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Running head: Long term consequences on normal young adults' core beliefs and brain functioning due to received parenting.

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Abstract

This study investigated whether parental behavior can have long term influences on children's brain and mental development.

To investigate the long term effects of parental behavior, a questionnaire was used among 49 normal young adults (mean age 22.3 years) to measure representations about their mother's and father's behavior, conceptualized as in whether or not the parents met certain needs during participants' childhood. With another questionnaire the young adults' core beliefs were measured, thus what the participants believed about themselves. MRI scanning was used to see whether people who report more negative on their parents than others, have different gray matter densities in areas throughout the brain.

The results show that when people report that there was a lack of meeting emotional needs by their mother and father during childhood, this leads to self-defeating core beliefs later in life. However, maternal behavior seems to be a more important influence to the adults' core beliefs, than paternal behavior. Further, adults who report more negatively on their mother's behavior show alternate formations in gray matter volume of certain areas in the brain: anterior medial temporal, parahippocampal gyrus, cerebellum, PMA, occipital and frontal pole areas. These affected areas are associated with information integration and emotional semantic processing, as well as a past and future thinking.

We concluded that parental behavior that fails meeting important emotional needs of children, can be viewed as the origin of certain self-defeating core beliefs, and have an influence on brain functioning. Because the effects were found in young adults, we may say that the early childhood experiences with primary caregivers have long term mental and neurological effects.

Introduction

Early in life, children's bond and interactions with primary caregivers serve as the basis for mental models about the self and other people (Bretherton, 1985; Bowlby & Ainsworth, 1992; Cichetti & Toth, 1995). Theories about the influence of caregivers on children's view about themselves and others are set by attachment theorists and psychoanalysts and were greatly concerned with the relationship between outer reality and individual's inner world. As Craik (1943) states:

> 'Thought models, or parallels, reality… If the organism carries a 'small-scale-model' of external reality and of its own possible actions within its head, it is able to try out various alternatives, conclude which is the best of them, react to future situations before they arise, and utilize the knowledge of past events in dealing with the present future...' (p.61)

Research shows that a child's mental development is influenced by the security of the bond with its caregivers, their caregivers'

ability to meet the child's needs, and the way the environment serves as a model for expressing emotions. Having these experiences or not, appears to have consequences for children's self-definition, self-worth, their emotion regulation and even moral development and empathy (Warren, Huston, Egeland, and Sroufe, 1997; Muris, Meesters and Van den Berg, 2003; Lafreniere et al., 2006; Allen et al., 1998; Bretherton & Munholland, 1999; Thompson, 1994; Laible & Thompson, 2000). It can thus be concluded that experiences of a child with caregivers' parenting behavior has an effect on the way he or she will perceive him or herself and others, and this is supposedly because of developed internal working models.

Sheffield et al. (2006) were the first to actually investigate the direct relationship between parenting behavior and the development of internal working models. They measured among a large group of young adults the validity of two by Young (1998) constructed questionnaires, which were originally designed for use in cognitive therapy. Young uses for one questionnaire the term 'core beliefs' to refer to the concept of internal working models that are linked to parenting behavior during childhood. He states that core beliefs are convictions about the self that are repeatedly thought throughout ones life. For parenting behavior, he based a second questionnaire on the idea that core beliefs can be related to basic emotional needs (Harris & Curtin, 2002; Leung, Thomas, & Waller, 2000; Shah & Waller, 2000). The results of this study show that there is indeed a relationship between adults' core beliefs and report about their parents' behavior, in a way that having maladaptive core beliefs could predict that the parents of the participants failed to have met basic emotional needs during their childhood. They also found through factor analyses that there are, as Young proposed, different types of core beliefs that can be linked to different kinds of received parenting.

In this study, we will also refer to a child's basic emotional needs when we talk about the aim of parenting. We will then investigate its predictability in the development of core beliefs. The idea of measuring core beliefs in young adults and trying to predict them based on early experiences with caregivers' behavior is very insightful when you try to think about possible long term effects of parenting on psychopathology or overall personality development. In fact, it would be even more informative to investigate whether or not meeting emotional needs of children has an influence on their long term brain development.

To explain why there would be reason to believe a relationship between brain development and early social life experiences, we can review research in which has been found that environmental influences affect the growth and survival of nerve cells and connections between them. Joseph (1992; 1998) was the first to theorize that there is, as in animals, also in humans a correspondence between phases of social emotional development, e.g. the formation of loving attachments and maturation of brain areas. In animals and humans, these brain areas are mainly the limbic system, i.e. amygdala, septal nuclei and cingulate gyrus. In addition for humans, healthy social emotional development also involves maturation of the orbital frontal lobes, which are an evolutionary derivative of limbic system's amygdala and cingulate gyrus.

