



universität
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DISSERTATION / DOCTORAL THESIS

Titel der Dissertation /Title of the Doctoral Thesis

„Evaluating the appropriateness of central constructs and measurement in current fatherhood research“

verfasst von / submitted by

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angestrebter akademischer Grad / in partial fulfilment of the requirements for the degree of

Doktor der Naturwissenschaften (Dr. rer. nat.)

Wien, 2018

Studienkennzahl lt. Studienblatt /
degree programme code as it appears on the student
record sheet:

A 796 605 298

Dissertationsgebiet lt. Studienblatt /
field of study as it appears on the student record sheet:

Psychologie

Betreut von / Supervisor:

Univ.-Prof. Dr. Dr. Lieselotte Ahnert

Acknowledgments

First, I want to thank my supervisor Prof. DDr. Lieselotte Ahnert for the fruitful collaboration in the past six years, her support and the chance to write my dissertation in the context of her projects. I am also grateful to my fellows Barbara Supper, Tina Eckstein-Madry, Nicole Zaviska, and Andrea Witting – you are the best co-workers one can hope for. Special thanks go to Nina Ruiz, Felix Deichmann, and Lukas Teufl who are not only the finest colleagues there are, but were also kind enough to offer me feedback on my thesis. All remaining errors are my sole responsibility, though.

Then, I want to thank my friends Michaela Binder and Georg Sulyok who were great moral support whenever I doubted me being in academia.

Next, I want to thank my grandparents for their confidence in me and keeping me on track.

To my parents: Thank you so much for the constant and endless support in every respect.

Finally, to my loved ones, Ilyas, Yasemin, and Melek: A wholehearted thank you for always having my back and supporting me in everything I do. This thesis would mean nothing without you, and I am sorry that my dissertation on fatherhood at times kept me from being the best father and husband I could be.

Publications included in this dissertation

- Piskernik, B., Supper, B., & Ahnert, L. (2018). Measurement invariance analysis of the Parental Stress Index. *European Journal of Psychological Assessment*, Advance online publication. doi: 10.1027/1015-5759/a000463
- Piskernik, B., & Ruiz, N. (in press). Measurement, structural, and functional invariance of parent-child play quality coding across multiple games and parent gender. *European Journal of Developmental Psychology*.
- Ruiz, N., Piskernik, B., Witting, A., Fuiko, R., & Ahnert, L. (2018). Parent-child attachment in children born preterm and full-term: A multigroup analysis. *Manuscript submitted for publication*.
- Piskernik, B., & Ahnert, L. (2018). What does it mean when fathers are involved in parenting? *Manuscript submitted for publication*.

Conference contributions connected to this thesis

Symposia

- Ahnert, L. & Piskernik, B. (2017). *Facetten gelebter Vaterschaft*. Symposium held at PAEPSY 2017: Gemeinsame Tagung der Fachgruppen Entwicklungspsychologie und Pädagogische Psychologie, Münster, Germany.

Talks

- Piskernik, B., & Ahnert, L. (2017). *Vaterschaft im Spiegel typischer Vater-Kind-Aktivitäten*.
Talk given at the PAEPSY 2017: Gemeinsame Tagung der Fachgruppen Entwicklungspsychologie und Pädagogische Psychologie, Münster, Germany.

Piskernik, B., & Ahnert, L. (2016). *Father-child activities in view of father-child attachments*.

Talk given at the International Expert Meeting on Research on Fatherhood funded by the Society of Research in Child Development, Ann Arbor, Michigan, USA.

Ruiz, N., Piskernik, B., & Ahnert, L. (2015). *Father-child attachment and time spent together*.

Talk given at the 7th International Attachment Conference (IAC), New York City, USA.

Ruiz, N., Piskernik, B., & Ahnert, L. (2015). *Vater-Kind-Bindung und Zeitinvestition*. Talk

given at the 22. Tagung der Fachgruppe Entwicklungspsychologie (EPSY), Frankfurt am Main, Germany.

Ahnert, L., Piskernik, B., Supper, B., Witting, A., & Ruiz, N. (2015). *Father-child attachment*

as related to frustration tolerance and stress reactivity in pre-term and full-term

babies. Talk given at the 14th European Congress of Psychology (ECP), Milan, Italy.

Piskernik, B., & Supper, B. (2014). Unterschiede im Belastungserleben der Mütter und Väter

von Kleinkindern. Talk given at the 11. Tagung der Österreichischen Gesellschaft für Psychologie (ÖGP), Vienna, Austria.

Posters

Piskernik, B., & Ahnert, L. (2016). *Joint father-child activities on fathers' working and work-*

free days. Poster presented at the 24th Biennial Meeting of the International Society

for the Study of Behavioural Development (ISSBD), Vilnius, Lithuania.

Piskernik, B., Supper, B., & Ahnert, L. (2015). *Differences of perceived maternal and*

paternal stress. A measurement invariance analysis of the Parental Stress Index.

Poster presented at the 2015 SRCD Biennial Meeting, Philadelphia, Pennsylvania,

USA.

Abstract

Fathers shape the lives of their children in multiple ways. Compared to mothers, however, we know very little about how they feel as a parent and how they engage in parenting. The present thesis aimed to contribute to research on fatherhood by evaluating some measurements used to gather empirical data on fathers' lives as well as subsequent modeling procedures to obtain reliable outcomes. The thesis focused on the issues (1) how comparability of mothers and fathers regarding measurement and functional invariance can be assured, and (2) how qualitative differences among fathers can be used to operationalize paternal involvement as a major construct in current fatherhood research.

The first two studies evaluated whether two essential constructs in family research, i.e., parental stress and parent-child play quality, are measurement-invariant between mothers and fathers. Results indicated that the measurement instruments (the traditional Parental Stress Index, and a self-constructed rating system for play) unbiasedly assessed the constructs independently of parent gender. Above and beyond, functional equivalence of parent-child play quality in relation to parent-child attachment-quality was tested in the second study of the thesis confirming equal functioning among parents. Moreover, the third study explored differences in the mechanisms of attachment formation between fathers and mothers but also comprised a sample of parents with children born preterm. The fathers of children born preterm were substantially more affected by developmental status and child gender than other parents were, illustrating that environmental conditions affected the functioning of these fathers.

As follows, consequential qualitative differences between various subgroups of fathers greatly challenge the applicability of measurement instruments in fatherhood research. Particularly the established unidimensional continuous operationalization of paternal involvement seems problematic. Hence, the fourth study of the thesis proposed a new operationalization approach for paternal involvement that incorporates qualitative distinct engagement patterns in different fathers.

Zusammenfassung

Väter beeinflussen die Leben ihrer Kinder auf unzählige Arten. Im Vergleich zu Müttern wissen wir dennoch nur wenig darüber, wie sie sich als Eltern fühlen und ihre Elternschaft gestalten. Das Ziel dieser Doktorarbeit war, durch die Evaluation exemplarischer Messinstrumente und der Modellierung ihrer Ergebnisse zur Väterforschung beizutragen. Die Kerngebiete dabei waren (1) ob Vergleichbarkeit zwischen Vätern und Müttern in Bezug auf Mess- und Funktionsäquivalenz gewährleistet ist, und (2) wie qualitative Unterschiede zwischen Vätern zur Operationalisierung väterlicher Beteiligung, ein zentrales Konstrukt der aktuellen Väterforschung, genutzt werden können.

Die ersten zwei Studien überprüften, ob die in der Familienforschung relevanten Konstrukte „elterliche Belastung“ und „Eltern-Kind Spielqualität“ messinvariant zwischen Müttern und Vätern sind. Die Ergebnisse zeigten, dass die Messinstrumente (das Elternbelastungsinventar und ein selbst erstelltes Spiele-Bewertungssystem) für beide Eltern ohne Bias die Konstrukte erfassten. Darüber hinaus testete die zweite Studie die funktionale Äquivalenz der Eltern-Kind Spielqualität bezüglich Eltern-Kind Bindung und konnte diese bestätigen. Die dritte Studie explorierte Unterschiede in den Mechanismen der Bindungsentstehung zwischen Müttern und Vätern und verwendete dabei auch eine Stichprobe aus Eltern mit frühgeborenen Kindern. Die Väter frühgeborener Kinder waren erheblich mehr betroffen von Entwicklungsstand und Geschlecht des Kindes als andere Eltern. Dies zeigte, dass väterliche Funktionsweisen durch externe Variablen beeinflusst werden.

Dadurch lässt sich auf qualitative Unterschiede zwischen Väter-Subgruppen schließen, was die Anwendbarkeit mancher Messinstrumente der Väterforschung in Frage stellt. Besonders problematisch erscheint die etablierte, eindimensional kontinuierliche Erfassung väterlicher Beteiligung. Die vierte Studie präsentierte deshalb eine neue Operationalisierung, die qualitativ unterschiedliche Vater-Kind Aktivitätsmuster berücksichtigt.

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General Introduction

About three-quarters of all men are or will become fathers during their lifetime and shape the lives of their children in multiple ways (Lamb, 2010). However, how fathers feel and behave or what the mechanisms behind the influence on their children are has been examined rather poorly so far (Ahnert, Supper, & CENOF, 2014). Despite an exponential growth of scientific publications about fathers since the 1990s, there is still much research on fathers missing and little consensus about theories of fatherhood (Adamsons & Palkovitz, 2014; Cabrera, Fitzgerald, Bradley, & Roggman, 2014). Specifically, the ongoing controversy in fatherhood research about its measurement instruments illustrates the lack of scientific agreement perfectly (Fagan, Day, Lamb, & Cabrera, 2014; Palkovitz, Trask, & Adamsons, 2014). In fact, parenting assessments were, and still are, routinely conceptualized with a “maternal template” in mind (Marsiglio, Amato, Day, & Lamb, 2000), developed with samples of mothers and psychometrically examined only for mothers (Roggman, Fitzgerald, Bradley, & Raikes, 2002). To overcome this bias in convergent measurements a series of father-specific divergent measures have been developed (for an overview see Day & Lamb, 2004). Explicitly designed for fathers, they were not applicable to mothers and once again precluded direct comparisons between both parents. Thus, the question of comparability of fathers and mothers remained open.

