



**Parental Reflective Functioning and Executive Functioning
in Mothers with Substance Use Disorder**

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Parental Reflective Functioning and Executive Functioning in Mothers with Substance Use Disorder

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Competing interests

The authors declare they have no competing interests.

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Abstract

Having a substance use disorder (SUD) may adversely affect caregiving capacities. Reflective functioning (RF) and executive functioning (EF) are both important capacities for sensitive parenting, and are often impaired in a SUD. Only a few studies have explored the possible association between the two phenomena. In this study, we used a neuropsychological test battery to assess EF, and the Parent Development Interview to assess RF in a sample of mothers with a SUD ($N = 43$). Although parental RF (PRF) was associated with EF, when controlled for intelligence (IQ) and mental health, there was no significant association between EF and PRF. Mental health, however, showed a significant negative association with PRF. Splitting the group in two based on PRF level, mothers with a negative to low PRF exhibited more severe difficulties in SUD-related aspects, as well as in several EF components, compared to mothers with an adequate to high PRF, highlighting the association between EF and PRF. The results from this study contribute to enhance our understanding of the dynamics underlying vulnerability in PRF that mothers with small children may experience. We suggest EF to be a prerequisite for adequate PRF, and for interventions to be customized accordingly regarding parents with a SUD.

Keywords: parental reflective functioning, infant, maternal, executive functioning, substance use disorder

Introduction

Several studies have shown that as a group, mothers with a substance use disorder (SUD) are at risk of maladaptive parenting practices (Cash & Wilke, 2003; Mayes & Truman, 2002; Walsh, MacMillan, & Jamieson, 2003) and associated with an increased risk of child neglect and abuse (Pajulo, Suchman, Kalland, & Mayes, 2006). Maternal SUD poses a threat to the quality of sensitive parenting (Siqueland, Smith, & Moe, 2012). A sensitive caregiving environment is proposed to be essential for a healthy development of the infant brain and biological system, and consequently the development of physical, social, emotional and cognitive capacities in the child (Atkinson, Leung, Goldberg, Benoit, Poulton et al., 2009; Shonkoff, Garner, Siegel, Dobbins, Earls et al., 2012).

Mentalization is a fundamental part of sensitive caregiving (Slade, 2005), which involves the ability to understand others and oneself in terms of feelings, wishes and thoughts, in addition to the capacity to interpret mental states underlying behavioural expressions (Fonagy & Target, 1997). Although there is some support for a moderate relationship between mentalizing and intelligence (IQ) (Capstick, 2008; Steele & Steele, 2008), as well as between IQ and embodied mentalizing (Shai & Belsky, 2017), others have not found such a relationship (Grienenberger & Slade, 2002). Reflective functioning (RF) is the manifestation of the capacity to mentalize, although the terms are often used interchangeably (Suchman, Ordway, de las Heras, & McMahon, 2016). RF is an innate human characteristic (Kovács, Téglás, & Endress, 2010), though it is continuously influenced by environmental experiences (Fonagy, Target, Gergely, Allen, & Bateman, 2003), and has been associated with mental health issues (Bouchard, Target, Lecours, Fonagy, Tremblay et al., 2008; Fischer-Kern, Fonagy, Kapusta, Luyten, Boss et al., 2013).

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Parental reflective functioning (PRF) refers to a mentalizing capacity in relation to one's child, including the caregiver's capacity to recognize the child's expression and behaviour as being linked to the inner world of mental states, and as being influenced by the parents' own mental state (Slade, 2005). As a group, mothers with a SUD are often reported to have impairments in PRF, although with individual variations (Pajulo et al., 2006; Suchman, McMahon, Slade, & Luthar, 2005).

PRF can be distinguished between being average too high or negative to low, in which the latter is related to not fully realized reflective capacities (Kelly, Slade, & Grienenberger, 2005; Taubner, Horz, Fischer-Kern, Doering, Buchheim et al., 2013). Mothers with a negative to low PRF have been found to have difficulties in recognizing and processing their own and their infant's emotions, which could result in distorted reflections concerning their own parenting abilities and the infant's capabilities (Luthar & Suchman, 2000). Accordingly, there is a risk of disruptions in the dyadic communication between mother and infant, which heightens the risk of insensitive maternal behaviour such as disengagement, withdrawal, hostility and intrusiveness (Kelly et al., 2005; Levy & Truman, 2002). Vulnerability in PRF is associated with poorer psychosocial infant development (Levy, Truman, & Mayes, 2001; Lyons-Ruth, Bronfman, & Atwood, 1999). PRF is also associated with both adequate and inadequate parenting behaviour (Levy & Truman, 2002), including neglect and abuse (Fonagy, Steele, Steele, Leigh, Kennedy et al., 1995). Parenting interventions targeted towards PRF in SUD mothers are associated with an improvement in caregiving capacities (Suchman, DeCoste, Castiglioni, Legow, & Mayes, 2008).

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Maternal sensitivity also involves executive functions (EF). EF are a multi-dimensional construct involving a number of cognitive processes, such as inhibition, working memory, cognitive flexibility, planning and regulation of attention and emotion (Pennington