It is important to realize that in order to develop normally, these limbic system nuclei, as well as the later to mature neocortex, require considerable social, emotional, perceptual, and cognitive stimulation during the first several months and years of life. Thus, differences in environmental stimuli can result in alternate brain maturation, which shapes the behavior of the child when it grows older.

To explain how the environment makes the development of brain areas go awry, we draw to the notion that norepinephrine (NE) neurotransmitters may decrease in response to even mildly adverse early experiences (including temporary separation from the mother (Joseph, 1979)). For NE serves a neuronal protective function and promotes maturation, depletion may lead to the formation of abnormal neural networks (Joseph, 1999). As a consequence, tendencies for displaying behavioral problems during social situations could be the result from a formed abnormal network between the amygdala, cingulate gyrus, septal nuclei, hypocampus, hypothalamus, pituitary and (orbito-)frontal regions.

To illustrate, lesions in limbic system areas involved in the formation of attachment are behaviorally noticeable in fear, disability to identify motivational and social-emotional nuances, social bullying, disability of emotion regulation or acting in an appropriate emotional fashion, isolation seeking and social withdrawal (LeDoux, 1992; Halgren, 1996; Izard & Harris, 1999). Further, Rots et al. (1996) found that maternal separation among rats and enduring stress were related to increased levels of stress hormones, which resulted in dysfunction of the hippocampus, hypothalamus and pituitary.

To illustrate more, particularly important for mastering complex human social interaction is a normally developed internal emotion regulation system. This system involves connections between visceral nuclei, the amygdale, cingulate gyrus and the orbito-frontal cortex. For complex social interaction, especially the connections to the cingulate gyrus and higher order orbito-frontal lobe are important, as these areas allow us to make rapid and subtle changes in our heart rate and breath, as we create social contact. Such immediate changes correlate with approach or distancing social behavior. However, an excessively intense and prolonged reaction to stress results in chemicals being mobilized for the defence reaction, and not to fine-tuned higher order social behavior. The disadvantage is that the chemical mechanism for defence does not stop as rapidly as the neuronal, higher order mechanism. Thus, the over sensitized fight or flight system creates a response that hampers a normal social and psychological reaction to the environment. Although we are not sure in what way young adults' experi-

ences with his or her caregivers' behavior has shaped their brain, we do think it is possible. There is reason to believe that care-giving behavior is so important for long term personality development, because it can affect brain and mental development simultaneously.

Assuming that caregivers are not all equally capable to meet emotional needs of children, finding differences between adults when investigating their mental and brain development based on their early childhood experiences will be possible. Keeping this in mind, this study will address the following hypothesis:

When certain needs were not met in childhood, adults also report high on maladaptive core beliefs that lead to unhealthy life patterns. We expect to find that the representations will be statistically predictive to the unhealthy core beliefs.
The relationships with the mother and the father separately produce differential outcomes (Carranza & Kilmann, 2000).
The density of nerve cells in brain regions differs for adults who report more negatively on representations about their parents' behavior.

Method

Participants

A group of 80 normal Dutch psychology students of the University of Amsterdam was scanned using a 3T Philips Intera MRI scanner with a 6 channel head coil. Two high resolution scans (3D T1, Turbo Field Echo, TE 4.6 ms, TR 9.6 ms, FA 8°, 182 sagittal slices of 1.2 mm, FOV 2502 mm, reconstruction matrix 2562) were recorded of the brain, while the participants were watching a movie.

Two years later, 49 people were found being willing to participate in completing questionnaires for this study. The mean age of the group was by this time 22.29 (*SD* = 1.87) and consists of 34 women. The participants filled in the questionnaires in groups of maximum 4 people at the time, which took them on average 45 minutes. Thirteen people requested to digitally receive the questionnaires at home, and sent a completed score form back through e-mail. Although the questionnaires are originally in English and have not been translated, all participants master English sufficiently well to study psychology at degree level, and have been asked after completion whether they had difficulties with the language, which none of them reported. Also after the survey, all participants received 14 Euros.

Materials and procedures
Core Beliefs

For the investigation of the young adults' core beliefs, the short version of the Young Schema Questionnaire (YSQ-Short) (Young, 1998) was used. This is a 75-item self-report questionnaire, which examines maladaptive, or negative, beliefs of a person that he or she repeatedly think throughout life.

The items of the YSQ-S are grouped into 15 scales. For example, the following items measure together the scale 'Dependence/ Incompetence': 'I do not feel capable of getting by on my own in everyday life', ´I think of myself as a dependent person, when it comes to everyday functioning´, ´I lack common sense', 'My judgment cannot be relied upon in everyday situations' and 'I don't feel confident about my ability to solve everyday problems that come up'.

Received Parenting

The Young Parenting Inventory (YPI) (Young, 1998) has been used to measure representations about mother's and father's behavior separately during childhood. This questionnaire consists of 72 items and 17 scales for mother and father respectively.