Clearly, being a parent means different things for mothers and fathers (Pedersen, 2012) and developmental trajectories of girls becoming mothers are fundamentally different from those of boys becoming fathers (Kinser, 2010). Accordingly, Palkovitz et al. (2014) advocate the existence of essential differences in mothering and fathering and distinctly operationalized constructs.

The main counterargument to this is the steep increase of time fathers spend in primary child care in the last decades and the simultaneous change of mother-child engagement patterns towards more concentration on playing and teaching (e.g., Bianchi,

Robinson, & Milkie, 2006; Gauthier, Smeeding, & Furstenberg Jr, 2004). In case of mothers working full time, which is still the exception (Margherita, O'Dorchai, & Bosch, 2009), parent's time with children has already almost reached unity (Gauthier & DeGusti, 2012; Raley, Bianchi, & Wang, 2012). According to Fagan et al. (2014), this change in work and family life converged mothering and fathering towards a general parenting construct, and differences in parenting measures, if there are still any, are mainly of quantitative but not qualitative nature.

In this debate about differences and equivalence across parent gender, studies that empirically tackle this conundrum are vitally needed. Such measurement invariance analyses (see Mellenbergh, 1989; Meredith, 1993; Meredith & Millsap, 1992) evaluate whether qualitative and quantitative equivalence hold true (Vandenberg & Lance, 2000). Furthermore, they can reveal which parts of the measurement instrument obstruct equivalence in what way (Millsap & Kwok, 2004). Such differences are of particular interest, because they do not represent shortcomings of the measurement instruments, but indicate which details differ across groups (Byrne & Watkins, 2003; van de Vijver & Tanzer, 2004). Measurement invariance analyses, however, are still scarce for psychological assessment instruments (Borsboom, 2006; Chen, 2008), especially regarding parent gender (Adamsons & Buehler, 2007). Within the small existing research body, we find similarities and differences in measures alike. For example, general parenting behaviors (Van Leeuwen & Vermulst, 2004), appraisal of one's child's strengths and difficulties (Chiorri, Hall, Casely-Hayford, & Malmberg, 2016), and feeding practices (Jansen, Harris, Mallan, Daniels, & Thorpe, 2018) can be assessed equally for both parents, while the interference of work with family life (Corwyn & Bradley, 2005), parental investment in the child (Whiteside-Mansell, Bradley, & Rakow, 2001), and parents' acceptance of the child (Adamsons & Buehler, 2007) cannot. However, even constructs that are equal among parents and their corresponding behaviors can be motivated and processed differently. Hence, uniform interpretations might still be faulty

(Fagan et al., 2014; Palkovitz et al., 2014). Therefore, functional equivalence, meaning that the regression weights between groups do not differ, needs to be tested. There are already several studies that have assessed functional equivalence (e.g., Van IJzendoorn, Vereijken, Bakermans-Kranenburg, & Riksen-Walraven, 2004), but without the prerequisite of measurement invariant constructs, this seemingly straightforward approach leads to wrong conclusions in realistic settings (Millsap, 1995, 1997, 2007).

Besides the problems with between parent comparisons, there is also the issue of vast within-gender differences of fathers in fatherhood research. Fathers are by no means a homogeneous group and fatherhood comprises a wide array of perspectives and circumstances (Fagan et al., 2014; Palkovitz et al., 2014). Some fathers get more involved in parenting, because challenging situations like e.g., having triplets (Brout, Lepofsky, Silverstein, & Auerbach, 2010), a child with a chronic health condition (Swallow, Lambert, Santacroce, & Macfadyen, 2011), or a child with mental illness (Wiens & Daniluk, 2009) require them to do so. Other fathers are not involved at all. Some cherry-pick those activities that they enjoy the most when interacting with their child while leaving the rest in the hands of the mothers (Johansson, 2011). Accordingly, motivation and processing might not only differ between fathers and mothers but also between different groups of fathers, and research in this regard is required.

Further, this heterogeneity in fathering is problematic for the measurement of paternal involvement, arguably the most important construct in fatherhood research. Historically, family researcher mostly operationalized involvement as the time fathers spent directly with their children, with little attention paid to how engaged fathers were and what they were doing with their children (Palkovitz, 1997). In recent years, there has been a shift from this omnibus approach to more selective measurements that focused on the amount of positive engagement in the form of interactive activities likely to promote development like playing and reading (Pleck, 2012). Both approaches assume that paternal involvement is a continuous construct

ignoring that this focus on the quantity completely ignores the heterogeneity in paternal engagement patterns. For example, a cherry-picking father might very well play as much with his child as a highly involved father who engages in a lot of other father-child activities but does not spend more absolute time with his child than a third father who mostly watches TV with his child. Consequently, Fagan et al. (2014, p. 391) suggested: “to take a step back and reassess how fathering is measured.”

Cabrera et al. (2014) see a possible solution to this problem in clustering techniques like latent class analysis. They argue that such approaches, which result in qualitative patterns, might be more appropriate for modeling paternal behavior than the traditionally continuous ones like overall or playing time. In addition to the method of modeling paternal involvement, their critique encompassed how researchers typically link this construct to other variables. They consider fathers as agents in dynamic transactional systems, influencing and being influenced by others (e.g., child and spouse) and the socioeconomic environment (see Bretherton, 2010; Sameroff, 2014). In such complex systems small changes in one part can lead to substantial effects in another part, and vice versa (Barton, 1994). As a consequence, conventional analytical strategies of focusing on isolated (linear) connections, e.g., how the amount of father-child play fosters child development, fail to capture the mechanisms in their complexity by neglecting the context and overly simplifying the dose-response relationship. To advance our understanding of paternal involvement as the central construct in fatherhood, it is paramount that research addresses these issues.

Aims

This dissertation aims to contribute to research on fathers and fatherhood by focusing on their measurement and the subsequent modeling of the outcomes. Exemplified on key constructs in family and parenting research it addresses measurement and functional invariance between fathers and mothers. Further, it proposes a new approach to operationalize paternal involvement and explores means to model the complex structure of interweaving

conditions that shape paternal involvement. Thereby the dissertation provides the foundation for future research in this area and deepens our knowledge about the constructs represented by the measurements. There are three main research aims:

1. Evaluate measurement invariance of assessment instruments in family and parenting research between fathers and mothers.
2. Evaluate functional equivalence between fathers and mothers.
3. Operationalize paternal involvement as engagement patterns and explore its (nonlinear) associations to characteristics of father, mother, and child.

Evaluation of Measurement Invariance

Within the scope of this dissertation, we inspected measurement invariance between fathers and mothers for two key constructs in family and parenting research, which are debatably different for parents. The first was *parental stress* as an essential element in models of parent behaviors and family functioning (Abidin, 1992; Deater-Deckard, 1998). The second was the quality of parent-child play, which is one of the major types of interaction between a parent and a child in western cultures (Gauthier & DeGusti, 2012) and one of the most focused on in research on fathers (Pleck, 2012).

Study 1 – Measurement invariance of the Parental Stress Index

Piskernik, B., Supper, B., & Ahnert, L. (2018). Measurement invariance analysis of the Parental Stress Index. *European Journal of Psychological Assessment*. doi: 10.1027/1015-5759/a000463

In this paper, we tested whether the German version of the Parental Stress Index (PSI; Abidin, 1995; Tröster, 2011) is measurement invariant for mothers and fathers. The PSI is applied not only in scientific context but has a practical value as well, e.g., in forensic assessments for child custody (Abidin, Austin, & Flens, 2013). Nevertheless, previous

research has not tested whether this measurement instrument unbiasedly assesses the same characteristics in mothers and fathers.

The PSI is hierarchically structured with a child and a parent domain, each comprising several subscales. Using an Austrian sample of cohabiting families, we assessed subscale and domain level invariance for mothers and fathers within a confirmatory factor analysis framework. As a result, we found that at least partial invariance holds true for all tested equality levels (i.e., configural, metric, scalar, and uniqueness). Partial invariance means that the overall structure was equal except for some minor differences. Whereas not adjusting for these disparities might produce misleading results on the subscale level, their total impact was negligible on the domain level. Accordingly, mother-father comparisons with the PSI are feasible for most use-case scenarios.

With a fair measure established we further compared mean levels between parents. While mothers and fathers did not differ on the child domain, assessing potentially problematic characteristics of the child, mothers reported more stress than fathers on the parent domain, which captures stress due to the way of life as a parent. This result supports previous work on mother-father differences in parental stress (e.g., Hildingsson & Thomas, 2014; Widarsson et al., 2013) and precludes that differences that have been found are artifacts due to missing measurement invariance.

Study 2 – Measurement invariance of parent-child play-quality

Piskernik, B., & Ruiz, N. (in press). Measurement, structural, and functional invariance of parent-child play quality coding across multiple games and parent gender. *European Journal of Developmental Psychology*.

Mothers and fathers play differently with their children. While fathers seem to favor physical games to excite, surprise, and encourage their children to take risks (Grossmann et al., 2002; Paquette, 2004), mothers are more likely to structure, guide, and teach in pretend-play situations (Gleason, 2005; John, Halliburton, & Humphrey, 2013). Nonetheless,

phenotypically different games might share a common latent play quality. Ahnert et al. (2017) proposed three observational rating scales of parent-child play as indicators for a latent play quality factor. In this paper, we tested whether those scales invariantly capture play quality in physical (father-preferred) and cognitive (mother-preferred) games for both parents and compared the latent mean levels.

Confirmatory factor analyses on data of Austrian cohabiting families yielded invariant measurement models regardless of the type of game and parent gender. Therefore, the rating scales by Ahnert et al. (2017) are an unbiased measure of parent-child play for either parent. Further, we found no latent mean differences of play quality in any parent-game combination. This supplements previous work on parent-child play, which focused mainly on phenotypical differences between mothers and fathers (Cabrera & Roggman, 2017).