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5 & Ozonoff, 1996). EF are thought to be a higher level cognitive functioning involved in the
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7 control and regulation of lower level functioning such as emotional and behavioural processes
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9 (Miller & Cohen, 2001). Even though EF are related to intelligence (IQ) (Friedman &
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11 Miyake, 2017), there is a diversity in how IQ relates to different EF components. One study
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13 has shown that working memory is associated with IQ, but inhibition and cognitive flexibility
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15 are not (Friedman, Miyake, Corley, Young, DeFries et al., 2006).
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19 Disruptions in a number of EF components are frequently described in addiction
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21 research (Kalivas & Volkow, 2005). In addition, executive dysfunction can be a risk marker
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23 for SUD (Dolan, Bechara, & Nathan, 2008). Substance use is also associated with neural
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25 abnormalities in the frontal lobes, and accordingly linked to alterations in EF (Bechara,
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27 Dolan, Denburg, Hines, Anderson et al., 2001; Moreno-López, Stamatakis, Fernández-
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29 Serrano, Gómez-Río, Rodríguez-Fernández et al., 2012).
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33 High EF are associated with perceptive, responsive and flexible parenting behaviour
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35 (Galinsky, 2010; Kienhuis, Rogers, Giallo, Matthews, & Treyvaud, 2010), including
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37 supportive responses to children's emotions (Hughes & Gullone, 2010; Valiente, Lemery
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39 Chalfant, & Reiser, 2007), as well as parental sensitivity and warmth (Chico, Gonzalez, Ali,
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41 Steiner, & Fleming, 2014; Gonzalez, Jenkins, Steiner, & Fleming, 2012). Mothers with low
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43 EF are less able to manage intense emotions and tend to dysregulate in response to parental
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45 stress (Skowron & Friedlander, 1998), in addition to expressing less positive parenting
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47 behaviour (Deater-Deckard, Sewell, Petrill, & Thompson, 2010). Furthermore, weaknesses in
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49 EF are known to be related to psychological distress and mental health issues (Dvir, Ford,
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51 Hill, & Frazier, 2014; Gonzalez, 2015; Gonzalez, Atkinson, & Fleming, 2009; Leyro,
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53 Zvolensky, & Bernstein, 2010). In addition, for individuals with a previous SUD, even if there
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55 may be an improvement in EF during substance abstinence, some deficits in EF are still
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5 present, despite the actual abuse being terminated (Verdejo-García, Bechara, Recknor, &
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7 Perez-Garcia, 2006). This implies that the etiological explanation for EF difficulties may be a
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9 consequence of a SUD (Giancola & Tarter, 1999), or they may originate before the onset of
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11 the actual addiction. Accordingly, EF difficulties in parenting practices might still exist, even
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13 when the use of substances is no longer present.
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17 In summary, although they are distinct capacities, PRF and EF are both essential in
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19 sensitive caregiving (Barrett & Fleming, 2011; Slade, Belsky, Aber, & Phelps, 1999) and both
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21 capacities are found to be impaired in individuals with a SUD (Giancola & Tarter, 1999;
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23 Suchman et al., 2005). Understanding the possible relationship between PRF and EF is
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25 important, as it may have implications for the dynamic underlying difficulties in parenting
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27 capabilities in SUD mothers.
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31 To the best of our knowledge, only two previous studies have explored the possible
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33 association between maternal RF and EF, and no significant correlations between the two
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35 phenomena were found when studying a group of mothers with small children in a non-
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37 clinical population (Turner, Wittkowski, & Hare, 2008). In a similar study examining urban
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39 mothers with 9- to 12-year-old children, no associations were found between EF and PRF,
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41 even after controlling for lifetime histories of depression and substance abuse (Capstick,
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43 2008). However, several studies have identified associations between EF and a phenomenon
44
45 closely related to RF, Theory of Mind (ToM) which might help to shed light on the possible
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47 relationship between EF and RF. ToM refers to the ability to comprehend and interpret
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49 thinking and feeling in another person as intentions (Frith & Frith, 2003; Premack &
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51 Woodruff, 1978). Although similar and often used interchangeably, there are important
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53 differences between RF and ToM. ToM refers to cognitive-perceptual “cold” knowledge of
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55 mind, whereas the ability to mentalize (i.e. RF) additionally requires the activation of
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5 relational and emotional “hot” representations (Górska & Marszał, 2014; Kalbe, Grabenhorst,
6 Brand, Kessler, Hilker et al., 2007). A positive association between ToM and EF has been
7 found in non-clinical populations of children (Austin, Groppe, & Elsner, 2014; Carlson,
8 Claxton, & Moses, 2015), adolescents (Vetter, Altgassen, Phillips, Mahy, & Kliegel, 2013)
9 and adults (Apperly, Samson, & Humphreys, 2009; Bull, Phillips, & Conway, 2008), showing
10 that a well-functioning EF system is related to an effective ToM.
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19 Several clinical studies have demonstrated a relationship between deficits in ToM and
20 deficits in EF. An association between ToM and EF has been shown in autism disorders
21 (Baron-Cohen, 1995; Fisher & Happé, 2005), maternal mental illness (Rigby, Conroy, Miele-
22 Norton, Pawlby, & Happé, 2016) and in SUD populations (Sanvicente-Vieira, Romani-
23 Sponchiado, Kluwe-Schiavon, Brietzke, Araujo et al., 2017; Verdejo-Garcia, López-
24 Torrecillas, de Arcos, & Pérez-Garcia, 2005). Although there are few studies that have
25 explored the explicit relationship between RF and EF, several studies make implicit
26 inferences of possible associations, which lead us to suggest a relationship between the
27 capacities. For example, a low capacity of self- and other-reflections (i.e. RF) is associated
28 with deficits in affect regulation and flexibility (i.e. EF) in mothers with a SUD (Suchman,
29 Pajulo, DeCoste, & Mayes, 2006). Furthermore, abilities in affect regulation (i.e. EF), and
30 maternal stress tolerance (Rutherford, Booth, Luyten, Bridgett, & Mayes, 2015) are associated
31 with stability, flexibility and deficits in RF (Fonagy, Gergely, & Jurist, 2004). Also,
32 neurological studies have found that the dorsolateral prefrontal cortex is important for EF
33 (Oldrati, Patricelli, Colombo, & Antonietti, 2016), as well as being the neural circuit partly
34 responsible for mentalizing (Abu-Akel & Shamay-Tsoory, 2011). These studies makes further
35 investigation of the possible explicit association between PRF and EF in mothers with a SUD
36 relevant.
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The current study

The study consisted of two parts. In the first part, we used a correlational design to examine associations between EF and PRF in mothers with a SUD caring for small children, controlling for IQ and psychological distress. In Part 2, we split the group of mothers, and investigated whether there were differences in SUD-related factors and EF, depending on the PRF level being negative to low or adequate to high. IQ and psychological distress were included as control variables.

Part 1 - We expected that EF and PRF, respectively, would gain low scores in the population of mothers in this study compared to average scores in a normal population. We based this assumption on previous studies that found these two capacities particularly affected by SUD (Deater-Deckard, 2014; Gonzalez, 2015; Suchman, Decoste, Leigh, & Borelli, 2010). We expected to find positive correlations between PRF and EF. Based on literature concerning the relationship between SUD and EF, we predicted working memory, inhibition, cognitive flexibility, planning and fluency all to be related to low PRF (Bechara, 2005; Fernández-Serrano, Pérez-García, Perales, & Verdejo-García, 2010; Graham, 2004; Mintzer & Stitzer, 2002; Valls-Serrano, Verdejo-García, & Caracuel, 2016; Verdejo-García & Pérez-García, 2007; Vik, Cellucci, Jarchow, & Hedt, 2004). In addition, we expected IQ moderately to affect the relationship between EF and PRF (Steele et al., 2008). Based on earlier studies on emotion regulation (Rutherford et al., 2015), we also expected the level of experienced psychological distress to affect the relationship between PRF and EF.

Part 2 - In the second part of the study, we separated the group of mothers in two, based on PRF level. We expected to find differences depending on the mother exhibiting either a negative to low PRF or an adequate to high PRF. We hypothesized that preference for a specific type of substance would be associated with PRF level. We expected that mothers

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5 preferring stimulants or opioids would exhibit a lower PRF than to mothers preferring alcohol
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7 or cannabis. We based these expectations on studies showing that the severity of substance
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9 abuse is associated with PRF level (Pajulo, Pyykkönen, Kalland, Sinkkonen, Helenius et al.,
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11 2012), and an assumption that an abuse of stimulants and opioids might reflect a more definite
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13 substantial substance abuse problem, while an abuse of alcohol and cannabis may be more
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15 diverse in its severity. We also anticipated that PRF level would be related to differences in
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17 the onset of substance use, as well as onset of the SUD. We based our hypothesis on our own
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19 expectation of an association between PRF and EF and previous research showing substance
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21 use onset-age to be related to severity in EF difficulties (Gruber, Sagar, Dahlgren, Racine, &
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23 Lukas, 2012), as well as a severity in SUD (Grant & Dawson, 1998). We expected mothers
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25 with a negative to low PRF to have an earlier onset of substance use, as well as an onset of
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27 SUD, compared to mothers with an average to high PRF. Moreover, we hypothesized that
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29 mothers with a negative to low PRF would exhibit more severe deficits in EF compared to
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31 mothers with an average to high PRF.
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40 Methods