For example, the following statements about mother and father measure together the scale 'Dependence/ Incompetence': My mother and father 'made me feel I couldn't rely on my decisions or judgment', 'did too many things for me instead of letting me do things on my own', and 'treated me as if I were younger than I really was'.

When the two questionnaires are used together, one is able to identify the most likely origins of core beliefs for a particular person. Basically, the questions of the YPI relate to basic emotional needs of a child that have not been met by the parents, and this ultimately results in negative convictions of the child about him or herself, as measured by the YSQ-S.

The best way to link the two questionnaires, is by grouping the scales of YPI and YSQ-S, and by doing so, narrowing down to 5 main domains (see below). Whereas the topics of the domains are the same for both YPI and YSQ-S, the YSQ-S measures these domains in the form of asking about maladaptive core belief, and the 5 domains of the YPI relate to parenting behavior that did not meet basic emotional needs of a child. This means that the questionnaires are constructed in such a way that the only difference is how the questions are posed (see above for the examples).

The domains of the questionnaires are (Young, 1999):

1. Disconnection and rejection. Expectation that one's needs for security, safety, stability, nurturance, empathy, sharing of feelings, acceptance, and respect will not be met in a predictable manner. Typical family origin is detached, cold, rejecting, withholding, lonely, explosive, unpredictable, or abusive.
2. Impaired autonomy and performance. Expectations about oneself and the environment that interfere with one's perceived ability to separate, survive, function independently, or perform successfully. Typical family origin is enmeshed, undermining of child's confidence, overprotective, or failing to reinforce child for performing competently outside the family.

3. Other-directedness. An excessive focus on the desires, feelings, and responses of others, at the expense of one's own needs -- in order to gain love and approval, maintain one's sense of connection, or avoid retaliation. Usually involves suppression and lack of awareness regarding one's own anger and natural inclinations. Typical family origin is based on conditional acceptance: children must suppress important aspects of themselves in order to gain love, attention, and approval. In many such families, the parents' emotional needs and desires -- or social acceptance and status -- are valued more than the unique needs and feelings of each child.
4. Overvigilance and inhibition. Excessive emphasis on suppressing one's spontaneous feelings, impulses, and choices OR on meeting rigid, internalized rules and expectations about performance and ethical behavior -- often at the expense of happiness, self-expression, relaxation, close relationships, or health. Typical family origin is grim, demanding, and sometimes punitive: performance, duty, perfectionism, following rules, hiding emotions, and avoiding mistakes predominates over pleasure, joy, and relaxation. There is usually an undercurrent of pessimism and worry---that things could fall apart if one fails to be vigilant and careful at all times.
5. Impaired limits. Deficiency in internal limits, responsibility to others, or long-term goal-orientation. Leads to difficulty respecting the rights of others, cooperating with others, making commitments, or setting and meeting realistic personal goals. Typical family origin is characterized by permissiveness, overindulgence, lack of direction, or a sense of superiority -- rather than appropriate confrontation, discipline, and limits in relation to taking responsibility, cooperating in a reciprocal manner, and setting goals. In some cases, child may not have been pushed to tolerate normal levels of discomfort, or may not have been given adequate supervision, direction, or guidance.

Scoring

The participant can score each item of the YSQ-S and YPI on a six point scale, with high scores reflecting unhealthy, maladaptive core beliefs, and parenting that failed meeting the person's needs as a child. Only the extremely high item scores (i.e. score 5 or 6) are picked out for further investigation.

Then, the questions are grouped to arrive at 15-17 scales. The importance of each scale for a particular person is simply determined by how many items of the scale have an extremely high score. Thus, for example the scale emotional deprivation will have a score of 2 when 2 questions in this scale have been reported with either a 5 or 6.

Finally, the scales are grouped to arrive at 5 domains. The importance of each domain for a particular person is simply determined by summing the previously calculated numbers of the scales that together form the domain. Although some items in the scales of the YPI and YSQ-S are not equally devided, the scales and domains of both questionnaires have been found to correspond well to each other (Young, 1998; Sheffield, 2006).

Reliability

The YSQ-S and YPI have been demonstrated to have good clinical and empirical reliability and validity, with support for the hypothesized scales and domains (Cecero et al., 2004; Welburn et al., 2002). In addition, due to good construct validity shown by its ability to predict psychopathological and psychiatric symptoms (Welburn et al., 2002), the YSQ-S is also used in non-clinical groups (Cecero et al., 2004; Waller et al., 2001).

