that although the results of some human studies were discussed in terms of brain areas ‘known to be rich in OT receptors,’ OT receptor distribution in the human brain was still unknown as of the end of 2012: a single study by Fabienne Loup et al. (1991) had addressed that question, and it turned out that the radioligands they used to detect OT binding sites were not selective for human OT receptors (Toloczko et al. 1997; L. J. Young & Flanagan-Cato 2012).

### *Oxytocin and ‘Maternal Behavior’: Experimental Findings in Animals*

Beyond inconclusive correlational findings, researchers have tried to establish the effect of OT on ‘maternal behavior’ in animals by manipulating the OT system. The first species studied was the rat; the sheep, the vole, the mouse, and the rhesus monkey followed.

When Jay Rosenblatt (1967) found that after a few days in contact with foster pups, female *and male* adult rats manifest the four main items characterizing ‘maternal behavior’ in that species (building a nest, licking the pups, crouching over them, and retrieving any separated pup), attempts were made to shorten the latency of this phenomenon by manipulating hormones. Cort Pedersen and Arthur Prange (1979) reported the first study on the effects of intracerebroventricular (ICV) administration of OT. They found that in virgin steroid-primed female rats, OT accelerated the onset of ‘maternal behavior,’ and subsequent studies showed a decrease in ‘maternal behavior’ scores after infusion of OT inhibitors. However, reviewing the studies having tried to replicate Pedersen and Prange’s initial finding, “one is struck that oxytocin’s

central effects were neither consistent nor, in most cases, robust\* (Numan & Insel 2003: 198). Indeed, two independent teams failed to replicate it (Bolwerk & Swanson 1984; Rubin et al. 1983), and after investigating these discrepancies, Susan Fahrbach et al. (1986) eventually reported that OT could facilitate 'maternal behavior' only if rats were tested after two hours of pre-test cage habituation, but not if they were tested in their home cage or in a cage without prior habituation. Finally, Marianne Wambolt and Thomas Insel (1987) puzzlingly found that after two hours of pre-test cage habituation, OT had effects in females with induced inability to perceive odors but not in intact ones. In short, in rats neither parturition nor suckling is mandatory to trigger or maintain 'maternal behavior,' and the rather common notion that a central administration of OT accelerates its onset is in fact not robustly supported.

In sheep, where it is only after parturition that females manifest 'maternal behavior' (licking and suckling their lambs while aggressing alien ones), a series of studies led by Keith Kendrick in England and Frédéric Lévy in France has produced results that are more in line with the OT-theory. Indeed, they found that OT levels increase in the CSF shortly after parturition, and that ICV administration of OT induces 'maternal behavior' in non-pregnant steroid-primed ewes as well as in parturient ones, with a peridural anaesthesia preventing both central OT release and the onset of this behavior (reviewed in Lévy & Fleming 2006).

In voles, a series of studies carried out by Thomas Insel and Larry Young's group from 1992 found links between the OT system and social bonding. But as regards parental behavior, only indirect findings based on OT receptor density comparisons or OT antagonist administration were reported (reviewed in Ross & Young 2009), not demonstrating the relevance of the OT-theory in this species.

In mice the only positive findings for OT and behaviors toward pups concern female infanticide of unrelated pups: Margaret McCarthy (1990) reported that its frequency was reduced by an ICV administration of OT, and André Ragnauth et al. (2005) reported

that in a stressful setting (supposed to mimic a socially competitive natural environment), it was systematic in mice lacking the OT gene (OT-KO mice) while it was not in wild-type ones. Except for these specific observations, there is strong evidence that OT is not involved in mouse 'maternal behavior,' whose characteristics are the same as in rats. Indeed, in four studies OT-KO females were found to exhibit the same 'maternal behavior' as wild-type ones, even though they could not nurse due to milk ejection dysfunction (Nishimori et al. 1996; Takayanagi et al. 2005; W. S. Young et al. 1996; L. J. Young et al. 1997). Only Pedersen et al. (2006) reported a decrease in pup licking and impaired pup retrievals by *virgin* OT-KO females compared with wild-type ones, and this may be due to confounding factors (Macbeth et al. 2010).

In primates, in addition to scarce and quite negative correlational findings, only two pilot experimental studies had been reported as of the end of 2012, both on rhesus macaques: Stephen Holman and Robert Goy (1995) found an increase of interest in unrelated infants following ICV administration of OT in two females, and Maria Boccia et al. (2007) found a reduced interest in an unrelated infant in *one* female following the administration of an OT receptor antagonist (with several methodological flaws stressed by the authors). The most one can say is that, in primates, OT "may act within the brain to facilitate the onset of maternal behavior; however, this conclusion must remain tentative" (Saltzman & Maestripieri 2011: 1197).