41 Participants

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43 Forty-three mothers (M age = 31 years, SD = 6.4 years, range 19 to 44) with a SUD
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45 were recruited during pregnancy or during the postpartum period. Twelve of the mothers
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47 (27.9%) were recruited from outpatient clinics, six (14.0%) from municipality health nurses
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49 and 25 (58.1%) from one of seven treatment facilities specialized in caring for pregnant
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51 women and families with small children and substance abuse problems. The recruitment
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53 period lasted for two years. The inclusion criteria were a SUD diagnosis of any severity and
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kind, whether with or without a comorbid mental illness. All the mothers were abstinent during the assessment period, but had previously been diagnosed with a SUD based on the ICD-10 classification of mental and behavioral disorders (World Health Organization, 1993). The diagnoses were confirmed by our assessments. The exclusion criteria were a full IQ below 70, multi-parity, premature birth (<32 weeks and <1500 g), or a severely ill or multi-handicapped child, whereas children with neonatal abstinence syndrome (NAS) were not excluded. For the majority of the mothers ($N = 27$), the target child was their first child. Although 16 of the mothers (37.2%) had older children, only one (2.3%) had custody of the older sibling of the target child. Siblings were either living in foster care or with their father. At assessment, the age of the target child ranged from four to 18 months ($M = 8.6$, $SD = 3.8$). There were 15 girls (34.9%), and 28 boys (65.1%). Eleven (25.6%) of the children were born with NAS and received medical intervention. During the inclusion period, 12 of the mothers (27.9%) lost daily custody of the target child.

Socio-demographic background variables. On average, participants were educated for 11.5 years (range seven to 18 years). Two participants (4.7%) did not complete primary school, and 22 (51.2%) started but did not complete high school. Six participants (14.0%) had a graduate or professional degree beyond high school. Twenty-two mothers (51.2%) did not have a partner and 13 (30.2%) had a cohabitant. One participant (2.3%) was married and seven (16.3%) had a partner who was not a cohabitant. Twenty-four mothers (55.8%) reported that the father of the child had an on going substance abuse problem, and 15 (34.9%) reported a previous, but currently abstinent substance abuse problem in the father. Four mothers (9.3%) reported that the father never had a substance abuse problem.

Measures

Socio-demographic variables and use of psychoactive substances - Substance use was registered with the *European Addiction Severity Index* (Europ-ASI) 5th edition (Kokkevi & Hartgers, 1995; McLellan, Kushner, Metzger, Peters, Smith et al., 1992), Norwegian version (Lauritzen, 2010). Europ-ASI is a semi-structured clinical interview, which consists of questions related to employment and support status, family and social relationships and legal and illegal substance use, as well as somatic and psychological issues. Reliability and validity for the Europ-ASI has been reported to be satisfactory (Kessler, Cacciola, Alterman, Faller, Souza-Formigoni et al., 2012; Kokkevi & Hartgers, 1995; McLellan et al., 1992).

Parental Reflective Function (PRF) - To assess PRF, we used the Parent Development Interview-Revised (PDI-R2) (Fonagy, Target, Steele, & Steele, 1998; Slade, Aber, Berger, Bresgi, Kaplan et al., 2003), Norwegian translation. PDI-R2 is a 20-question semi-structured interview designed to elicit narratives of parental representations. The interview addresses various themes concerning feelings, thoughts and intentions, both in the mother herself and in her child. The interview focuses on how these aspects might influence behaviour and mental processes in the person reflected upon (i.e. oneself or one's child). The PDI-R2 interview was recorded and transcribed from audio files, and the transcribed interviews were coded in accordance with guidelines for RF assessment (Fonagy et al., 1998) by an independent reliable coder who was not familiar with the respondents. A second independent rater coded 25% of the interviews for reliability purposes. There was a strong intra-class correlation between the coders ($r = .96$.) When there was a disagreement between the coders, we used the assessment from the first coder. The interviews were scored for PRF on an 11-point scale from -1 to 9, with higher scores reflecting a higher RF (Slade, Bernbach, Grienenberger, Levy, & Locker, 2005). A score of -1 indicates a negative RF and includes a violation of coherence (bizarre) or openly hostile responses. A score of 9 indicates an exceptional RF with

rich and full reflections. Although scores of 5 or above indicate a clear RF and evidence of mentalizing capacities in a normal population (Slade, 2005), in a stressed or vulnerable population, a score of 4 would constitute the average capacity (Kelly et al., 2005; Levy et al., 2001; Taubner et al., 2013). Therefore, a distinction between a negative to low PRF and an average to high PRF was set at a score of 4 in our sample. Validity for the PDI-RF is reported as being satisfactory in non-clinical populations and in populations of parents with a SUD (Levy & Truman, 2002; Slade, 2005; Slade et al., 1999).

Executive Functions (EF) - Neuropsychological measures of maternal EF included an assessment of several executive sub-functions. The raw scores were converted into t-scores. We assessed the following EF components:

Working memory - The Letter-Number Sequencing sub-test from the Wechsler Adult Intelligence Scale 4th Edition (Wechsler, 2014) was used. During this task, the participants were presented with an increasingly longer series of mixed letters and numbers at one-second intervals. The participants were required to repeat the series back to the administrator in a manner in which the numbers were presented first in order from the lowest to the highest, followed by the letters in alphabetical order. Higher raw t-scores and longer spans are consistent with a high capacity of auditory working memory.

Verbal Fluency - Two categories from the Verbal Fluency test from the Delis-Kaplan Executive Function System (D-KEFS) (Delis, Kaplan, & Kramer, 2001), Letter Fluency and Category Fluency were used to assess verbal fluency. Completion of the Letter Fluency condition required participants to say as many words as possible that started with a specific letter within in a 60-second time frame, which was done with the letters “F”, “A” and “S”. The participants were instructed that they could not use the names of people, places or numbers, and were only allowed to use each response once. Completion of the Category