Studies in Preparation – Measurement invariance of parent-child attachment-quality

In upcoming studies, we will demonstrate that attachment security, an essential construct in parent-child interaction influencing a multitude of children's developmental pathways (Cassidy & Shaver, 2016), can be invariantly measured regardless of parent gender. Its two most prominent measurement instruments are the *Strange Situation Procedure* (SSP; Ainsworth, Blehar, Waters, & Wall, 1978), a laboratory observational procedure yielding an attachment pattern classification (A, B, C, D), and the *Attachment Q-Sort* (Waters, 1995), an in vivo observational system based on q-sorting (Stephenson, 1953) 90 parent-child behaviors and correlating the sort with the sort of an ideally attached child to calculate a continuous -1 to 1 metric of attachment quality. In Piskernik and Ahnert (2018a) we will illustrate that a *C5.0* decision tree (Quinlan, 1993, 2013) trained on ratings of mother-child behavior during the SSP to predict the attachment pattern classification (accuracy = .92) works equally well for father-child dyads (accuracy = .95). In Ahnert, Eckstein-Madry, Supper, and Piskernik (2018) we used observations of almost 2000 attachment figure-child dyads, including mothers, fathers, childminders, and child care providers, within a confirmatory factor analysis

framework to de-ipsatize the q -sorted AQS items and found a common factor structure. The resulting factors were at least partially scalar invariant for all attachment figure-child combinations supporting attachment as a universal interaction quality between attachment figures and children.

Evaluation of Functional Equivalence

For the evaluation of functional equivalence, we focused on parent-child attachment as well. We aimed to contribute to the current debate about different formation mechanisms towards mothers and fathers (see Lucassen et al., 2011). With the prerequisite that parent-child attachment can be assessed for both parents without a bias (see Ahnert et al., 2018; Piskernik & Ahnert, 2018a) we examined the functional equivalence of its predictors.

Above and beyond the assessment of parent-child play quality's measurement invariance in the second study (Piskernik & Ruiz, in press), we tested play quality's functional equivalence regarding the AQS. Results indicated that play quality is equally linked to attachment quality for fathers and mothers independent of the game type. In the third study, we explored a different set of predictors.

Study 3 – Invariance in the formation mechanisms of attachment between mother and fathers and children born at term and preterm

Ruiz, N., Piskernik, B., Witting, A., Fuiko, R., & Ahnert, L. (2018). Parent-child attachment in children born preterm and full-term: A multigroup analysis. Manuscript submitted for publication. [status: under review at *PLoS one*]

With parents of children born preterm this study focused on a particularly interesting group in this discussion because faced with this stressful situation even in mothers the mechanisms seem to shift (Wolke, Eryigit-Madzwamuse, & Gutbrod, 2013). One could expect even more differences for fathers with paternal behavior being more sensitive to environmental conditions than maternal behavior (Lundy, 2002), but this has not been a focus of research, yet. This paper aimed to conduct an initial study in this void, exploring whether

basic characteristics of parent and child affect the parent-child attachment differently for mothers and fathers of children born at term and preterm.

Results indicated that child's gender and developmental status are much more influential for fathers of children born preterm than for those of children born at term or mothers in either situation. Developmentally delayed boys were particularly at risk of having low-quality attachments to their fathers. In another study (Ruiz, Witting, Piskernik, Supper, & Ahnert, 2018) we conducted a text analysis of interviews conducted with parents of children born at term and preterm with *Latent Dirichlet Allocation* (Blei, Ng, & Jordan, 2003) and found a matching result. Interestingly, fathers of children born preterm were more probable to communicate worries about the child's developmental than other parents. From a joint perspective of both studies, health professionals are advised to address those worries and pay particular attention to father-son dyads if a child is born preterm.

Operationalize paternal involvement as engagement patterns

The last aim in the scope of this dissertation was to operationalize paternal involvement as an engagement pattern and to explore how different patterns were positioned within the nonlinear system of father, mother, and child characteristics. This is in contrast to the established operationalization via the quantity of (positive) engagement (Pleck, 2010) and dealt appropriately with the heterogeneity in fathers while considering the complexity of fatherhood (Cabrera et al., 2014).

Study 4 – Paternal involvement as engagement patterns and its links to father, mother, and child characteristics

Piskernik, B., & Ahnert, L. (2018). What does it mean when fathers are involved in parenting? *Manuscript submitted for publication*. [status: under review at *Monographs of the Society of Research in Child Development*]

Foundation of this study were behavioral data of Austrian cohabiting fathers which were collected via experience sampling (see Hektner, Schmidt, & Csikszentmihalyi, 2006).

We thereby aimed to maximize ecological validity in comparison to previous approaches with questionnaire data, which are known to be ambiguous in this context (Mikelson, 2008) or diary data, which have a bias towards salient activities (Bolger, Davis, & Rafaeli, 2003). A latent class analysis clustered the fathers into three groups based on the various observed father-child engagement patterns found in the data. “Enriched” fathers stood out with a wide variety of activities with a focus on cuddling and STE (scaffolding, teaching, and educating) and abstaining mere supervision. “Balanced” fathers engaged in versatile activities as well but were prone to supervision while “restricted” fathers cherry-picked their activities and engaged only in a limited set.

To explore the associated complex structure of interweaving conditions of the groups, we applied the machine learning procedure of gradient boosted classification trees (Friedman, 2001) which can deal with vast numbers of nonlinear, interdependent predictors and still yield interpretable results. From a contextual perspective, the results contributed to fatherhood research by highlighting the importance of relationship characteristics (attachment quality to mother and father, the childhood experiences of fathers, maternal gatekeeping) in contrast to socioeconomic characteristics, which played only a subordinate role. From a methodical point of view, the results supported the notion that fathers are no homogenous group and paternal involvement is not a unidimensional continuous construct. Some characteristics playing an essential role in two groups, but being utterly irrelevant for the third illustrated this vividly.

For example good father-child attachment was associated with “enriched” fathers, the opposite was true for “restricted fathers”, and “balanced” fathers were not linked to father-child attachment at all. Conversely, mother-child attachment distinguished “balanced” and “restricted” fathers, but not “enriched”. Thereby this study not only outlined an alternative to the established operationalization of paternal engagement but also exemplified insights into the complex system “father” that can be gained that way.

General Discussion

This dissertation aimed at supporting fatherhood research by attending to three measurement and modeling problems in this field of research – comparability of mothers and fathers in terms of measurement and functional invariance and the operationalization of paternal involvement. Although measurement invariance is prerequisite to unbiased comparisons of groups (Vandenberg & Lance, 2000), it is still rarely assessed between mothers and fathers (Fagan et al., 2014) which compromises data quality and the integrity of derived results. Study 1 and study 2 tested whether two measurement instruments for central constructs in family research, parental stress and parent-child play quality, are likewise applicable to mothers and fathers. Overall, both the German version of the PSI (Abidin, 1995; Tröster, 2011), as an exemplary measurement of how parents feel and the rating scales of parent-child play by Ahnert et al. (2017), as an exemplary measurement of how parents behave, equally functioned regardless of parent gender. This adds two unbiased instruments to the toolbox of family researchers and practitioners. Concerning the debate whether a general concept of parenting is sufficient due to the convergence of mothers and fathers or essential differences still exist (see Fagan et al., 2014; Palkovitz et al., 2014), these results supported the former.

Despite measurement invariance being the methodical precondition for comparisons, it is not the only factor that needs to be considered. Palkovitz et al. (2014) remarked that motivation and processing might still differ. Two studies in this dissertation addressed this issue of functional equivalence and explored whether predictors for attachment quality differed between parents. Results were equivocal with no different functioning of play quality regarding AQS scores, but an impact of child's gender and developmental status only for fathers of children born preterm. Although mothers and fathers are known to play different parent-child games (Grossmann et al., 2002; Paquette, 2004), the equivalence of play quality was not totally unexpected considering that parent-child play is the most convergent activity

of mothers and fathers in terms of absolute time usage in western cultures (Gauthier & DeGusti, 2012). Further, play quality was solely examined in a community sample, whereas differences between parents were found only in fathers of children born preterm. In fact, fathers of children born at term did not differ from mothers of children born at term or preterm. This supports the notion that paternal behavior is more sensitive to environmental conditions than maternal behavior (Lundy, 2002). In sum, the results indicate equality in predictors of mothers and fathers within the prototypical modern cohabiting western middle-class family, but divergence at least for the father when these conditions change.

Beyond that, the fact that fathers of children born preterm function differently emphasized the heterogeneity of fathers as one of the principal reasons for our last study. Whereas the birth status of their children defined subgroups of fathers by an external variable, the final study applied a latent class analysis to group fathers from a community sample based on their engagement patterns. The resulting group membership represented an operationalization of paternal involvement that considered the heterogeneity of fathering by incorporating qualitative instead of the established, but problematic (see Fagan et al., 2014), unidimensional quantitative differences. In this way, we followed the petition of Cabrera et al. (2014) to explore clustering techniques regarding fathering and further heeded their appeal to reflect the complexity of fatherhood in the modeling approaches. In contrast to other studies that explored concomitants of paternal involvement (e.g., Cabrera, Hofferth, & Chae, 2011; Yeung, Sandberg, Davis-Kean, & Hofferth, 2001), not only was our operationalization of paternal involvement qualitative instead of quantitative, but the size of the array of characteristics was unprecedented, and the functions were not restrained to be linear. The results underscored the importance of relationship characteristics compared to SES and other contextual variables and illustrated that simple dose-response cannot adequately describe the complexity of fathering.

Limitations

The findings in the studies are limited in their generalizability mainly by their sample homogeneity. All samples consisted of cohabiting Austrian middle-class families. Families from low-income households, from ethnic minorities, and with under-aged or separated parents might function differently. This is also true for fathers of non-western cultures who have different role expectations (see Seward & Stanley-Stevens, 2014). Further, only a small, but relevant, set of measurement instruments was assessed. Results regarding the comparability of mothers and fathers cannot be extrapolated beyond the given scope.

Future Directions

Future research should attend to these limitations by evaluating additional instruments in and between more diverse sets of families. In this way, unbiased instruments, needed by research and practitioners alike, can be identified. Furthermore, variances found in the measurements point to discrepant details on the contextual level (Byrne & Watkins, 2003; van de Vijver & Tanzer, 2004). Such nuanced differences are an important augmentation to the typical mean contrasts and can deepen our understanding of the captured constructs.