In this study, the reliability of the YSQ-S is .70 on domain level, and for the YPI .80 on domains about the representations of mother's behavior and merely .54 on father's behavior. According to the results, we will attempt to theorize whether the latter is an issue. Although the reliability on item level for all three questionnaires is higher, we direct ourselves to the reduction of data in domains, because the analyses will be easier to interpret. In addition, for the brain analyses it is required to have as less predictive variables as possible, which is why we will carry out a component factor analyses on the clusters, to see if we can even derive to one single factor for mother's and father's behavior separately.

Statistical methods

To establish whether or not core beliefs can be predicted by parents' behavior, we carried out a series of exploratory multiple regression analyses. Stepwise methods were used, as these are suited to exploratory model building (Field, 2000), and allow us to establish which set of origins explains the greatest amount of variance in the core beliefs measures.

To justify regression, one has to ensure that the assumptions of regression are not violated. We therefore assessed the inter-correlations between the parental behavior scales, and between the core belief scales. Whilst the scales of the questionnaires were often significantly correlated with one another, no correlation coefficient was greater than 0.7, a cut-off point recommended for tolerance within regression analysis (Field, 2000).

Further, by calculating the partial correlations, we controlled for paternal behavior when predicting core beliefs based on behavior of mothers. Hereby we can show whether there is indeed a separate influence of mothers and fathers on core beliefs.

Further, we carried out a Mann-Whitney test to establish if there are gender differences when people report on their mother, father and their core beliefs.

Brain imaging

Voxel-based morphometry analyses were carried out with FSL-VBM, which is part of the FSL package (Smith *et al.*, 2004). For the analyses, two independent VBM sets were generated; the first consisted of all the first T1 scans, and the second set consisted of all the second T1 scans. For the analyses, we arrived at a number of 42 participants after excluding some participants who did not have a second brain scanning, which we used to compare the significant brain regions of the first set of scannings to.

Data preprocessing consisted of brain extraction using BET (Smith, 2002), averaging of the two co registered images per participant, segmentation of the resulting brain-only images using FAST4 (Zhang *et al.*, 2001), alignment to standard space, and nonlinear registration. All images were averaged in a single file, to which the original gray matter images were re-registered. The registered images were modulated by dividing the Jacobian of the warp field and smoothed using a Gaussian kernel of 4 millimeters.

A voxelwise General Linear Model (GLM) analysis was conducted using permutation-based non-parametric testing on the first VBM set using the demeaned maternal factor. This factor was established by conducting a component factor analysis on the 5 domains of representations about maternal behavior, which resulted in one single factor. The GLM analysis resulted in depiction of anterior medial temporal and parahippocampal gyrus, cerebellum, PMA, occipital and frontal pole areas.

Next, clusters were extracted from the voxel-based thresholded positive and negative t-statistic images using cortical and subcortical masks. Subcortical regions were extracted using a minimum cluster size of 50 voxels (p threshold <.01) and cortical regions were extracted with a minimum cluster size of 100 voxels (p threshold <.01). These regions served as weighted masks to extract individual gray matter values from the second set.

The resulting gray matter values were used to correlate back to the questionnaire data, i.e. the 5 domains that measure mother's behavior. Herewith we test our hypothesis that maternal behavior that fails to meet emotional needs of a child will be statistically predictive to the amount of gray matter density in previously mentioned depicted brain areas. Note that this means that we do not have subgroup comparisons, but a continuous scale for assessing the relationship.

Results

Descriptive Statistics

5 participants could not report on their father, which leaves us with missing data and a smaller sample size for assessing paternal behavior. The rest of the data contained no missing values.

In order to assess whether we can use male and female reports equally when conducting analyses the Mann-Whitney test will show if there are gender influences when people report on their core beliefs, mother's behavior and father's behavior. There was a significant difference between male and female report on only one scale. That is, women report more than men that their mother have unrelenting standards $t(49) = -2.01$, $p = .05$. Since this effect is only just significant, we will report on the group as a whole.

Table 1 gives the mean and standard deviation scores of the domains on paternal behavior, maternal behavior, and core beliefs.

TABLE 1. Mean and standard deviation scores of domains for negative representations on mother and father components as measured by the YPI (Young, 1999), and unhealthy core beliefs measured by the YSQ-S (Young, 1999).

	Mean	Standard deviation
Domains		
YPI		
Mother (N=49)		
Disconnection and rejection	53	2.1
Impaired autonomy and performance	1.00	1.8
Other directedness	1.16	1.5
Overviligance and inhibition	2.73	3.4
Impaired limits	.43	.9
Father (N=44)		
Disconnection and rejection	.25	.5
Impaired autonomy and performance	.43	.8

Other directedness	.75	1.0
Overviligance and inhibition	.27	2.5
Impaired limits	.45	.9
YSC-S		
Core beliefs (N=49)		
Disconnection and rejection	.79	2.1
Impaired autonomy and performance	.18	.6
Other directedness	.59	1.2
Overviligance and inhibition	1.12	1.8
Impaired limits	.76	1.1

The mean scores for rapport on father's behavior are quite low compared to those on mothers' behavior, indicating that the participants reported relatively more positive on their father than on their mother.