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5 Fluency condition required participants to first say as many animals as possible in a 60-
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7 second time frame, and then as many boys' names as possible. Higher t-scores on these tasks
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9 are indicative of high levels of verbal fluency.
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12 **Cognitive inhibition** - The Colour-Word Interference Test, Condition 3 from the D-
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14 KEFS (Delis et al., 2001) was used to assess cognitive inhibition. Participants had to inhibit
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16 themselves from reading a colour word, and instead say the name of the colour in which the
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18 word was printed as quickly as possible. A longer time to complete the task, as well as a
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20 higher frequency of errors, indicated more difficulties with inhibition and provided a lower t-
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22 score.
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26 **Cognitive flexibility** - The inhibition-switching task in the Colour-Word Interference
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28 Test, Condition 4 from the D-KEFS (Delis et al., 2001) was used to assess cognitive
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30 flexibility. Participants were required to switch between reading the colour word and naming
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32 the colour in which the colour was printed. The time used and the numbers of errors
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34 committed during the task were measured. A longer time to complete the task, in addition to
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36 having more errors, indicated difficulties with cognitive flexibility and provided a lower t-
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38 score.
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42 **Planning** - The Tower Test (Delis et al., 2001) measures planning, rule learning and
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44 the ability to establish and maintain an instructional set. Participants were requested to place
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46 discs of varying sizes on a board with three vertical pegs in the same manner shown on a
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48 picture in front of them as effectively as possible, both regarding the number of movements
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50 and time usage. There is an increasing complexity of the test as it progresses from starting
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52 with two discs and ending with five discs. Taking a longer time to complete the task, as well
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54 as a high frequency of errors, indicated difficulties in planning and yielded a lower t-score.
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5 **Intelligence** - .The Wechsler Abbreviated Scale of Intelligence (WASI) (Wechsler,
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7 1999, 2014) measured the participants average estimated full scale IQ, verbal IQ and non-
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9 verbal IQ scores.
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12 **Mental health** - To assess mental illness, we used the diagnostic interview M.I.N.I
13 plus version 5.0.0, Norwegian version (M.I.N.I) (Mordal, Gundersen, & Bramness, 2010).
14 The instrument is a diagnostic interview related to the diagnostic criteria in DSM-IV
15 (Association, 2000) and ICD-10 (World Health Organization, 1993). M.I.N.I constitutes of 16
16 modules, and covers 27 psychiatric diagnoses. The instrument has a high inter-rater and test-
17 reliability (Rush, First, & Blacker, 2008).
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26 We used the Hopkins Symptom Checklist (HSCL-10) to measure general mental
27 health status. HSCL-10 is a self-administered questionnaire designed to measure symptoms of
28 anxiety and depression. HSCL-10 is a shortened version of the HSCL-90 (Derogatis, Lipman,
29 Rickels, Uhlenhuth, & Covi, 1974), and has satisfactory validity and reliability (Haavet,
30 Sirpal, Haugen, & Christensen, 2010; Strand, Dalgard, Tambs, & Rognerud, 2003). The
31 HSCL-10 consists of 10 items, in which responses ranges from 1 = not at all to 4 = very
32 much. The average item score is calculated by dividing the total score of the number of items
33 answered, the cut-off score of 1.85 is considered to indicate psychological distress (Strand et
34 al., 2003).
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46 **Procedures**

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48 We examined the participants at their home or in the treatment facility where they
49 were currently living. Participants were interviewed with Europ-ASI and M.I.N.I plus to
50 establish and/or confirm SUD diagnoses and mental health diagnoses according to ICD-10
51 (World Health Organization, 1993). The mothers answered the HSCL-10 questionnaire to
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5 indicate the presence of psychological distress. They were interviewed with the PDI-R2 and
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7 also completed the neuropsychological assessments. It should also be mentioned that we
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9 collected data from a large battery of measures, and only selected results are presented in this
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11 paper. The estimated time for data collection using the larger test-battery was approximately
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13 seven hours per family, and each participant met with the researcher on three to six separate
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15 occasions to complete the assessment. Each session lasted between one to two hours. A
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17 clinical psychologist (UH) supervised by a specialist in clinical neuropsychology (MØ)
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19 collected all data, with the data collection for this particular part of the test battery lasting for
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21 approximately four hours per respondent.
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24 25 26 **Ethics**

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28 The study was approved by The Norwegian Regional Committee for Medical
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30 Research Ethics in Eastern Norway (REK-Ost), and was conducted in accordance with the
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32 Helsinki Declaration of the World Medical Assembly.
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35 36 **Statistical analyses**

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38 All cases ($N = 43$) were included in the analyses and there was no missing data. In Part
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40 1 of the study, we used descriptive statistics of socio-demographic variables, substance use,
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42 PRF and EF. In addition, we calculated Pearson product moment correlations between PRF
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44 and EF for the total sample. We also conducted a Principal Component Analysis (PCA), on
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46 the EF measures and calculated the factor scores of the extracted dimensions. The criteria for
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48 the number of factors extracted were set at Eigenvalues >1 . One major factor was extracted
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50 accounting for 56.9% of the unrotated variance (Eigenvalue = 3.4). The factor loadings of the
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52 six EF components were the following: inhibition: .87; working memory: .86; cognitive
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54 flexibility: .80; planning: .79; category fluency: .57; and letter fluency: .57. To further inspect
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the links between PRF and EF, we carried out a hierarchical ordinary least square regression analysis, using PRF as the criterion variable, the EF-factor score as predictor variable and total IQ and mental health (HSCL-10) as control variables. Control variables and the predictor variable were entered in two blocks: The first block consisted of the control variables total IQ and HSCL-10. The second block consisted of the EF-factor score. This analytic strategy allowed us to see how much additional variance in PRF the EF-factor accounted for after controlling for IQ and mental health.

In Part 2 of the study, analyses were carried out to test the differences between two groups of mothers differentiated based on exhibiting an adequate to high PRF or exhibiting a negative to low PRF. We used Chi-Square analyses to test differences in reported preference of particular substances, as well as differences in report of multiple substance use in mothers with negative to low PRF and mothers with adequate to high PRF. We conducted a multiple analysis of variance (MANOVA) to test onset-age of substance use, onset-age of SUD and EF, controlling for total IQ and mental health status. All statistical analyses we carried out using IBM Statistical Package for Social Sciences (SPSS) version 24.

Results

Results Part 1

Characteristics of the respondents

Specifications for substance use, outcomes for general PRF and the results of cognitive tests, IQ tests and variables for mental health are presented in Table 1:

Insert Table 1 about here

As seen in Table 1, although 86% of mothers ($n = 37$) reported multi-substance use, all of the respondents could define a preferred substance. The most commonly preferred substances among the mothers were central stimulants and opioids. Twenty-two mothers (51%) reported injecting substances intravenously, thereby indicating a substantial substance use problem in the group. The majority of the mothers, 67% ($n = 29$) reported having had one or more serious overdoses. Eleven of the mothers (25.6%) were receiving medically assisted rehabilitation and were prescribed either Methadone or Buprenorphine, and four (9.3%) mothers were prescribed medication for Attention Deficit Hyperactivity Disorder (ADHD). Eight (18.6%) women reported regularly using other types of prescribed medications, including anxiolytics, sedatives or anti-depressants.

The majority of the mothers reported alcohol to be the first substance they used. When investigating onset-age, nearly all of the mothers 98% ($n = 42$) reported having used alcohol and cannabis, with an average onset-age of 13.1 years for alcohol and 16.2 years for cannabis. A majority of the mothers, 86%, also reported using prescribed medication illegally, with an average onset-age of 18.1 years. The average onset-age for the use of stimulants was 17.8 years, and 88.4% of the mothers reported having used the substance at one point in time. Although a majority of the mothers also reported having tried opioids (58%), this was a minor group compared to reports of usage of other substances. The onset-age for the use of opioids was also somewhat older, with an average onset-age of 20.3 years. The majority of mothers in our sample, 86.0%, reported multi-substance use.