The same applies to our proposed operationalization of parental involvement. Prior research has indicated that different societal structures can either hinder or facilitate men's family and parenting time (e.g., Boll, Leppin, & Reich, 2014) and future research should explore and compare other family backgrounds. Further, we only focused on paternal activities, but the results emphasize the importance of the relational system in families. Accordingly, future research would benefit from studying the mother, as well as the father, ideally, over longer periods of time, to gain more insight into the transactional nature of parenting.

Conclusion

This dissertation aimed to promote the scientific field of fatherhood research by evaluating measurement instruments of key constructs, examining the comparability of

mothers and fathers, and exploring heterogeneity of fathering and how qualitative differences can be used to operationalize paternal involvement. Our research showed that unbiased measuring regardless of parent gender is possible. However, fathers were found to be affected by environmental conditions, such as a child born preterm, leading to different functioning between parents and within fathers as a group. As follows, consequential qualitative differences between various subgroups of fathers greatly challenge the applicability of measurement instruments in fatherhood research. Particularly the established unidimensional continuous operationalization of paternal involvement seems problematic. Hence, the fourth study of the thesis proposed a new operationalization approach for paternal involvement that incorporates qualitative distinct engagement patterns in different fathers.

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Original Manuscripts

Study I

Piskernik, B., Supper, B., & Ahnert, L. (2018). Measurement invariance analysis of the Parental Stress Index. *European Journal of Psychological Assessment*, Advance online publication. doi: 10.1027/1015-5759/a000463



Measurement Invariance Analysis of the Parental Stress Index

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Abstract: While parenting research continues to compare similarities and differences in mothers' and fathers' behaviors based on mean values on the respective dimensions, measurement invariance as a prerequisite for these comparisons has seldom been assured. The present study thus subjected the well-known Parenting Stress Index (PSI), widely used in models of family functioning, to a rigorous measurement invariance analysis based on ($N = 214$) Austrian couples with children younger than 3 years of age. We evaluated configural, metric, scalar, and uniqueness invariance on item and subscale levels, and tested for structural invariance of means and variances of the PSI parent and child domain by second-order confirmatory factor analyses. As a result, only measurement differences on the scalar levels affected the factor scores, though negligibly. On the structural levels, no differences were found on the PSI child domain across parents, but on the PSI parent domain, mothers reported more stress.

Keywords: measurement invariance, father-mother distinction, parental stress

Parental stress is one of the key constructs in models of parent behaviors and family functioning (e.g., Abidin, 1992; Deater-Deckard, 1998), which has been associated with children's negativity and behavioral adversity (Thamer et al., 2012). Parental stress has also proven to diminish the ability to adapt parenting to children's needs (Paulussen-Hoogeboom, Stams, Hermanns, & Peetsma, 2008), and to cause an authoritarian rather than authoritative parenting style (Deater-Deckard & Scarr, 1996), which in turn might impair good parent-child relationships. Thus, numerous empirical studies linked elevated parental stress to less secure parent-child attachment (e.g., Diener, Nievar, & Wright, 2003) and bad parenting beliefs (Respler-Herman, Mowder, Yasik, & Shamah, 2012).

The most frequently used measure of parental stress in those studies is Abidin's *Parenting Stress Index* (PSI; Abidin, 1983) by which researchers repeatedly reported higher stress levels in mothers than in fathers, specifically on the PSI subscales *Role Restriction*, *Isolation*, and *Spouse* (Hildingsson & Thomas, 2014; Widarsson et al., 2013). However, it remains unsolved whether the perceived results on parents and parenting are really comparable for mothers and fathers and thus justify to speak about differences on those scales (Day & Mackey, 1989).

Searching through family research, remarkably few equivalence analyses across parents exist (see Adamsons & Buehler, 2007; Fagan, Day, Lamb, & Cabrera, 2014). Some studies indicated equivalence between parents (e.g.,

Finley, Mira, & Schwartz, 2008; Prinzie, Onghena, & Hellinckx, 2007; Van Leeuwen & Vermulst, 2004), and other studies found more differences than similarities across the parents (e.g., Adamsons & Buehler, 2007; Corwyn & Bradley, 2005; Whiteside-Mansell, Bradley, & Rakow, 2001). For example, when mothers and fathers reported on children's behavioral problems and temperament they normally agree only moderately (Grietens et al., 2004) even though measurement invariance on these scales seemed to hold (Chiorri, Hall, Casely-Hayford, & Malmberg, 2016; Clark et al., 2016). Likewise, scores of perceived global stress confirmed equivalence across the gender of the parents (Lavoie & Douglas, 2012; Taylor, 2015) whereas reported stress reactions scored higher in women than in men (Schlotz, Yim, Zoccola, Jansen, & Schulz, 2011). Unfortunately, specific parental stress reactions were explored only by one measurement invariance analysis (Deater-Deckard & Scarr, 1996) in which only the PSI short form was tested (Abidin, 1995). As several items were excluded metric invariance of the PSI was evaluated only for 17 out of 36 items, so it remains problematic to generalize this result to the complete construct of parental stress as assessed by PSI. Moreover, without scalar measurement invariance, it is questionable whether mean differences between mothers and fathers reflect true differences of the respective latent variable.

The present study therefore aims to evaluate the full version of the PSI measurement in terms of its invariance

across the parents. Using confirmatory factor analyses, we assess all applicable levels of measurement invariance, gaining insights into qualitative equivalence, biases, levels of noise, mean levels, and spread (see Vandenberg & Lance, 2000).

Methods

Participants

The sample was recruited in Lower Austria and Vienna as part of the CENOF Research Study (see Ahnert, Supper, & CENOF, 2014). The present study involved $N = 214$ couples with young children (52% female). Ages of the target children ranged from 12 to 32 months with $m = 19.1$ ($SD = 4.9$) months. Mothers were on average 34.0 ($SD = 5.3$) and fathers 36.3 ($SD = 7.0$) years old. All couples were either married (63.4%) or lived in a solid partnership. The sample represented typical Austrian middle to upper class with 42.7% of both parents holding a master degree and above. In 17.9% of the families only the father and in 20.6% only the mother had finished university. All but three fathers were in paid work ($m = 41.5$ hr/week, $SD = 10.3$), in contrast to only 53.2% of the mothers, who worked on average 18.6 hr/week ($SD = 9.4$). The mean household size was 3.6 ($SD = 0.8$) persons on average. Each household was visited twice. During the visits, mothers and fathers filled out the questionnaires of the PSI on different days and in randomly assigned orders. All participants gave signed informed consent.

Measures

Parental Stress

Parental stress was assessed using the German version of the Parenting Stress Index (Tröster, 2011), which contained some minor differences to the PSI 3rd edition (Abidin, 1995). In the German version, items were removed due to practical and theoretical considerations, finally keeping 48 of the 101 original items. Reasons for removal were, for example, cultural adequacy like not using “being happy with the last purchase of clothing for oneself” as an indicator of depression, and items which failed the commensurateness for fathers and mothers of older children, for example, “concerns with the time in hospital immediately after giving birth.” However, the original structure in terms of a *child* and a *parent domain* – each including several subscales with four items each – was preserved. The parent domain comprises the original subscales: (a) *Competence* capturing lack in practical knowledge and management skills of parenting, (b) *Isolation* measuring social isolation due to child rearing responsibilities, (c) *Attachment*

assessing inability to observe and understand the child’s feelings and needs accurately, (d) *Health* capturing deterioration in health as a result of parenting, (e) *Role Restriction* reflecting restrictions in maintaining former freedom and identity, (f) *Depression* relating to guilt and unhappy feelings, and (g) *Spouse* describing lack of emotional and active support of the other parent. The child domain consists of the subscales: (h) *Distractibility/Hyperactivity* depicting behavioral symptoms of the child, like restlessness and short attention span, (i) *Adaptability* assessing the child’s inability to adjust to environmental changes, (j) *Demandingness* describing child’s tendency to insist, (k) *Mood* capturing the child’s negative emotions, and (l) *Acceptability* as a measure of how troubled the parent is with the child not meeting his or her expectations, but omits the original subscale *Reinforces Parent*. In contrast to the original PSI, which utilizes multiple response formats, all 48 items were scored on a consistent 5-point Likert scale, ranging from 1 = *strongly disagree* to 5 = *strongly agree* with Cronbach’s α ranging between .68 and .77 for all subscales of the child domain and between .61 and .83 for all subscales of the parent domain (according to the German manual). Cronbach’s α for the whole child domain is .91 and .93 for the parent domain.

Data Analysis

All confirmatory factor analyses were conducted with MPlus 7.1 (Muthén & Muthén, 1998–2012) leading to two models for the child and parent domain for each parent, which were later compared across the parents.

Base Model

With respect to the distinct nature of the child and parent domain, we modeled both domains separately, but proceeded with them in an analogous fashion. To preserve the domain-subscale-item hierarchy, we translated all data to a second-order confirmatory factor analyses, using the domains as second-order factors, the subscales as first-order factors, and the items as manifest indicators. Data of both parents were modeled simultaneously with correlated errors for the same items across parents. Those correlations were necessary to avoid estimation errors due to non-consideration of data dependence (Card, Selig, & Little, 2008). The resulting configural invariance models served as a base for consequent analyses (see Figure 1 for the model scheme).