Further, the standard deviations of the domains in the father-scale are small, which indicates that people reported similarly about their father.

Prediction of Core Beliefs by Parents' Behavior during Childhood

A series of stepwise regression analyses where used to establish whether the representation of parents' behavior during childhood can predict core beliefs. For each domain of the core beliefs, we investigated which domain of parental behavior predicted the existence of it significantly (see **Table 2**).

Thus, the predictors are the representations about mother's and father's behavior during childhood, as described in the most left column. The supposed outcomes are the core beliefs, described in the second left column.

The amount of variance explained (*R*2) is presented to allow interpretation of the relative contribution of each of the origins to the explanation of variance in unhealthy beliefs.

Furthermore, the standardized regression coefficients (beta values) are provided to indicate the relationships between the standard deviations of each variable.

Prediction of core beliefs by mother's behavior

Overvigilant and inhibited mothers will raise their children to become overvigilant and inhibited as well, or on the contrary, not feeling any internal boundaries.

Meanwhile when mothers were said to not have set limits, this predicted that the adults had beliefs about oneself as being impaired in autonomy and performance.

TABLE 2. Significant predictors of core beliefs identified by 10 stepwise regression analyses.

Predictors	Outcomes	Beta	R^2	F	<p
Mother's behavior	*Core Beliefs*				
Overvigilance and inhibition	Overvigilance and inhibition	.208	.456	12.357	.001
Overvigilance and inhibition	Impaired limits	.140	.334	5.919	.019
Impaired limits	Impaired autonomy and performance	.112	.374	7.647	.008
Impaired autonomy and performance Disconnection and rejection Impaired limits	Disconnection and rejection	.645 .692 .723	.417 .479 .532	33.562 21.163 16.455	.000 .000 .000
Disconnection and rejection Impaired autonomy and performance	Other directedness	.644. 697	.414 .486	33.237 21.755	.002 .005
Father's behavior	*Core Beliefs*				

Other directedness	Overviligance and inhibition	.456	.208	12.357	.001
Other directedness	Impaired limits	.441	.194	10.118	.003
Other directedness	Impaired autonomy and performance	.409	.167	8.414	.006
Impaired limits	Disconnection and rejection	.174	.417	8.817	.005
	Other directedness				

No stimulation for autonomy and performance by the mother, together with disconnection and rejection from the mother to the child and not setting limits, predicted that the adults feel disconnected from and rejected by other people.

Finally, disconnection and rejection from mother to child, together with not stimulating autonomy and performance, predicted core beliefs about other directedness; thus being overly focused on other peoples' feelings and needs, at the expense of their own.

Prediction of core beliefs by father's behavior

Fathers that demand that the child has to suppress its own feelings and needs in order to gain his love and approval, will end up perceiving oneself as overvigilant, inhibitive, being impaired in autonomy and performance, and will have impaired internal limits.

Not setting limits by the father predicted that the adults feel disconnected and rejected by others.

Confounding factors taken into account

We arrived at a single variable for maternal behavior by simply summing up the 5 domains. As can be seen in the table, a negative representation about the mother's behavior has a significant relationship with increase in all developed unhealthy core beliefs, except for autonomy and performance.

The representation about the mother's behavior also shows a significant correlation with the participants' representation about the behavior of their father $r\,(44) = .32$, $p < .05$. However, **table 3** shows that the correlation between the mother's behavior and the development of core beliefs still is significant after controlling for the father's behavior, meaning that there is indeed a separate influence of mother and father on core beliefs, and that the questionnaire thus indeed measures two separate concepts.

Brain analyses

For several reasons, we expected we could better use a single factor about mother's behavior than father's behavior for regression analyses on VBM MRI-images. Firstly, the reliability of the questionnaire about maternal behavior is high enough, and secondly, given that the component analysis on the representations about mother's behavior resulted in one factor, and a component analysis on representations about father's behavior in two, it is more practical to use the scale on mother's behavior for brain analyses. This turned out to be an accurate choice, for when we actually did use representations about father's behavior in the GLM analysis, we did not find any influence on the depicted brain areas. Therefore we describe the influence of mother's behavior as in not succeeding to meet the emotional needs of their child on the childs' gray matter density in the brain when he/she grows older.

TABLE 3. Correlations between representations about the mother and developed core beliefs, before and after controlling for representations about father's behavior.

Variables	Core beliefs				
	Disconnection and rejection	Impaired limits	Autonomy and performance	Overvigilance and inhibition	Other directedness
Mother's behavior	.579(**)	.351(*)	.173	.409(**)	.548(**)
Mother's behavior while controlling for father's behavior	.554(*)	.326(*)	-.068	.393(*)	.568(*)

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

TABLE 4. The significant relationships between representations about mother's behavior and brain areas, after controlling for gender.