We found a large variability in PRF scores in the group of mothers. However, scores indicated that overall PRF in the group was poor, as 74.4% of the mothers scored 3 or lower, with a mean PRF score of 2.91 ($SD = 1.17$, skewness was $-.09$). T-scores identified considerable within group variability for distinct cognitive functions. Cognitive flexibility and

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5 inhibition, and to some extent working memory, stood out as being low in our sample
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7 compared to the average scores expected within a normal population. Planning capacities,
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9 letter and category fluency were close to the expected average in a normal population,
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11 however, with a large within group variability.
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14 The mean total IQ was 94.1, with a rather large difference between verbal IQ: 89.7,
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16 and non-verbal IQ: 98.8, qualifying this group of mothers on the low end of average for
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18 verbal capacities, but on average for non-verbal capacities.
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21 The mothers in our study qualified for several SUD diagnoses, and 28 (65.1 %) of the
22
23 mothers had one or more diagnosis for mental health issues in addition to the SUD diagnosis
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25 according to ICD-10 (World Health Organization, 1993). Eight (18.6%) of the mothers
26
27 qualified for F10 (mental and behavioural disorders due to the use of alcohol), 24 (55.8%)
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29 qualified for F11, (mental and behavioural disorders due to the use of opioids). Whereas 27
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31 (62.8%) of the mothers qualified for F12 (mental and behavioural disorders due to use of
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33 cannabinoids), 58.1% ($n = 25$) had a diagnosis of mental and behavioural disorders due to the
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35 use of other stimulants, specifically amphetamines. None of the mothers qualified for any of
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37 the other SUD diagnoses.
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42 The mothers in our study qualified for numerous mental health diagnoses. During
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44 assessment with the M.I.N.I plus version 5.0.0, Norwegian version (Mordal et al., 2010),
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46 37.2% ($N = 16$) of the women reported an ongoing depression. Two (4.7%) were diagnosed
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48 with bipolar affect disorder. Twenty-six (60.5%) mothers had a panic disorder and 12 (27.9%)
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50 and 21 (48.8%) had agoraphobia and social phobia respectively. Twenty-three (53.5%) of the
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52 mothers qualified for a generalized anxiety disorder (GAD). None of the women had a
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54 schizophrenia diagnosis, while 16 (37.2%) of the women reported having an eating disorder
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56 that were either anorexia, bulimia, overeating or a combination of these. Only four (9.3%) of
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5 the mothers reported having an ADHD diagnosis. Sixteen mothers (37.2%) reported having a
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7 post-traumatic stress disorder (PTSD). As a group, the mothers reported an average score of
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9 2.5 on the HSCL-10, thus indicating a high level of current psychological distress, as shown
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11 in Table 1.
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14 See Table 2 for a presentation of inter-correlations between general PRF, EF, IQ and
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16 mental health status:
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20 *Insert Table 2 about here*
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23 There were significant positive correlations between PRF and the following items:
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25 working memory ($r = .74$), planning ($r = .63$), cognitive flexibility ($r = .58$), inhibition ($r =$
26
27 $.42$), but significant negative correlation with mental health status ($r = -.56$). We also found
28
29 moderate positive correlations between PRF and total IQ ($r = .44$), verbal IQ ($r = .41$), and
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31 non-verbal IQ ($r = .33$). Additionally, we found numerous positive significant correlations
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33 between specific EF, in which the following items correlated most highly with each other:
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35 inhibition and working memory ($r = .72$), planning and working memory ($r = .65$) and
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37 cognitive flexibility and working memory ($r = .64$). There were also significant **negative**
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39 correlations between HSCL-10 and several EF components. There were no significant
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41 correlations between PRF and verbal fluency.
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46 Table 3 presents the results of the multiple regression analysis.
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49 *Insert Table 3 about here*
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52 Total IQ and mental health explained 37% of the variance in PRF ($R^2 = .37$, adjusted
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54 $R^2 = .34$, $F = 11.8$, $df = 2$, $p < .000$). Adding the EF-score increased the explained PRF variance
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56 to 41% ($R^2 = .41$), i.e. an increase of only 4% ($\Delta R^2 = .04$), which was not significant ($F = 2.6$,
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58 $df = 1$, $p = .12$). Thus, controlled for IQ and mental health there was no significant association
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5 between EF and PRF. Mental health showed a significant negative association with PRF, that
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7 is, we found that less distress was associated with higher PRF. Therefore, it was interesting to
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9 look more closely into differences between mothers who had a negative to low PRF and
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11 mothers with an adequate to high PRF. These results are described in more detail in Part 2 of
12
13 the study.
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15 16 17 **Results for Part 2**

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19 In Table 4 we present differences in reported preference for particular substances and
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21 multiple substance use between mothers with negative to low PRF and mothers with adequate
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23 to high PRF.
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27 *Insert Table 4 about here*
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30 We found no significant differences between the groups based on a preference for any
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32 particular substance, except that mothers with a negative to low PRF were found to
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34 significantly report more frequent patterns of multiple substance abuse ($\chi^2 = 7.3$, $df = 1$, $p =$
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36 $p < .01$), compared to mothers with an adequate to high PRF.
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39 Chi-square tests were conducted to test the differences in the use of prescribed
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41 medications, including Buprenorphine, Methadone, and medication for ADHD, anxiolytics,
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43 sedatives or anti-depressants between mothers with adequate to high RF and mothers with
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45 negative to low RF. Results indicated there were no significant differences between the
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47 groups ($\chi^2 = .92$, $df = 1$, $p = .34$).
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51 In Table 5, differences between mothers with a negative to low PRF and mothers with
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53 an adequate to high PRF based on substance use onset-age and SUD onset-age are presented:
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57 *Insert Table 5 about here*
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The MANOVA analysis showed significant differences between the two groups regarding onset-age concerning all substances. Mothers with a negative to low PRF had a significantly earlier onset age of substance use of the following substances: alcohol ($F=9.1$, $df=1$, $p<.01$), prescribed medications ($F=11.0$, $df=1$, $p<.01$), cannabis ($F=8.7$, $df=1$, $p<.01$), stimulants ($F=6.0$, $df=1$, $p<.01$) and opioids ($F=7.0$, $df=1$, $p<.01$).

We also found significant age differences between the two groups when reporting the onset of problems with a particular substance at a level qualifying for a SUD diagnosis. Mothers with a negative to low PRF developed a SUD significantly earlier than mothers with an adequate to high PRF on the following substances: alcohol ($F=17.7$, $df=1$, $p<.01$), prescribed medications ($F=8.1$, $df=1$, $p<.01$), cannabis ($F=6.9$, $df=1$, $p<.01$) and opioids ($F=13.4$, $df=1$, $p<.01$), but not to stimulants.

As seen in Table 6, there were significant differences in a number of EF components when we compared mothers with a negative to low PRF to mothers with an adequate to high PRF controlling for IQ and mental health status (HSCL-10):

Insert Table 6 about here

Mothers with a negative to low PRF performed significantly poorer than mothers with an adequate to high PRF on the following EF: working memory ($F=7.3$, $df=1$, $p<.01$), cognitive flexibility ($F=4.7$, $df=1$, $p<.05$) and planning ($F=5.6$, $df=1$, $p<.05$), but not on inhibition, verbal or categorical fluency.