Model Estimation

For model estimation, we treated item responses as ordered categories (see Elosua, 2011) and used the robust weighted least squares algorithm (WLSMV; Muthén, du Toit, &

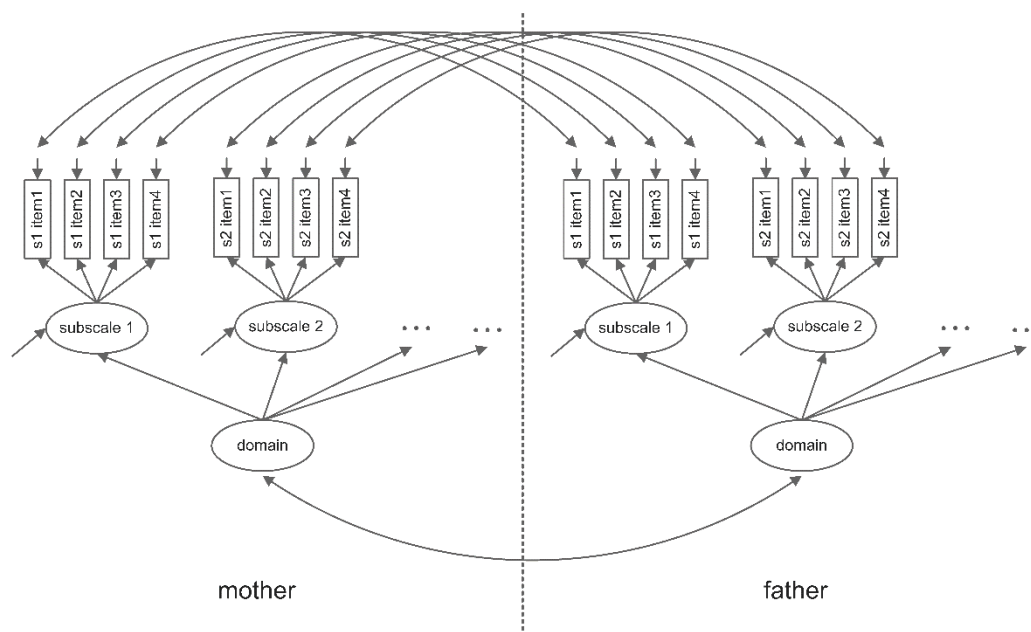


Figure 1. Schema of the PSI domain base model.

Spisic, 1997) because category distributions appeared asymmetric and the category number was as low as three for some items. WLSMV performed well under these conditions (Savalei & Rhemtulla, 2013).

Model Comparison

After controlling for adequate fit of the configural invariance model ($CFI \geq .90$ and $RMSEA \leq .08$) we aimed to test higher levels of invariance. Those tests consisted of stepwise fixation of parameter classes across parents (see Millsap & Yun-Tein, 2004). The change in model fit was evaluated with chi-square difference tests using the MPlus function *DIFFTEST*. To minimize type I errors, we set the statistical significance level conservatively at $p < .01$.

Assessed Levels of Invariance

In the sequence of model constraints, we deviated slightly from the usual course for second-order multigroup factor invariance analysis (Chen, Sousa, & West, 2005). Because item thresholds in the categorical case cannot be as easily disjoined from the corresponding factor loadings as item intercepts in linear models, we kept them together. Instead of alternating between items and subscales for each invariance level, all levels of invariance at the item level were evaluated before we moved to the subscales. The analyses sequence was metric, scalar, and lastly uniqueness invariance for the item levels, followed by the same

sequence for the subscale levels. Finally, the structural parameters, mean and variance of the domains were tested for invariance. Confronted with significant differences on any level, we eventually aimed to achieve partial invariance by removing the most problematic parameter constrain until the fit difference vanished (see Dimitrov, 2010). Thereby, we were able to identify gender differences of parental stress in detail.

Results

The Child Domain

The configural invariance model of the child domain fitted the data acceptably without any further adjustments (see Table 1). Within the consecutive models, we encountered invariances only when testing scalar invariance on item level (see Table 2). Furthermore, differences were small and partial invariance was attainable. For *Distractibility/Hyperactivity* item 1: *My child is more active than most other children*, fathers' first two thresholds were lower than those of the mothers. In other words, given the same true latent value on this subscale, fathers were less prone to disagree than mothers. In contrast, fathers had higher thresholds on *Demandingness* item 1: *Some behaviors of my child (linger,*

Table 1. Tests of measurement equivalence of the PSI child domain

Model	Model fit				Difference test ¹		
	df	χ^2	RMSEA	CFI	vs.	Δdf	$\Delta\chi^2$
Measurements at item level							
1. Configural invariance	709	1,071.5*	.049	.920	–	–	–
2. Metric invariance	724	1,046.5*	.046	.928	1	15	12.7
3. Scalar invariance	796	1,145.1*	.045	.923	2	72	142.0*
3a. Partial scalar invariance ²	791	1,120.9*	.044	.927	2	67	93.5
4x. Residual variance free	771	1,128.8*	.047	.921	–	–	–
4. Uniqueness invariance ³	791	1,120.9*	.044	.927	4x	20	15.3
Measurements at subscale level							
5. Metric invariance	795	1,109.7*	.043	.930	4	4	1.8
6. Scalar invariance	799	1,115.7*	.043	.930	5	4	9.2
7. Uniqueness invariance	804	1,116.5*	.043	.931	6	5	3.9
Structural parameters							
8. Invariance of domain mean	805	1,118.9*	.043	.930	7	1	2.4
9. Invariance of domain variance	806	1,126.6*	.043	.929	8	1	4.6

Notes. ¹Due to the WLSMV estimation a corrected $\Delta\chi^2$ was computed by the MPlus function DIFFTEST. ²Thresholds #2–4 of demandingness item 1 and thresholds #1, 2 of distractibility/hyperactivity item 1 were freed. ³Equal to model 3a, but nested in and compared to a different model (4x not 2). * $p < .01$.

Table 2. Non-equivalent parameters (standardized) across mothers and fathers within the PSI child domain

Parameter	Mothers		Fathers	
	Estimate	SE	Estimate	SE
Item thresholds				
Demandingness item 1 #2	–1.03	0.13	–0.30	0.11
Demandingness item 1 #3	–0.59	0.11	0.13	0.11
Demandingness item 1 #4	0.95	0.12	1.74	0.17
Distractibility/Hyperactivity item 1 #1	–1.36	0.14	–1.90	0.18
Distractibility/Hyperactivity item 1 #2	–0.27	0.10	–0.95	0.12

whine, disobey, object) cost me a lot of energy. Hence, fathers reported less agreement than mothers with the same true latent value on the subscale *Demandingness*. No further significant measurement differences were found, and mean and variance of the child domain proved to be equivalent as well. All input data as well as the results of all analysis steps are provided in Electronic Supplementary Materials, ESM 1.

The Parent Domain

The configural invariance model of the parent domain fitted the data acceptably without any further adjustments (see Table 3). Although partial equivalence was found for all higher levels of measurement invariance, there were some differences regarding location parameters between mothers and fathers (see Table 4). On the item level *Attachment* item 4: *It takes a long time for parents to develop*

close, warm feelings for their children, *Isolation* item 4: *I often feel left alone to myself*, and *Spouse* item 2: *Since having my last child, I have had less interest in sex* had higher thresholds for fathers than for mothers. Therefore, fathers' agreements to these items were comparatively lower than mothers' based on equal true latent values on the respective subscales.

On the subscale level, the location biases were more heterogeneous. While the paternal intercept of the subscale *Depression* was lower than the maternal one, the opposite was true for the subscales *Isolation* and *Attachment*. As a result, less stress was reported by fathers on the *Depression* subscale, whereas mothers displayed less stress on the *Isolation* and *Attachment* subscales. On the structural level, we found that fathers stated less stress within the parent domain in general, taking all measurement biases into account. For the results of all analysis steps see ESM 1.

Table 3. Tests of measurement equivalence of the PSI parent domain

Model	Model fit				Difference test ¹		
	df	χ^2	RMSEA	CFI	vs.	Δdf	$\Delta\chi^2$
Measurements at item level							
1. Configural invariance	1,441	1,755.1*	.032	.943	–	–	–
2. Metric invariance	1,462	1,777.4*	.032	.943	1	21	34.4
3. Scalar invariance	1,565	1,970.0*	.035	.930	2	103	374.1*
3a. Partial scalar invariance ²	1,556	1,879.8*	.031	.941	2	94	127.2
4x. Residual variance free	1,528	1,856.7*	.032	.941	–	–	–
4. Uniqueness invariance ³	1,556	1,879.8*	.031	.941	4x	28	37.5
Measurements at subscale level							
5. Metric invariance	1,562	1,878.9*	.031	.943	4	6	8.4
6. Scalar invariance	1,568	1,949.5*	.034	.931	5	6	84.6*
6a. Partial scalar invariance ⁴	1,565	1,883.9*	.031	.942	5	3	7.5
7. Uniqueness invariance	1,572	1,888.0*	.031	.943	6a	7	8.9
Structural parameters							
8. Invariance of domain mean	1,573	1,931.8*	.033	.935	7	1	18.2*
9. Invariance of domain variance	1,573	1,858.7*	.029	.948	7	1	1.2

Notes. ¹Due to the WLMSV estimation the corrected $\Delta\chi^2$ was computed by the MPlus function DIFF1LSI. ²Thresholds #1–3 of isolation item 4 and spouse item 2 and thresholds #2–4 of attachment item 4 were freed. ³Equal to model 3a, but nested in and compared to a different model (4x not 2). ⁴Intercepts of isolation, oppression and attachment were freed.

Table 4. Non-equivalent parameters (standardized) across mothers and fathers within the PSI parent domain

Parameter	Mothers		Fathers	
	Estimate	SE	Estimate	SE
Item thresholds				
Attachment item 4 #2	0.52	0.11	1.05	0.13
Attachment item 4 #3	0.96	0.12	1.64	0.16
Attachment item 4 #4	1.70	0.16	2.46	0.28
Isolation item 4 #1	–0.71	0.13	0.50	0.16
Isolation item 4 #2	0.25	0.12	1.70	0.20
Isolation item 4 #3	0.68	0.12	2.08	0.21
Spouse item 2 #1	–0.97	0.11	–0.42	0.10
Spouse item 2 #2	–0.29	0.12	0.55	0.11
Spouse item 2 #3	–0.04	0.10	0.89	0.13
Subscale intercepts ¹				
Attachment	0	0	0.31	0.11
Depression	0	0	–0.39	0.11
Isolation	0	0	0.71	0.11
Structural parameters ¹				
Latent domain mean	0	0	0.36	0.08

Note. ¹Due to model identification, parameter is only estimated freely for fathers.