Variables	Brain areas						
	Right cerebellum	Right parahippocampal gyrus	Left parahippocampal gyrus	Right anterior middle temporal gyrus	Right LO	Left frontal pole	Right precentral gyrus
Maternal behavior	-.398*	.357*	.453*	-.592*	-.342*	-.292*	.347*

* correlation is significant at the 0.05 level (2-tailed).

Results of the regression analyses based on the computed single factor for representations about maternal behavior that fails to meet a childs' needs show significant effects on gray matter density, see **Table 4**.

A *negative* relationship was depicted in the following areas in both weighted and unweighted images: right cerebellum, right temporal/ parahippocampal gyrus, right anterior middle temporal gyrus and right lateral occiptical area. Respectively, a *positive* relationship was depicted in the left and right parahippocampal, and right precentral gyrus.

A negative correlation between maternal behavior and a brain area means that not meeting the emotional needs of children by the mother is associated with less developed nerve cells in this area. Respectively, a positive correlation between maternal behavior and a brain area means that not meeting the emotional needs of children by the mother is associated with more developed nerve cells in this area.

As can be seen, the right anterior middle temporal gyrus seems to be affected most when maternal behavior fails to meet certain emotional needs during childhood. Given that the relationship is negative, this means that it will result in long term less gray matter volume in this brain area. An image of the correlation is shown below in **Figure 2**.

Although this sounds promising, we checked beforehand whether gender is a confounding factor when correlating the computed factor for representations about maternal behavior to the statistic scores of these brain areas. The statistics showed that only after controlling for gender all associations were significant. Without controlling for gender, the factor for mother's behavior was only significantly associated with the right anterior middle temporal gyrus, and left cerebellum. This means that apparently the gender of the participants has a relationship that has to be taken into account to either the representations about mother's behavior, density in brain areas, or both.

We decided to check this. The results showed no significant relationship between the gender of the participants and the representations about their mother's behavior during childhood.

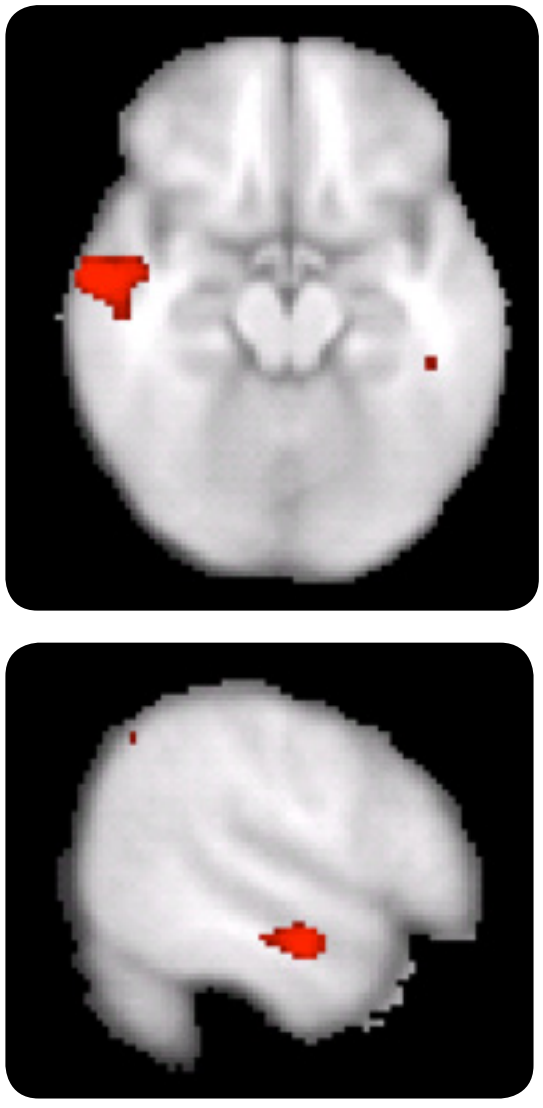

FIGURE 2. Images A and B shows a significant difference prediction of the factor about participants' representations on negative maternal behavior and gray matter density in right medial temporal gyrus.

TABLE 5. The correlations between representations about domains measuring mother's behavior and brain areas.