In summary, the findings revealed that there were several significant associations between PRF, EF, IQ and psychological distress. PRF was significantly associated with working memory, planning, cognitive flexibility and inhibition, as well as with IQ. Psychological distress was negatively associated with PRF and EF, specifically working

memory, planning, cognitive flexibility and inhibition. When we controlled for mental health status and total IQ, the association between EF and PRF was no longer significant in the mothers as a group; however, mental health showed a significant negative association with PRF. We found numerous between-group differences when we separated the group of mothers based on RF level though (negative to low vs. adequate to high), even after controlling for total IQ and mental health status. Mothers with a negative to low PRF reported a significantly earlier onset age of substance use and age of acquiring a SUD diagnosis, as well as more often reporting multiple substance abuse compared to mothers with an adequate to high PRF. Mothers with an adequate to high PRF also exhibited significantly higher scores in working memory, cognitive flexibility and planning capacities, but not in inhibition, verbal and category fluency compared to mothers with a negative to low PRF

Discussion

Part 1

Mothers in this study demonstrated a lower capacity for PRF compared to what is expected in a normal population (Fonagy & Target, 1997; Slade, 2005), and in a vulnerable or stressed population (Pajulo et al., 2012; Rutherford et al., 2015; Taubner et al., 2013). Although there were variations within the group, the mothers exhibited an average PRF score lower than 3, indicating that as a group, the ability to keep a mental model of oneself and the child in mind was poorly integrated, although not completely absent. In addition, in previous studies of SUD populations, including studies of mothers with SUD, deficits in EF are reported (Cuevas, Deater-Deckard, Kim-Spoon, Watson, Morasch et al., 2014; Deater-Deckard, 2014; Koob & Volkow, 2016; Schmidt, Pennington, Cardoos, Durazzo, &

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5 Meyerhoff, 2017). These studies support our findings of impairments in cognitive flexibility,
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7 inhibition and working memory. Contrary to our hypothesis, and previous studies in SUD
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9 populations (Fernández-Serrano et al., 2010; Verdejo-García & Pérez-García, 2007), verbal
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11 fluency and category fluency were within the normal range in the mothers in this study.
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15 Our results partly support our main hypothesis that PRF relates positively to EF. We
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17 found moderate to strong positive correlations between PRF, working memory, planning,
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19 cognitive flexibility and inhibition. In contrast to our results, previous studies have found no
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21 significant associations between PRF and EF in a normal population of mothers with infants
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23 (Turner et al., 2008), or in a sub-clinical group of mothers with older children (Capstick,
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25 2008). It is possible that the association between PRF and EF were more relevant in a clinical
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27 group like ours that exhibited considerable vulnerability in both EF and PRF. When we
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29 controlled for IQ and mental health problems, the unique contribution of EF on PRF was not
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31 significant. However, psychological distress was significantly related to PRF. In accordance
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33 with our results, previous studies have reported that psychological distress may exhaust
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35 emotion regulation capacities so that it decreases the effectiveness of EF components and PRF
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37 (Heim, Shugart, Craighead, & Nemeroff, 2010; Rutherford, Booth, Crowley, & Mayes, 2016).
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39 Psychological distress could also affect the capacity for flexible thinking and attention by
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41 impairing the capacity for perspective taking (Allen & Fonagy, 2002). Supporting our results,
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43 numerous studies have demonstrated that mental health issues adversely affect RF (Borelli,
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45 West, Decoste, & Suchman, 2012; Conklin, Bradley, & Westen, 2006; Lemma, Target, &
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47 Fonagy, 2011; Luyten, van Houdenhove, Lemma, Target, & Fonagy, 2012). Our findings
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49 indicate that psychological distress significantly influences PRF capacity in mothers with a
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51 SUD and we suggest that individual differences needs to be taken into consideration for a
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53 better understanding of the association between PRF and EF.
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Part 2.

In the second part of the study, our aim was to investigate whether differences within the group of mothers with a SUD existed based on PRF. Contrary to our hypothesis, there were no significant differences between the type of substance used and PRF level. We expected that the use of substances commonly associated with severe substance abuse (i.e. opioids and central stimulants) would be more common in the group of mothers with a negative to low PRF. A link between preferred substance and PRF level and a link between preferred substance and successful interventions targeting PRF have previously been reported (Pajulo et al., 2012). In addition, one study found an association between type of preferred substance and social cognition (Quednow, 2017), which is considered a capacity related to RF (Humfress, O'Connor, Slaughter, Target, & Fonagy, 2002). Although we did not find any significant differences in a preferred substance based on PRF level, multiple substance abuse was significantly more frequent in mothers with a negative to low PRF. It could be that a potentially more chaotic use of substances reflected PRF level more than any particular type of substance preference. Furthermore, it seems that our results are supported by a study that found an association between usage of multiple substances and impaired ToM (Sanvicente-Vieira et al., 2017). Together, our findings suggest that the group of mothers with a negative to low PRF may have had challenges in regulating complex affective states which could have contributed to the need to use many different substances simultaneously to manage arousal.

We found between group differences in PRF depending on the onset age of substance use. Mothers with a negative to low PRF started using substances significantly earlier compared to mothers with an average to high PRF. The effect was present for all substances reported in the group (e.g. alcohol, cannabis, prescribed medication, stimulants and opioids).

Moreover, mothers with a negative to low PRF developed SUD significantly earlier when reporting an addiction to alcohol, prescribed medications, cannabis and opioids, but surprisingly not to stimulants. Interestingly, the onset of a SUD was during adolescence for all types of substances for mothers with a negative to low PRF, whereas mothers with an adequate to high PRF developed a SUD in adulthood. Early onset of substance use has previously been associated with a low PRF (Suchman, McMahon, Zhang, Mayes, & Luthar, 2006). This supports our findings that onset-age may be related to PRF capacity. Furthermore, early onset-age of substance use has been suggested as a precursor of severe substance abuse, mental health problems and psychosocial adversity (DeWit, Adlaf, Offord, & Ogborne, 2000; Jordan & Andersen, 2016; Richmond-Rakerd, Slutske, Lynskey, Agrawal, Madden et al., 2016), and according to our results, possibly impaired mentalizing abilities. Multiple studies have proposed early substance use to adversely impact brain development, especially for prefrontal cortex functions (PFC) (Andersen, 2016; Lubman, Yücel, & Hall, 2007). PFC functions are important for the development of both EF (Davidson, 2001; Tekin & Cummings, 2002) and mentalizing skills (Frith & Frith, 2003; Frith & Frith, 2006; Powell, Lewis, Dunbar, García-Fiñana, & Roberts, 2010). Taken together, these findings imply that the early onset of substance use heightens the risk of an impaired development of PRF. Another possibility is that vulnerability in PRF and EF could have been present before the onset of substance use, due to either genetic factors (Richmond-Rakerd et al., 2016) or adverse childhood experiences (Anda, Felitti, & Corwin, 2014; Bick & Nelson, 2016). Some of the mothers might have been at risk for development of diverse psychological problems, including SUD (Tarter & Horner, 2015). An early onset-age of SUD may also have affected normal neuropsychological development, possibly leading to deficits in both PRF and EF. A lack of social and emotional experiences normally present in adolescence and young