Impact of Bias on Differential Test Functioning

As metric invariance on item and subscale level held true, the PSI assesses qualitatively equal constructs in mothers and fathers. Above and beyond, the reliability was equal

for both parents, because uniqueness and factor variance were invariant as well. Nonetheless, violations of scalar invariance were found in both domains, which make direct comparisons of score levels across the domains unfeasible. Notably, full measurement invariance models, which do not account for biases, would still adequately fit the data (child

domain: CFI = .924, RMSEA = .044; parent domain: CFI = .930, RMSEA = .034). To assess the magnitude of differential test functioning considering the complex data structure, that is, hierarchical and interdependence across groups, we simply compared the factor scores of the final partial invariant models with those of their fully invariant counterparts.

In the child domain, the resulting factor scores of both models were a close match. The rank order was very similar with a maximal shift of two ranks and a mean shift of 0.24 ranks for fathers and 0.26 for mothers. Between the parents, differences were pooled in fathers' factor scores because mothers' latent domain mean was fixed to zero for model identification. The paternal scores resulting from the partial invariant model were small with $m = 0.022$ SD ($SD = 0.008$), but consistently larger than their full invariant counterparts. Using the R package *BayesFactor* (Morey & Rouder, 2015), we compared the Bayesian hypothesis that the modulus of the difference is not greater than 0.05 SD with its counterpart to test whether the difference has any practical relevance. Therefore, we used the Bayesian alternative to significance tests, the Bayes factor, which depicts the ratio of the likelihood probability of the two competing hypotheses. The doubled logarithm of the resulting Bayes factor was 502.1 surpassing by far the threshold for very strong evidence (> 10) as suggested by Kass and Raftery (1995). This is a decisive support for no larger shift than 0.05 SD caused by bias within the child domain. For details of the analysis see ESM 1.

In the parent domain, the results were quite similar. Rank shifts were small with $m = 0.39$ ($SD = 0.66$) and a maximum of five ranks for fathers, and $m = 0.55$ ($SD = 0.81$) and a maximum of four ranks for mothers. The scores resulting from the partial invariant model were consistently larger than their full invariant counterparts with $m = 0.031$ SD ($SD = 0.010$). The doubled logarithm of the Bayes factor for the hypothesis of a difference not larger than 0.05 SD was 298.9. Again, this clearly exceeded the threshold for very strong evidence (> 10), lending firm indication that the mean parent domain scores bias is smaller than 0.05 SDs. For details of the analysis see ESM 2.

Discussion

Despite unabated scientific interest in the commonalities and differences in parenting between mothers and fathers, measurement invariance as a prerequisite for such comparisons is very rarely examined. This is true for investigations of parental stress as well, even though comparative parental behaviors are reported in many applied areas, for example,

in forensic assessments for child custody (Abidin, Austin, & Flens, 2013) where unbiased results are especially important.

The present study assessed measurement invariance of the German PSI, which captures a broad spectrum of stress for both parents. Results indicated partial measurement invariance for both the child and parent domain. Differences solely occurred in scalar invariance, while metric and uniqueness invariance held true. Hence, qualitatively, the same constructs with equal reliabilities were assessed for mothers and fathers, but a bias of the score levels was found. The bias was located on two items in the child domain pointing toward behavioral maladjustment of the child, whereas three items and three subscales in the parent domain revealed differences among the emotional aspects of parenthood.

Compensating for these biases, we compared mean and variance of the two latent domains across the parents. While no differences were found in the child domain, mothers had a higher mean score than fathers on the parent domain. This result supports previous work (e.g., Hildingsson & Thomas, 2014; Widarsson et al., 2013) which demonstrated a general parental appraisal to difficult child characteristics, but revealed more stress of being a parent for mothers than fathers. The scope of parental stress, however, differed for neither domain as indicated by equal variances across the parents.

As only few biases were found and full invariant models fitted the data acceptably as well, we assessed the magnitude of different functioning of the domain scores. The results for child and parent domain were similar and the biases seemed to mostly cancel each other out (see Bao, Dayton, & Hendrickson, 2009). Changes in the rank order of scores within the domains were negligible and score differences on the domain levels didn't exceed 0.05 SD. The magnitude of these differences appeared insignificant on a practical level, and comparisons of both domains between mothers and fathers were applicable in most scenarios.

Despite the overall cancelation of biases, meaningful differences between mothers and fathers existed on a more granular level. For example, fathers reported more stress due to social isolation, which is consistent with research on men in general (Wellman & Frank, 2000) and particularly with fathers (Patulny, 2012) who might be integrated in smaller social networks, receiving less social support than mothers. Mothers described more stress in form of depression, on the other hand, which matches the known high incidence rate of clinical depression in women (Piccinelli & Wilkinson, 2000) and in mothers in particular (Davé, Petersen, Sherr, & Nazareth, 2010). The bias against fathers on the attachment subscale leads to current debate on closeness in fatherhood (see Ahnert et al., 2014), but more research is warranted.

Results, however, are limited as they are based on a quite homogeneous sample from preliminary middle to upper class. Thus, future research must focus on measurement invariance for parents with low income, from ethnic minorities, and being underaged or separated. Because measurement invariance is not an intrinsic property of a measurement instrument, but rather an indicator of potentially different characteristics of the measurement respondents, detailed analyses might help the debate on parenting by revealing if, when and how mothers and fathers are discriminant from each other.

On a practical level the PSI domain scores seem comparable for fathers versus mothers, while some subscales alone are more problematic. Further, we need to keep in mind that mothers generally report more stress on the PSI parent domain, and equal scores still might impact mothers' and fathers' lives differently.

Acknowledgments

This work has been carried out as part of CENOF (the Central European Network on Fatherhood with headquarters at the University of Vienna) and was supported by the Jacobs Foundation (AZ: 2013-1049).

Electronic Supplementary Materials

The electronic supplementary material is available with the online version of the article at <https://doi.org/10.1027/1015-5759/a000463>

ESM 1. Data, Text (.pdf)

Measurement invariance analysis of the PSI parent domain (German version).

ESM 2. Data, Text (.pdf)

Measurement invariance analysis of the PSI child domain (German version).

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Received November 15, 2016

Revision received July 18, 2017

Accepted August 13, 2017

Published online March 28, 2018

EJPA Section/Category Differential Psychology

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Study II

Piskernik, B., & Ruiz, N. (in press). Measurement, structural, and functional invariance of parent-child play quality coding across multiple games and parent gender. *European Journal of Developmental Psychology*.

Measurement, structural, and functional invariance of parent-child play quality coding across
multiple games and parent gender

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This work has been carried out as part of CENOF (the Central European Network on
Fatherhood with headquarters at the University of Vienna) and was supported by the Jacobs
Foundation (AZ: 2013-1049)

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Abstract

Mothers and fathers prefer different games when playing with their children, nonetheless, they share common latent play characteristics. This study aimed to evaluate an observational coding system comprising three rating scales for adjustment, calibration, and familiarity of parent-child play situations that, together, indicate latent parent-child play-quality. 335 toddlers and preschoolers and their parents (332 fathers and 158 mothers) were observed during both physically (father-preferred) and cognitively stimulating (mother-preferred) parent-child games. Measurement, structural, and functional invariance were assessed concerning the type of game and parent gender. No differences were found in any respect. Results showed that the coding system is reliable and unbiased for both parents and game types, indicated equal validity in regard to the external criterion attachment security, and revealed no differences in latent parent-child play-quality across parent gender.

Measurement, structural, and functional invariance of parent-child play quality coding across multiple games and parent gender

Parent-child play is one of the major types of interaction between a parent and a child in western cultures (Gauthier & DeGusti, 2012). Thereby it fosters a wide range of child competencies ranging from cognitive to social, emotional, and behavioral skills (Ginsburg, 2007; Lindsey & Mize, 2000; Stgeorge & Freeman, 2017). However, mothers and fathers play differently with their children. While fathers seem to favor physical games to excite, surprise, and encourage their children to take risks (Grossmann et al., 2002; Paquette, 2004), mothers are more likely to structure, guide, and teach in pretend-play situations (Gleason, 2005; John, Halliburton, & Humphrey, 2013).

This seems contradictory to the observed convergence of mothering and fathering towards a general parenting construct in the last decades (Fagan, Day, Lamb, & Cabrera, 2014), but phenotypically different games might share a common latent play quality that is equivalent for both parents. In fact, Ahnert et al. (2017) proposed three observational rating scales of parent-child play as indicators for a latent play quality factor, and demonstrated scalar invariance for fathers and a limited sample of mothers. Although the observed games allowed for pretend play (mother-preferred), they were primarily physical (father-preferred) in nature, therefore it remains unclear whether equivalence of parent-child play quality generalizes to other play types like more cognitively stimulating games. The present study aims to answer this question by evaluating the coding system in terms of its invariance across physical and cognitive games, and both parents. Using confirmatory factor analyses, invariance (see Vandenberg & Lance, 2000) of measurement (configural, metric, scalar, uniqueness, and additionally, due to the dependence of mothers and fathers, covariance of errors) was assessed.

If invariant assessment of parent-child play quality generalizes to other play types, then this would provide a broadly applicable, unbiased measurement instrument of parent-child, which is much needed given the current interest of family research in similarities and differences in parenting between mothers and fathers (see Fagan et al., 2014). Only if measurement invariance holds true fair group comparisons, which are the base of most research, are possible (Borsboom, 2006). Furthermore, the present study intends to add to the field of comparison of parents by extending the invariance analyses with the structural parameters mean, variance, and covariance to contrast parents regarding level and spread of play quality in different games and its association between parents. At last, functional equivalence regarding the prediction of attachment quality was tested. As a key concept in parent-child interaction (Cassidy & Shaver, 2016), attachment quality is an excellent external validation criterion and the results supplement the ongoing discussion of different formation mechanisms of attachment towards mothers and fathers (e.g., Lucassen et al., 2011).