Variables		Brain areas						
		Right cerebellum	Right parahippocampal gyrus	Left parahippocampal gyrus	Right anterior middle temporal gyrus	Right LO	Left frontal pole	Right precentral gyrus
Maternal	Overvigilance and inhibition	-.420*	.306	.428*	-.594*	-.323*	-.302	.432
	Disconnection and rejection	-.250	.427*	.398*	-.411*	-.322*	-.227	.158
Behavior	Impaired autonomy and performance	-.238	.300	.296	-.371*	-.202	-.191	0.14
	Impaired limits	-.034	.505	.337*	-.432*	-.047	-.155	.079
	Other directedness	-.334*	.273	.331*	-.452*	-.307	-.221	.233

Then, we checked whether gender correlated with the brain areas. The results showed that gender has a significant association to right temporal/ parahippocampal gyrus $r = +.368$, $n = 42$ $p < .05$, and right lateral occiptical area $r = -.308$, $n = 42$ $p < .05$. Women apparently have more gray matter density in right temporal/ parahippocampal gyrus than men, and less in right lateral occipital area. For our further analyses, we therefore decided to keep controlling for gender.

Table 5 shows the significant associations between the 5 domains about maternal behavior and the obtained values of gray matter density in the participants' brain areas. We can see whether each domain separately is important enough to correlate with gray matter
volumes.

As can be seen in this table, overvigilance and inhibition among mothers is associated with more gray matter density in their childs' left parahippocampal gyrus and right precentral gyrus, and less density in their childs' right anterior middle temporal gyrus and right lateral occiptical area. Disconnection and rejection from mother to child results in more density in their childs' right and left parahippocampal gyrus, less density in their childs' right anterior medial temporal gyrus and right lateral occipital area. No stimulation for autonomy and performance by the mother can result in less density in their childs' right anterior medial temporal gyrus. Not setting limits by the mother is associated with the development of more gray matter density in their childs' left parahippocampal gyrus, and less density in the right anterior medial temporal gyrus. Finally, an emphasis by the mother on directing oneself to other people is associated with less gray matter volume in a persons' right cerebellum and right anterior middle temporal gyrus, and more volume in left parahippocampal gyrus.

Discussion

Experiences with caregivers and the development of core beliefs
This study provides support for the theory that children's experiences with primary caregivers influence the development of their core beliefs. Although the sample was very small compared to a previous study of Sheffield et al. (2006), who tested in a non-clinical sample of 422 students the psychometric validation of the Young Parenting Inventory and its relationship with core beliefs, the hypothesis that adults have developed self-defeating thoughts when parenting failed to meet certain emotional needs during their childhood, can be accepted based on the results.

Further, the results showed also which parenting behavior has been most influential for which core beliefs. A presumed causal relationship that states, for example, that parents who do not set limits for their child create problems for the boundaries within the child itself, cannot be demonstrated. We assume that when a child's emotional need has not been met, this can influence many internal working models. In the results can be seen that for example mothers that do not set constructive limits will have children that are more inclined to develop destructive thoughts about their own autonomy and performance. We therefore assume that children start to develop certain core beliefs not because of the content of the parenting behavior per se, but because of underlying emotional needs that are disregarded by the parenting behavior.

Given that the reports of the young adults about themselves can be linked to their early childhood experiences, we can also accept the hypothesis of a long term effect of parenting behavior. Alongside with the complexity of the causal relationships, this also implicates that there is a developmental process at work here.

Differences between father's and mother's behavior as predictors of core beliefs

The differences in the results of this study between reported father's and mother's behavior as predictors of the adults' core beliefs support our hypothesis that the relationships with mother and father separately produce differential outcomes. Apparently, fathers affect the development of self-defeating core beliefs particularly when they are conditionally accepting or loving; this appeared to be the predictor of almost all developed negative core beliefs. This behavior in mothers appeared to be the lowest predictor (it resulted in none of the core beliefs), in contrast mothers influenced the development of their childs' core beliefs with all other types of behavior.

Perhaps the underlying reason for this difference is that mothers and fathers have different roles in meeting a child's emotional needs. This can be supported by the results which show for example that setting limits by fathers is apparently internalized by children as a sign of affection, whereas when mothers set limits, besides perceiving it as a sign of affection, children also end up feeling more adequate and independent.

Additionally, seeing these results in young adults also shows that both mothers and fathers are important as a long term influence in developing mental models about oneself.

Experiences with caregivers and the development of the brain

The MRI results support the hypothesis that people who report that their mother did not meet their needs during childhood have gray matter density alternations in areas throughout their brain. This is interesting for it supports that there is reason to believe that the functionality of the brain is influenced by environmental circumstances, that is, early parent-child experiences. Investigating the influence of an early period is very important, because the brain is then developing and specializing a lot more then in later stages of development.

This study contributes also to brain research, because it is the first one that investigates the functionality of brain areas in a developmental perspective with the use of structural data, i.e. MRI analyses. However, we therefore can only base theorization about the functions of the areas that we found, on other MRI research that is directed to current, momentary brain influences and fMRI research.

We found both positive and negative correlations between maternal behavior and gray matter density. A negative correlation between maternal behavior and a brain area means that not meeting emotional needs during childhood by the mother is associated with less nerve cell density in this area. Respectively, a positive correlation between maternal behavior and a brain area means that not meeting emotional needs during childhood by the mother is associated with more nerve cell density in this area.