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5 adulthood might have caused heightened levels of emotional dysregulation and stress, a factor
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7 known to affect both PRF (Rutherford et al., 2015) and EF (Zelazo & Cunningham, 2007).
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10 As expected, there were significantly more deficits in a number of EF components for
11 mothers with a negative to low PRF, even after controlling for psychological distress and IQ.
12 Interestingly, the mothers with an adequate to high PRF performed in accordance with
13 expected norms in a normal population on all the EF components. It appeared that when an
14 adequate EF was present, PRF and EF were well coordinated and appeared to be consistently
15 interconnected.
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24 Mothers with negative to low PRF exhibited significantly poorer capacities in working
25 memory. Working memory refers to the capacity to remain emotionally regulated when
26 processing new and unknown information, as well as integrating information from multiple
27 sources (Schmeichel, Volokhov, & Demaree, 2008). Therefore, working memory is an
28 important capacity in caregiving (Gonzalez, 2015) and emotion regulation (Rutherford et al.,
29 2016). Working memory is required for complex cognitive tasks such as reasoning and
30 problem solving (Miyake, Friedman, Emerson, Witzki, Howerter et al., 2000; Miyake &
31 Shah, 1999), and considered an essential capacity for reflective learning in childhood (Zelazo,
32 2015). We suggest the same process to be essential for the development of adequate PRF.
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45 Mothers with negative to low PRF also showed significantly more deficits in planning
46 capacities compared to mothers with adequate to high PRF. Our results support previous
47 research that have found SUD populations have impairments in planning (Carlson, Moses, &
48 Claxton, 2004). Specifically, planning in low structured situations that are highly
49 representative of everyday activities are considered particularly challenging in individuals
50 with a SUD (Janke van Holst & Schilt, 2011; Valls-Serrano et al., 2016). Deficits in planning
51 impair the capacity to prepare and organise for future events and outcomes, as well as the
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5 ability to focus. Although we could not find any studies investigating the explicit relationship
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7 between planning and RF, research on ToM suggests that planning is an essential skill for
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9 making effective reflections about oneself and others (Carlson et al., 2015; Carlson et al.,
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11 2004). Based on our results, we suggest that planning is an important component for adequate
12
13 PRF.
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17 Perspective taking is an essential capacity for adequate EF (Bradford, Jentzsch, &
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19 Gomez, 2015; Decety & Jackson, 2004). Our results indicate that mothers with adequate to
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21 high PRF had significantly higher cognitive flexibility capacities compared to mothers with
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23 negative to low PRF. These results support studies that have found deficits in perspective
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25 taking to be negatively related to cognitive flexibility (Carlson et al., 2015; Stuss & Knight,
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27 2002; Wunderli, Vonmoos, Niedecker, Hulka, Preller et al., 2016). Individuals easily
28
29 distracted by stimuli have been found to exhibit deficits in attributing complex emotional and
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31 motivational states to others (Decety & Sommerville, 2003). According to our results, the
32
33 capacity to maintain attentional control and ability to shift focus are functions necessary for
34
35 adequate PRF. Indeed, the capacity to mentalize requires the individual to be regulated
36
37 emotionally and attentively, in a manner that allows for perspective taking (Allen, Fonagy, &
38
39 Bateman, 2008) and impairments in these regulatory capacities have been associated with
40
41 deficits in EF (Hofmann, Schmeichel, & Baddeley, 2012; Zelazo & Cunningham, 2007).
42
43 Difficulties in controlling and regulating emotions have also been proposed to be a core
44
45 component of SUD (Schore, 2005), and in a low RF (Fonagy et al., 2004). Studies have
46
47 shown that parents with a SUD struggle to conceptualise and experience their own emotions
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49 while simultaneously reflecting about the mental states of the child (Neger & Prinz, 2015;
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51 Slade, Grienenberger, Bernbach, Levy, & Locker, 2005). We suggest that psychological
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53 distress, non-reflective habitual responses or emotional dysregulation might overrule EF,
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5 thereby having a negative effect on the PRF seen in the group of mothers with negative to low
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7 PRF in this study. Therefore, it could be that SUD mothers with adequate to high PRF may
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9 have a more sophisticated EF system.
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11 12 13 14 15 **Limitations**

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18 Although robust findings, the results should be considered preliminary due to sample
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20 size. Replication studies should include a control group and a larger number of respondents to
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22 help strengthen the power of analysis. Furthermore, as an exploratory analysis/study we
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24 predominately conducted correlations and regression analysis to analyse the data and
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26 therefore determining causality between variables is limited. It remains unclear whether the
27
28 effects seen are a product of a SUD, or whether pre-existing or comorbid factors explain the
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30 variation and associations between PRF and EF. Although we attempted to control for mental
31
32 health by including HSCL-10 in our analyses, our results could have been due to underlying
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34 mental health issues commonly reported to be comorbid with SUD (Choi & Ryan, 2007;
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36 Miles, Svikis, Kulstad, & Haug, 2001). Mothers with SUD have a significant heightened
37
38 occurrence of early childhood and lifetime trauma, including neglect and abuse (Ashley,
39
40 Marsden, & Brady, 2003; Wilsnack, Vogeltanz, Klassen, & Harris, 1997), and these factors/
41
42 experiences are known to affect EF (Teicher & Samson, 2016), RF (Nazarov, Frewen, Parlar,
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44 Oremus, MacQueen et al., 2014) as well as SUD (Cecil, Viding, Fearon, Glaser, & McCrory,
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46 2017). Even though we reported a high prevalence of PTSD, the dynamics underlying the
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48 possible developmental trauma is not thoroughly investigated in the current study. These
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50 issues raised should be considered for future research.
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55 56 57 **Clinical implications**

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5 Resiliency studies strongly suggest the importance of individually adjusted
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7 interventions to help address maternal functioning in clinical populations (Luthar, 2015;
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9 Rutherford et al., 2015). Based on our results, we suggest EF and PRF to be related
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11 phenomena in mothers with negative to low PRF and EF and in mothers with adequate
12
13 capacities. The relationship between the two phenomena needs to be taken into consideration
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15 when trying to understand the possible challenges a certain group of mothers with a SUD may
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17 experience in parenting. The enhancement of PRF in mothers with a SUD has been found to
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19 be effective for improving parenting capabilities and preventing child neglect and abuse
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21 (Pajulo et al., 2012; Suchman, DeCoste, Ordway, & Mayes, 2012). Even so, a group of
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23 mothers with a low PRF and deficits in EF might not benefit on commonly used intervention
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25 strategies. We suggest that the group of mothers with deficits in PRF and EF would benefit
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27 from interventions customized to improve selective executive capacities as a prerequisite to
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29 enhance poor PRF. Mothers with a SUD are a stigmatized group often considered
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31 homogenous and difficult to offer appropriate interventions. This study contributes to an
32
33 understanding of the importance of individually customized interventions and how these
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35 could be carried out more effectively. It is of further interest to consider how capacities,
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37 deficits and the relationship between PRF and EF seen in this study may affect the
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39 relationship between mother and child, and how adjustments in interventions can help
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41 strengthen these capacities.
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Tables

Table 1

Descriptive Statistics of Substance Use, Parental Reflective Functioning, Performance on Cognitive Tests presented by T-scores, IQ and mental health status

Variable	M	SD	%	N	Range
Preferred Substance ^{a)}					
Central Stimulant			37.2	16	
Opioids			32.6	14	
Alcohol			16.3	7	
Cannabis			14.0	6	
Simultaneous use of several substances ^{a)}			86.0	37	
Injecting substances ^{a)}			51.2	22	
Overdoses in life ^{a)}					
0			32.6	14	
1-5			48.9	21	
>5			18.5	8	
Prescribed Medications ^{a)}					
Medically Assisted Rehabilitation			25.6	11	
Medication for ADHD			9.3	4	
Other			18.6	8	
Debut age of substance use and report of ever having used a specific substance for intoxication ^{a)}					
Alcohol	13.1	2.2	97.7	42	5-19
Prescribed Medications	18.1	5.8	86.0	37	2-36
Cannabis	16.2	4.4	97.7	42	12-36
Central Stimulants	17.8	4.4	88.4	38	14-36