Methods

Participants

The sample was recruited in Lower Austria and Vienna as part of the CENOF Research Project (Ahnert, Supper, & CENOF, 2014). The present study involved $N = 335$ children (50.9% female) and their parents (332 fathers and 158 mothers). In 154 families both parents at least contributed data on one game. Mothers were undersampled because of the design of the original project, which in its first phase focused solely on fathers and started collecting data on both parents only later on. Since this sampling transition did not change the recruiting strategy of finding parents in Kindergartens and playgroups, we did not expect systematic differences between both sample groups. This assumption is supported by the absence of any significant distributional differences (see online supplement 1). Ages of the target children ranged from 12 to 67 months with $m = 29.4$ ($sd = 16.9$) months. Mothers were 35.0 ($sd = 5.1$) and fathers 38.0 ($sd = 6.4$) years old on average. The sample represented

typical Austrian middle to upper classes, with 53.3% of mothers and 52.7% of fathers holding a bachelor's degree and above. Each household was visited twice. During the visits, a trained research assistant videotaped mothers and fathers while playing the parent-child games and observed them afterwards together with a second research assistant to assess parent-child attachment quality. Mothers and fathers were examined on different days and in randomly assigned orders. All participants gave signed informed consent.

Measures

Play quality. The coding system of parent-child play quality by Ahnert et al. (2017) comprises three 5-point Likert scales assessing: (a) *familiarity* reflecting parent and child feelings of togetherness and joy, and thus the social-emotional quality of the play situation; (b) *calibration* indicating the coordination of the play situation focusing on how play scripts had been mutually developed; (c) *adjustment* capturing structural features of the situation that are seen from the father's and the child's side. For more information on the scales and how they are coded, see online supplement 2. All rated videos were rated by one out of 21 trained research assistants. Interrater reliability was calculated based on 68 father-child and 70 mother-child games and reached an intraclass correlation for the average random rater of $ICC(2,k) = .71$ for familiarity, .87 for calibration, and .70 for adjustment. In case of multiple ratings the integer value of the median was used in the subsequent analyses.

Games. Play quality was coded based on four different games, one physical and one cognitive game for toddlers (<36 months) and preschoolers (≥ 36 months), respectively. In the physical game for the younger children, *Candy Bomber* (212 fathers, 115 mothers), parents were asked to hold the child in a vertical position and move him or her around so that a little ball could be picked up and dropped into a bowl. Parents of older children (95 fathers, 31 mothers) were instructed to play *Horse Polo*, which involved carrying the child on their back while the child tried to hit small balls with a long-handled mallet. The cognitive games included *Wild Berry* for the younger children (215 fathers, 105 mothers), where parents hid a

small ball (Berry) under one of three cones, like in a classic game of thimblorig. The preschoolers and their parents played *Build-Up* (75 fathers, 29 mothers) and had to build something together out of construction materials. The average game lasted 4 minutes and 49 seconds ($sd = 2;49$). For more information on the games, see online supplement 3.

Attachment. The Attachment Q-Sort (AQS; Waters, 1995) was used to describe the quality of the attachment relationship in a natural setting. The AQS consists of 90 items describing children's attachment behavior in the presence of another person. The items are q-sorted in nine sets ranging from 1 = "not typical at all" to 9 = "most typical" of ten items each. The resulting sets were correlated with the set of an ideally securely attached child, providing a score between -1.0 to +1.0, which was normalized via r -to- z transformation. Each parent-child relationship was independently rated by two out of 88 trained observers during two-hour home observations. The number of raters is high because the AQS is a key measurement in the original project and several hundred more families were assessed. The interrater reliability in the given data set was $ICC(2,k) = .95$ and the average score of both raters was used for the subsequent analyses. AQS scores were available for 230 fathers and 124 mothers.

Data Analysis

All invariance analyses were conducted within a CFA framework with MPlus 8.0 (Muthén & Muthén, 2017). The CFAs treated item responses as ordered categories and used the robust weighted least squares algorithm WLSMV (Muthén, du Toit, & Spisic, 1997) for model estimation. Since children contributed multiple data points to both levels of comparison, games and parents, all invariance evaluations took the resulting dependence structure into account. The games were modelled as distinct groups with data from the same clusters, while both parents' parent-child play quality was modelled in parallel within each group with correlated errors between the same indicators across parents (see Card, Selig, & Little, 2008).

Model succession. With respect to the two levels of comparison, the sequence of analyses started with a configural model. Assessment of metric (equal factor loadings) and scalar invariance (equal indicator thresholds) across game types and then parents followed, before uniqueness invariance (equal indicator residual variance) for all combinations was evaluated. The last step is not required for unbiased mean value comparisons, but in combination with equal factor variances uniqueness invariance translates to equal reliability between groups, which we deem a property of interest. Testing measurement invariance was concluded by comparing the indicator error covariances across game types. Next, invariance analyses of the structural parameters factor mean, variance, and covariance followed. Finally, the model was extended by adding the child's attachment security to each parent to the most restrictive accepted model and regressing it on play quality. Invariance of regression paths and error variances was tested across game types and parent gender.

Model evaluation. After controlling for adequate fit of the configural invariance model ($CFI \geq .90$ and $RMSEA \leq .08$; see McDonald & Ho, 2002), testing higher levels of invariance was aimed for. These tests consisted of stepwise fixation of parameter classes across games and parents (see Millsap & Yun-Tein, 2004). The change in model fit was evaluated with χ^2 difference tests using the MPlus function *DIFFTTEST* and with the change in CFI (Chen, 2007). Changes in the invariance level with less than or equal to $\Delta CFI = -.01$ and $\alpha < .01$ were considered as acceptable.

Results

The configural invariance model fitted the data excellently without any further adjustments, and none of the consecutive models revealed any indication of non-equivalence of measurement and structural parameters across game types and parents (see Table 1 for all essential results and online supplement 4 for additional fit indices and all parameter estimates). Hence, the coding system of parent-child play quality qualitatively assesses the same construct due to equal factor loadings, without bias due to equal thresholds, and with the

same precision due to equal uniqueness and factor variance across cognitive and physical games, and mothers and fathers. Further, the play quality differed neither in level, spread, nor in covariation represented by factor mean, factor variance, and factor covariance, respectively, between parents in any combination. See Figure 1 for the parameters of the final model.

The results of the assessment of functional invariance were strikingly similar. The initial model, which amended the final model of equal factor covariances with AQS scores of both parents, fitted the data well, $\chi^2(79) = 124.0, p < .001$, CFI = .990, and RMSEA = .043, and neither fixing all regression paths, $\chi^2(82) = 122.8, p = .002$, CFI = .991, RMSEA = .040, and $\Delta\text{CFI} = .001$, $\Delta\chi^2(3) = 1.8, p = .61$, nor the error variances, $\chi^2(85) = 125.5, p = .003$, CFI = .991, RMSEA = .039, and $\Delta\text{CFI} = .000$, $\Delta\chi^2(3) = 2.3, p = .52$, deteriorated the fit significantly. In the most restrictive model play quality regressed attachment security consistently with $\beta = .30, p < .001$. Accordingly, the play quality coding can regress the same percentage of AQS score variance ($R^2 = .09$) for both parents, regardless of the underlying game type. For additional fit indices and all parameter estimates see online supplement 4.

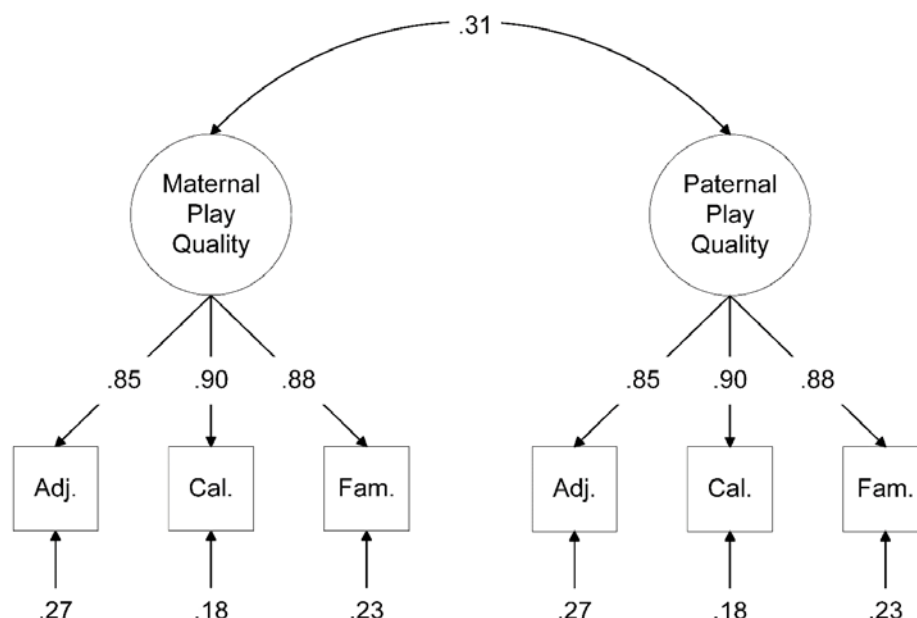


Figure 1. Standardized final model of maternal and paternal parent-child play quality. Note: Correlations between the errors for the same items across parents are not displayed because none was significant.

Table 1. Tests of measurement and structural invariance.

Model	Model fit					Difference test ¹				
	df	χ^2	p	RMSEA	CFI	vs	Model Changes	$\Delta\chi^2$	Δdf	p
Measurement invariance										
1. configural	10	12.4	.26	.028	.999	-		-	-	-
2. metric (games)	14	13.8	.47	.000	1.0	1	equal factor loadings between games	1.3	4	.86
3. scalar (games)	36	41.0	.26	.021	.999	2	equal indicator thresholds between games	27.3	22	.20
4. metric (parents)	38	44.4	.22	.023	.999	3	equal factor loadings between parents	3.7	2	.16
5. scalar (parents)	49	57.9	.18	.024	.998	4	equal indicator thresholds between parents	13.9	11	.24
6x. residuals free	43	54.0	.12	.029	.998	-	free indicator residual variance	-	-	-
6. uniqueness ²	49	57.9	.18	.024	.998	6x	equal indicator residual variance	3.5	6	.74
7. residual covariance	52	60.7	.19	.023	.998	6	equal indicator residual covariance	2.9	3	.41
Invariance of structural parameters										
8. mean	55	65.6	.15	.025	.998	7	equal factor means	3	4.6	.21
9. variance	58	74.2	.07	.030	.996	8	equal factor variances	3	6.1	.11
10. covariance	59	84.1	.02	.037	.994	9	equal factor covariances	1	4.2	.04

¹) Due to the WLSMV estimation a corrected $\Delta\chi^2$ was computed by the MPLus function DIFFTEST.