The area that seems to be affected the most by maternal behavior during childhood is the right anterior medial temporal gyrus, which seems to be 'thinner' in people with negative maternal experiences. fMRI studies have associated this area with emotional information processing (Okuda et al., 2003; Onitsuka et al., 2004) and semantic information This implies the capability of acquiring information across various contexts and use that across different situations; it refers to being able to notice that we share general facts and meanings with others (Tulving, 1990).

Another result that may be informative is the correlation between the anterior medial temporal gyrus and the left frontal pole. Okuda et al. (2003) found in an fMRI study that the frontal pole and the medial temporal lobes were activated during 'future and past tasks', suggesting that thinking of the future by the frontal pole is closely related to retrospective memory by the anterior medial temporal gyrus.

Further, the results show that both left and right parahippocampal gyrus, and right precentral gyrus appear to be 'thicker' in people with negative experiences with their mother's behavior during childhood. Especially the left parahippocampal gyrus seems to be effected. fMRI studies showed that the parahippocampal gyrus is associated with past memory retrieval (Okuda et al., 2003; Onitsuka et al., 2004).

The positive and negative influence by parenting behavior on gray matter density in adult brains is hard to explain. What we should keep in mind is that there is a developmental aspect involved, so investigating one point in life, for example young adulthood, cannot give a lot of clear information. For now we can therefore only conclude that there appears to be an influence, but it is difficult to fully understand.

However, little is known about the influence of parenting and parental behavior on brain development of children, so this study definitely contributes to the field of human development for it does show the possibility that functional differences in brain areas can be the result of environmental factors early in life. It gives special importance to the impact of maternal rearing behavior as being a predictor for both psychology and brain functioning later in life.

Methodological implications

One of the main limitations of this study is the size of our sample, which makes it not very easy to conclude on some aspects. For instance, the low reliability of the father-questionnaire may be due to the fact that our sample size was just too small, given that the reliability of the paternal scale in the study of Sheffield et al. (2006), who used 422 participants, was sufficiently high enough.

It may also be the case that our group of people just reported very similar about their father's behavior, resulting in a group that is not heterogeneous enough. This was the case in our

study, shown by the low standard deviations for reports on father's behavior. This means that the behavior of fathers might have a less variable influence on core beliefs than the behavior of mothers. In addition, we also did not find any influence of paternal behavior during childhood on brain development like we did for maternal behavior, which may be another indication for more importance of mothers on development over fathers.

However, we cannot conclude with certainty if the low reliability of the father-questionnaire is due to real homogeneity in the group, more importance of maternal behavior on core belief and brain development, or if the group was still just too small, given that we also even lacked in information on fathers because of missing values. We therefore highly recommend investigating the influence of paternal behavior on core beliefs and brain development again with the inclusion of more participants.

Aside from a larger sample size, another recommendation would be the inclusion of more males, to investigate gender differences in reports on experienced parental behavior during childhood. Although we did not find any gender differences in questionnaire reports, we did find an influence of gender on brain areas that are related to maternal behavior. Although it might be that the brain is simply different for males and females, we still should investigate with the inclusion of more male data whether perhaps men view their mother's behavior differently and therefore are affected differently.

Further, our sample consisted of a group of university students, which may have influenced our results. For example, the maternal scale in general (when we do not differentiate between the 5 domains of maternal behavior), has no relationship with impaired autonomy and performance among these participants. This may be due to the possibility that the parents of these participants themselves are highly educated, have a higher IQ, and a higher social economic status, which makes it plausible to think that these factors themselves have confounding effects on autonomy and performance. Therefore, there should be controls for these aspects when investigating the influence of parental behavior, or include a wider range of people with different social economic and educational backgrounds.

Finally, we should have included an instrument that supports the justification of our use of the YPI for investigating parental behavior during early childhood. Although we can conclude based on our results that the mother and father scales indeed measure two distinct concepts, a questionnaire that measures for example a personality trait to complain in general might well be used as a controlling variable to see whether this trait has had an influence to report more negatively on parental behavior.

Implications for further research

The results of this study indicate the importance of parent-child relationships for psychology and brain development later in life. However, the results of this study only give an indication of brain development and psychology at the point of young adulthood, so we re unable to conclude on why the brain or how the co0re beliefs are influenced this way. Thus, in order to fully understand the long term influence of parent-child relationships, it is necessary to start measuring this relationship from an early age onward in a longitudinal study.

In addition, the use of spontaneous fMRI can be very informative, for this method can highlight the functionality of brain networks that are highly associated to personality development (Farb et al., 2007; Fair et 0al., 2007; Buckner et al., 2008; D'Argembeau et al., 2008).

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