Extrapolating from animals to humans, always fraught with problems, is especially difficult when it comes to behavior, and particularly in this case. Indeed, the findings from animal behavioral studies vary widely, and although the amygdala, the hippocampus, and the striatum are among the assumed sites for the central action of OT in some species at least, Loup et al. (1991) did not show any evidence of OT binding sites in these areas in the human brain. As of end of 2012 the sheep was the only species in which robust findings consistent with the OT-theory existed, and even (boldly) assuming that displaying typical human nurturing behaviors is of the same nature as licking and suckling

one's own lambs while aggressing alien ones, there seems to be a crucial difference between ewe's and women's changes in OT levels in the CSF at parturition. Consequently, findings in humans would have been required to provide a scientific support to the OT-theory.

### *Oxytocin and the Behavior of Human Mothers Toward their Infants*

For obvious reasons, researchers can hardly manipulate the OT system of women in order to check whether and how this affects their attitude toward their infants. One exception is the quite common intravenous administration of synthetic OT to promote labor, which as a 'natural experiment' does not provide any support for the OT-theory, since no behavioral effects seem to have been reported.

The first findings which could somehow support the theory of OT-based 'maternal' drive or skills in human emerged in the mid 2000s, when several studies in neuroeconomics and biological psychiatry suggested that OT may enhance the motivation to engage in social interactions or improve 'social cognition' (Meyer-Lindenberg et al. 2011). However, the results of those studies, which used four approaches—correlation with OT levels, genetic association, neuroimaging, and intranasal administration—have been neither clear nor conclusive. As regards intranasal administration in particular, it can neither demonstrate a central effect of OT nor be extrapolated to the physiological rise in OT levels (Churchland & Winkielman 2012). Note that the authors of those studies, when they introduced or commented on their findings, often argued erroneously that OT had been shown to be involved in 'maternal behavior.' Generally speaking, when introducing or commenting human studies on OT, the results of animal studies are often wrongly summarized as demonstrating a causal role of OT in 'maternal behavior' in mammals. In my view, this is one of the reasons why the OT research field might have been "experiencing

an irrational exuberance that could burst after a few more years of careful scrutiny" (L. J. Young & Flanagan-Cato 2012: 227).

Starting from the late 2000s, a few studies designed to bring to light a possible causal role for OT in human parental attitudes were published. Since they used one of the four approaches mentioned above, they were essentially inconclusive due to possible confounding factors (in particular, correlations with OT levels can often be explained by a prior interaction causing a rise in peripheral OT), in addition to various methodological flaws, lack of replication, and contradictory findings. For instance, the main contributor to that field claimed to have shown that OT correlates with the "social-affective repertoire" in mothers and with the "object-oriented stimulatory play" in fathers on the one hand, and to have shown that OT is associated with the former in both mothers and fathers whereas vasopressin correlates with the latter on the other hand (Feldman 2012: 385, not noting this inconsistency). More importantly, the much-cited study having supposedly shown that OT levels across the postpartum period "predict mother-infant bonding" (Feldman et al. 2007) by no means supports the OT-theory. First, this study neither supports the notion that the rise in OT *during delivery* promotes mother-infant bonding, as OT levels were measured several weeks before and several days after delivery, nor the notion that the rise in OT *during breastfeeding* has such effects, as none of the studied variables showed differences between breastfeeding and non-breastfeeding mothers. Second, even if that study based on a non-representative sample of sixty-two women happens to be replicated, the finding may be explained by a third factor affecting both plasma OT levels and mothers' behavior, as the authors themselves wrote. Third, although the authors arbitrarily prioritized OT levels over other variables (and chose to ignore some others) in their hierarchical multiple regression analysis, OT levels accounted for only 7% of the variance in the 'maternal behavior' score. Finally, the same authors (Levine et al. 2007) published separately partly inconsistent findings from the same study instead of discussing them jointly, and they refused to provide me with the raw data for reanalysis.

In summary, the OT-theory is very far from being supported by human or animal studies. Yet, the notion that this theory has been scientifically established has become widespread in French public space.