Opioids	20.3	6.0	58.1	25	12-36
Multiple Substances	18.4	4.8	86.0	37	12-36
Parental Reflective Functioning ^{b)}					
General RF	2.91	1.71			0-6
Performance on Cognitive tests					
Working Memory ^{c)}					
Letter-Number	41.2	8.8			25-65
Inhibition ^{d)}	39.8	11.3			20-65
Cognitive Flexibility ^{d)}	35.2	11.4			20-63
Verbal Fluency ^{e)}					
Letter Fluency	48.4	11.4			21-70
Category Fluency	59.0	11.4			30-80
Planning ^{f)}					
Tower	45.1	6.5			30-59
IQ ^{g)}					
Verbal IQ	89.7	17.1			55-127
Non-verbal IQ	98.8	14.0			74-132
Total IQ	94.1	14.6			71-125
Mental health ^{h)}					
SCL-10	2.5	0.6			1.3-3.5

a) European Addiction Severity Index (Europ-ASI), 5th edition

b) Parental Development Interview - Revised, Reflective Functioning Scale

c) Letter-Number Sequencing sub-test in the Wechsler Adult Intelligence Scale, 4th Edition

d) Colour-Word Interference Test, Conditions 3 and 4 from Delis-Kaplan Executive Function System (D-KEFS)

e) Verbal fluency test from Delis-Kaplan Executive Function System (D-KEFS)

f) Tower Test from Delis-Kaplan Executive Function System (D-KEFS)

g) Wechsler Abbreviated Scale of Intelligence (WASI)

h) Hopkins Symptom Checklist (SCL-10)

Table 2
 Correlation coefficients between Parental Reflective Functioning (item 1), measures of Executive Functions (items 2-7), IQ (items 8-10) and mental health status (item 11)

Functions	1	2	3	4	5	6	7	8	9	10
1 Reflective Functioning										
2 Working memory ^{b)}	.74**									
3 Inhibition ^{c)}	.42**	.72**								
4 Cognitive Flexibility ^{c)}	.58**	.64**	.64**							
5 Planning ^{d)}	.63**	.65**	.61**	.61**						
6 Letter Fluency ^{e)}	.01	.34*	.44**	.41**	.19					
7 Category Fluency ^{e)}	.03	.39*	.42**	.22	.37*	.36*				
8 Verbal IQ ^{f)}	.41**	.62**	.45**	.47**	.44**	.48**	.38**			
9 Non-verbal IQ ^{f)}	.33**	.60**	.51**	.47**	.53**	.46**	.34*	.56**		
10 Total IQ ^{f)}	.44**	.69**	.56**	.55**	.54**	.59**	.41**	.90**	.83**	
11. HSCL-10 ^{g)}	-.56**	-.61**	-.48**	-.57**	-.53**	-.10	-.26	-.29	-.38*	-.38*

*p < .05., **p < .01.

a) Parental Development Interview - Revised, Reflective Functioning Scale

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f) Wechsler Abbreviated Scale of Intelligence (WASI)

g) Hopkins Symptom Checklist (SCL-10)

Table 3
 Multiple regression Analyses for Executive Functioning
 predicting Reflective Functioning controlled for total IQ
 and mental health status (HSCL-10)

Variable	B	SE B	β	t	Sig
Total IQ	.01	.02	.07	.04	NS
HSCL-10	-.63	.29	-.33	-2.2	*
EF-factor	.39	.25	.33	1.6	NS

* $p < .05$. ** $p < .01$. NS = No significant results
 N=43

Table 4

Differences in psychoactive substance use between mothers with an adequate to high Parental Reflective Functioning and mothers with a negative to low Parental Reflective Functioning; Chi square analyses

Substance ^{b)}	Adequate to High RF ^{a)}		Negative to Low RF ^{a)}		Sig.
	N:11		N:32		
	N	%	N	%	
Alcohol	4	36.5	14	48.3	NS
Cannabis	7	63.6	28	87.5	NS
Central Stimulants	6	54.5	25	78.1	NS
Opioids	4	36.4	16	50.0	NS
Multiple Substances	5	45.5	27	84.4	**

N=43, ** = $p < .01$, * = $p < .05$, ns = no significant differences.

a) Parental Development Interview - Revised, Reflective Functioning Scale

b) European Addiction Severity Index (Europ-ASI), 5th edition

Table 5

Differences in reported substance use debut age and age of SUD onset between average to high Parental Reflective Functioning and negative to low Parental Reflective Functioning; controlling for total IQ and mental health status (HSCL-10); Multiple Analysis of Variance (MANOVA)

Substance ^{b)}	Adequate-High RF ^{a)}		Negative-Low RF ^{a)}		Sig.
	N: 11		N: 32		
	Mean	SD	Mean	SD	
Debut					
Alcohol	14.8	1.9	12.6	2.1	**
Prescribes Medications	23.9	6.1	16.7	4.9	**
Cannabis	19.5	6.5	15.2	3.0	**
Central Stimulants	20.8	6.6	16.9	3.1	*
Opioids	26.8	7.0	18.0	5.0	*
Multiple Substances	17.0	8.1	15.2	6.7	NS
SUD					
Alcohol	24.8	7.9	15.4	2.2	**
Prescribed Medications	24.0	5.5	19.0	3.4	**
Cannabis	22.6	7.0	17.8	3.5	*
Central Stimulants	21.3	7.4	18.5	3.2	NS
Opioids	27.3	6.3	18.8	3.5	**
Multiple Substances	23.3	7.1	18.4	3.1	*

N=43, ** = p<.01, * = p<.05, ns = no significant differences.

a) Parental Development Interview - Revised, Reflective Functioning Scale

b) European Addiction Severity Index (Europ-ASI), 5th edition

Table 6

Differences in Executive Functions between mothers with adequate to high Parental Reflective Functioning and mothers with a negative to low Parental Reflective Functioning controlling for total IQ and mental health status (HSCL-10); Multiple Analysis of Variance (MANOVA)

Variable	Adequate-High PRF ^{a)} N:11		Negative-Low PRF ^{a)} N:32		Sig.
	Mean	SD	Mean	SD	
Working Memory ^{b)}	49.1	9.3	38.4	6.9	*
Inhibition ^{c)}	46.2	12.6	37.6	10.2	NS
Cognitive Flexibility ^{c)}	44.7	9.8	31.9	10.1	*
Letter Fluency ^{d)}	48.6	11.3	48.3	11.6	NS
Category Fluency ^{d)}	60.3	8.6	58.6	12.3	NS
Planning ^{e)}	50.6	5.4	43.2	5.7	*

N=43, ** = $p < .01$, * = $p < .05$, ns = no significant differences.

a) Parental Development Interview - Revised, Reflective Functioning Scale

b) Letter-Number Sequencing sub-test from the Wechsler Adult Intelligence Scale, 4th Edition

c) Colour-Word Interference Test, Conditions 3 and 4 from the Delis-Kaplan Executive Function System (D-KEFS)

d) Verbal fluency test from the Delis-Kaplan Executive Function System (D-KEFS)

e) Tower Test from the Delis-Kaplan Executive Function System (D-KEFS)

Parental Reflective Functioning and Executive Functioning in Mothers with Substance Use Disorder

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