### **Dissemination of the Oxytocin-Theory in French Public Space**

In the context of my research in popular science discourses concerning 'natural' psychological sex differences, I have systematically analyzed the full contents of several French magazines, daily newspapers, websites, as well as TV and radio programs, from 1989 to 2012 for *Science & Vie* magazine and on random sub-periods for the other media. I have complemented this systematic analysis by exploring the full contents retrieved by keywords searches in digital archives of several media outlets and of one press agency (AFP), by reading approximately twenty popular books by the most cited authors in that context, and by interviewing two scientists who endorsed the OT-theory in French public space. Finally, I have studied the media controversy surrounding Elisabeth Badinter's second book, in which she inveighs against the notion that childcare is 'naturally' at the heart of women's lives. She assumes instead that there is no such thing as 'maternal instinct' in humans and highlights historical and sociological evidence of the variability of mothers' attitudes toward their infants (Badinter 1980, 2010).

This controversy was symptomatic of the dominance and widespread acceptance of the OT-theory, for except rare references to purported psychological effects of prolactine—a pituitary hormone promoting lactation—it was the only biological argument put forward against Badinter's thesis, and nobody criticized it in the media. Symptomatically again, after I used my blog (<http://allodoxia.blog.lemonde.fr>) and interventions on a web forum dedicated to parenting in 2012 to create a controversy specifically on this unchallenged OT-theory, people including a science

journalist insisted that it had been scientifically established. That was not really surprising given that it had previously been endorsed by several influential experts.

### *Dissemination of the Oxytocin-Theory by Experts with Various Motivations*

The first significant expert was Jean-Didier Vincent, a pioneering neuroendocrinologist in France and staunch advocate of the biological basis of behavioral gender differences in the public arena. In 1986, he sketched out the OT-theory in his first book (Vincent 1986), a French bestseller in which, on this topic among others, he wrongly summarized and boldly extrapolated from the results of his and others' rodent studies. Later the same year, the AFP uncritically relayed his claim that he had just proven that OT was the cause of 'maternal instinct' in rats, and that the same mechanism probably existed in women. After him, the theory was not significantly reaffirmed until the early 2000s, when other prominent personalities perceived as experts in relevant biomedical fields endorsed it.

One of them was Michel Odent, former surgeon in a French maternity ward and key player in the 'natural childbirth' movement from the 1970s. In a book addressing "*The scientification of love*" (Odent 2001) and elsewhere later (including a documentary broadcast on a French public TV channel in 2012), he stated that OT is the hormone of 'mother-love' and is properly released only if childbirth takes place in the 'natural' conditions he advocates. His discourse has been relayed by midwives as secondary experts, calling for the demedicalization of childbirth both as a defense of their profession and as a means for women to 'reclaim' childbirth.

Another one was Edwige Antier, a pediatrician providing advice to parents in popular books and radio programs from the early 1980s, and an active member of a right-wing party. In a book she published in 2001 and elsewhere later (including during the controversy surrounding Badinter's book published in 2010),

she claimed that OT “is the hormone of maternal instinct” (Antier 2001: 65, translation OF). Such theory is an obvious argument for her conservative political agenda, for she bluntly warns that by ‘negating’ and antagonizing ‘maternal instinct,’ society prevents mothers from devoting themselves to their infant(s), which according to her has disastrous consequences for children and makes women unhappy.

Another crucial promoter of the theory was the American primatologist and sociobiologist Sarah Blaffer Hrdy, advocating for her view on motherhood essentially rooted in her early work on infanticide in animals and her personal experience as a mother. It started in 2002 with the French translation of her book *Mother Nature* (Blaffer Hrdy 2002). At that time, OT was only one of the biological factors she used to invoke about mothers’ special orientation to infants’ needs, but later she focused on OT, notably in a French documentary devoted to her thesis on ‘maternal instinct’ broadcast on a French public TV channel in 2009.

A broader theory of OT as the ‘love hormone’ spread with the popularization of Insel and Young’s seductive review of their and others’ findings on OT and ‘attachment’ (Insel & Young 2001), as well as of a neuroimaging study that supposedly showed that viewing a picture of their child elicits in mothers a specific brain activity in areas rich in OT receptors (Bartels & Zeki 2004). A key player in that movement was Lucy Vincent, professional communicator, freelance science journalist, and wife of Jean-Didier Vincent, supervisor of her PhD on the neurobiology of lactation in rats. In her first bestseller on the (neuro)biology of love, she explained that OT “ensures the attachment of a mother to her child through its massive release in her brain during delivery and breastfeeding” (Vincent 2004: 67, translation OF). She made similar claims elsewhere as well. The description of OT as the ‘love hormone’ was reiterated by several psychiatrists, either joining in on the profitable business she had initiated (e. g., Reynaud 2005), or more generally involved in the promotion of the notion that ethology and biology provide important cues for understanding sex differences in behavior (e. g., Cyrulnik 2006).

In a very different context, this theory was also endorsed by scientists working for the National Center for Scientific Research (CNRS), with which French science journalists have special connections. Whether investigating OT’s possible action in babies’ brains (Françoise Muscatelli in Marseille), OT’s possible therapeutic use in autism (Angela Sirigu in Lyon), or OT receptor function (Marcel Hibert in Strasbourg), they have supported the relevance of their research programs by claiming that OT is responsible for the emergence of ‘maternal feelings,’ promotes mother-infant bonding, or plays a role in ‘maternal behavior.’

The specific interests of some of those experts may explain why they brought the OT-theory forward. But the fact that they embraced it despite its remarkably weak scientific support deserves additional explanation.

#### *Possible Deciding Factors of a Collective Delusion*

It is obviously important that OT’s reputation as psychotropic substance has been co-constructed by several research fields with frequently overstated or biased references to previous findings. The fact that Thomas Insel, best known for his research on the implication of OT and vasopressin in social behaviors, has been directing the US National Institute of Mental Health from 2002, may also have been an incentive. The uncritical dissemination of the OT-theory in French media has doubtless been further fostered by structural defects in science journalism. But when analyzing the context of its emergence and comparing its spreading to other scientific theories, it seems that some characteristics have been key elements in its success among experts, journalists, and the general public.

First of all, the OT-theory is simple and consistent with common sense as well as with old scholarly myths. It conveniently explains the feelings expressed by a number of mothers, and ties in with the common psychoanalysis-based notion that women’s psyche and the experience of pregnancy make them develop a unique

bond with their infant. It also seems logical from the evolutionary-psychology perspective that has become widespread since the mid 1990s: as frequently stated, since an infant has to be breast-fed by a woman, *natural selection* has 'logically' put in the same substance the power to help a woman give birth and milk and to cause her to be willing to take care of her newborn.

Beyond these aspects, several reasons for the acceptance of the OT-theory appear to be linked to the post-feminist context, defined as a set of reactions to the perceived or real (lack of) impact of second-wave feminism. One characteristic of that context is that mothers are still the main caregivers to children although they are seemingly free not to behave in this way. The OT-theory is a seductive explanation for that observation, especially since many experts endorsing it are women and even self-identified feminists, or men apparently wanting 'women's weal' like Odent: as such, they seem above the suspicion that they might be acting against women's empowerment. In addition, believing that OT naturally triggers postpartum development of adequate attitudes toward the infant is a way for women to handle the pressure that is put on them through the injunction to be successful at maternity, a side-effect of the right to a 'chosen maternity' obtained in the 1970s. Indeed, it reassures mothers-to-be as regards their mothering ability, and in case they fail to feel fulfilled as mothers, invoking a biological dysfunction allows them to avoid questioning their life choices.

Another characteristic of this context is that while traditional gender roles have been widely challenged, society is still deeply gendered and heteronormative. Biology can then act as a precious anchor for masculine and feminine identities as fundamental landmarks in a gender-troubled society. OT as a cause of 'typically female' caring attitudes, symmetrical to testosterone for 'typically male' adventurous and vigorous ones, looks like an ideal candidate for providing such an anchor. Indeed, OT can be viewed as the essence of femininity without precisely defining a place for women, as a psychoactive fluid that induces a certain mood or propensity without determining specific behaviors. And this essence is

associated with only positive dispositions and skills, in contrast to ovarian hormones which are believed to be involved in troubles such as mood disorders, anorexia, or over-sensitivity to pain. Besides, since OT is also present in men and widely varies both inter- and intra-individually, it does not relentlessly assign childcare as 'natural destiny' to all women, and to women only, and for their whole life after they have given birth. OT thus can serve as a positive and relatively supple biological anchor for femininity, compatible with women being more or less 'feminine' as well as with men having a so-called 'feminine side.' It contrasts with the somewhat repelling notions generally attached to genes: human beings like 'programmed' machines, and a strict categorization of individuals based on their genotype. In this way, the OT-based theory of 'maternal instinct' participates in the *hormones mystique* which is at the heart of the mainstream conception of gender as biologically rooted phenomenon, and which more generally seems to take precedence over the *DNA mystique*, at least in France.

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