²) Equal to model 5, but nested in and compared to a different model (6x not 4).

Discussion

Despite mothers' and fathers' divergent game preferences and play strategies (Gleason, 2005; Grossmann et al., 2002; John et al., 2013; Paquette, 2004), the coding system by Ahnert et al. (2017) unbiasedly captures parent-child play quality indicated for both parents and across game types. Interestingly, play quality differed neither in level nor in relation to the external criterion attachment security between parents. This aligns with the progressing convergence of aspects of mothering and fathering towards parenting in the last decade (Fagan et al., 2014).

Results, however, are limited as they are based on a quite homogeneous sample from primarily middle to upper class from Austria. Thus, future research must focus on measurement invariance for parents with low income, from ethnic minorities, and those who are under-aged or separated. We will also need to investigate non-western cultures with more distinct gender roles in parenting. Further, given the limited sample size of mothers, no invariance analyses were conducted regarding the additional distinction criteria age and gender of the child, which are of interest for future research as well. Apart from that, we do not expect any impairment due to missing cases, because they originated from design rather than sampling bias.

Meanwhile, the coding system of parent-child play quality by Ahnert et al. (2017) can be considered as a reliable, valid, in respect to its association with attachment security, and unbiased measurement for mothers and fathers across different game types.

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Study III

Ruiz, N., Piskernik, B., Witting, A., Fuiko, R., & Ahnert, L. (2018). Parent-child attachment in children born preterm and full-term: A multigroup analysis. *Manuscript submitted for publication.*

Status: under review at *PLoS one*

Parent-child attachment in children preterm and full-term:

A multigroup analysis

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Abstract

Objective: While ample research exists about mother-child attachment, so far little focus has been on specifics of father-child attachment. Even less research is available on the nature of the father-child relationship for children born preterm. The objective of this study was to determine whether children born preterm (23 to 37 weeks gestation) differ in their attachment to their fathers and mothers from their term peers (> 37 weeks gestation), and whether certain child characteristics, such as sex, twin status, and developmental status, have an influence on the parent-child relationship.

Methods: The sample consisted of $N=290$ children ($n=140$ girls) born before term (including 45 twin pairs) and 100 term children (age range 12 to 36 months) and their fathers and mothers. Attachment of participating mothers and fathers with their children was assessed by the Attachment Q-sort during two home visits. Children's developmental status was measured with the Bayley Scales of Infant and Toddler Development.

Results: Within a multigroup analysis of parents of children born preterm and at term more secure attachment was found for both parents in the full-term sample. To investigate the within group variance of attachment across the four parent-child dyads the model was extended to test different functioning in the individual parent-child dyads. Correlates of attachment specific to fathers of children born preterm accumulated to an explained variance of $R^2 = .82$. For those fathers less education as well as lower development scores and male sex of the child, were associated with lower attachment scores. In the three other parent-child constellations the explained variance did not exceed 20%.

Conclusion: The findings highlight the importance of informing fathers about preterm birth, possible problems, and developmental consequences. Health professionals are advised to create interventions focusing on fathers in order to enhance the quality of attachment in father-child dyads in children born preterm.

Introduction

Early attachment experiences work as an interface between parenting and child development. If attachment is not sufficiently established, children show a variety of problems (1). Although current research has shown that multiple attachments arise from early on, and have an inherent potential to strengthen or compensate for attachment experiences with the main caregiver, the majority of results are on mother-child attachment for normally developing children (2).

Until now research on mother-child attachment in children born preterm produced controversial results. Whereas some studies found no difference between children born preterm and children born at term regarding mother child attachment (3, for an overview see 4), others reported less beneficial patterns in those born too early (5). Potential risk factors for impairments in attachment can be found on both the parent's and the child's side. Besides a variety of physiological issues, children born preterm show difficulties in emotional regulation (6) and attention deficits. Social behavior seems already atypical at an early age, shown by the fact that children born preterm react with shorter fixation times on social contents compared to children born at term (7). Furthermore children show developmental problems in early childhood (8, 9), that may persist until adulthood (10).

Consequently, preterm birth has been associated with the vulnerable child syndrome (11), which usually refers to physical illnesses but may be observed for developmental issues as well. The term means that parents perceive a child as vulnerable although there is no reason, although there might have been one in the past. A persistent perception of vulnerability (12) as well as parental anxiety (13) after a preterm birth seem to be associated with less positive parent-child interaction and parental attitudes. Parents of children born before term often fear possible handicaps (14) and therefore might focus on developmental delays which could affect the relationship. On the parents' side preterm birth increases the risk of anxiety, depression, and PTSD (15), and it requires more adaptive competence in order to

compensate for children's reduced responsivity (16), which could lead to insecure attachment. Furthermore, both mothers as well as fathers of children born preterm are more stressed than parents of terms, with mothers being more stressed than fathers (17). The situation might be aggravated by the fact that a growing population among babies born preterm are twins as a result of infertility treatment. Meeting the needs of two vulnerable infants is even more challenging, which could lead to even higher rates of insecure attachment in twins.

Due to the factors described, impairments in interaction as the most frequent violation for secure attachment have been a focus in research about prematurity. It nevertheless remains unclear whether children born preterm experience more or less positive interaction with their caregivers than other children (18-20), although maternal sensitivity seems to be the same (21). Several researchers have proposed that vulnerable children, in particular, profit from positive interaction and need even more positive input to reach the same levels as less vulnerable children (22). This proposal might be transferable to the formation of mother-child as well as father-child attachment.

As described the children themselves differ in many ways from healthy term children. Even though child age is adjusted with regards to prematurity when assessing child development, this does not seem to completely do justice to the differences. There seem to be long-lasting consequences (e.g. 10, 23), indicating fundamental dissimilarities between children born preterm and full-term, which have the potential to influence attachment. It seems as if it is not so much the parental behavior that is different, but more the child, that was born preterm, itself (20). Therefore sensitivity for example does not seem to be as crucial for attachment in mother-child dyads for children born before term as it is for those born after 37 weeks of gestation (21), suggesting that other variables are relevant for attachment in preterms.

Although there is only a small association between development and mother-child attachment for infants born at term (24), this link seems to be stronger in children born

preterm (5). Most studies describe developmental issues as the base for potential problems in mother-child attachment in children born preterm, but they focus on different facets and do not examine (with the exception of 5) the link in their research. Therefore this study includes child characteristics as a base to describe attachment in children born preterm.

Paternal behavior seems to be more sensitive to environmental conditions than maternal behavior (e.g. 25) and evidence suggests that child characteristics might be especially relevant to fathers (26). However, systematic research with respect to this assumption is scarce. Overall father-child attachment has not been a particular focus in research about children born preterm. There seems to be no difference between fathers of children born before and at term when it comes to bonding after birth (27). A study that examined attachment in a small sample of fathers of children born very low birthweight (<1500g) and at term found no differences in the distribution of attachment patterns (28).

The aim of the present study was to compare mothers and fathers of preterm and term-children and explore the specifics of parent-child attachment in preterm children. Furthermore we tested if the effects of certain child characteristics on the parent-child relationship function differently between these groups. This question is important for interventions in neonatal intensive-care units, targeting not only mothers but fathers equally.

While controlling for socioeconomic status (SES), healthy children born preterm were compared with term children in order to answer two research questions: (1) Do preterm and term children differ in their attachment towards mothers and fathers? (2) Are child characteristics, such as twin, gestational, and developmental status as well as child sex predictive for children's attachment?

Methods

Procedure

Data was collected between 08/2013 and 12/2015 as part of the [name deleted to maintain the integrity of the review process] research study. Singleton and twin children born

between 23 and 37 weeks of gestation were recruited from the [name deleted to maintain the integrity of the review process] and a reference group of children born at term (> 37 weeks of gestation) recruited from playgroups and nursery schools. All families were seen at three home visits to observe the children separately with their fathers and mothers, in quasi-randomized sequence. For the families with twins, one child was randomly selected as the target-child. For most cases data on the second twin was also available (see S1 Table).

The Ethics Committee of the [name deleted to maintain the integrity of the review process] University approved the research study [access number deleted to maintain the integrity of the review process], and parents provided written informed consent before participation.

Sample The sample consisted of 245 cohabiting fathers and mothers and their children, of whom 190 were born preterm (45 of them twin pairs) and 100 at term (for an overview see S1 Table). In all families the mother was the primary and the father the secondary caregiver. All families with children, that were born preterm and were between 12 and 36 months of age within the data collection period, born or treated at the clinic of the Medical University, were contacted after a screening at the clinic. Exclusion criteria were cognitive or physical impairment, single- or step-parental care, or non-German speaking families, which in total ruled out 43% of the children born in the hospital at the time. Out of the remaining families equal numbers in respect to gestational age, as well as sex of the child were drawn. About 20% of the families could not be reached due to missing or wrong contact information and 22% of the contacted families refused to participate. Refusal was not connected to child age, sex or gestational age at birth. To allow reliable estimation of the effect of being a twin, this group was oversampled within the target population.

S1 Table. Demographics of Participating Preterm and Term Born Children Subjected to the Main Analysis.

	Total <i>n</i> = 276			Term Singleton <i>n</i> = 96			Preterm Singleton <i>n</i> = 95			Preterm First Twin <i>n</i> = 43			Preterm Second Twin <i>n</i> = 42		
	<i>M</i> / %	95% CI		<i>M</i> / %	95% CI		<i>M</i> / %	95% CI		<i>M</i> / %	95% CI		<i>M</i> / %	95% CI	
Sex female, %	49.6	43.7–55.5		53.1	43.1–63.1		50.5	40.5–60.6		44.2	29.3–59.0		45.2	30.2–60.3	
Gestational age, weeks, <i>M</i>	33.6	32.9–34.2		39.9	39.7–40.2		29.4	28.6–30.2		31.0	30.1–32.0		31.0	30.1–32.0	
Child age, months, <i>M</i>	19.4	18.7–20.1		19.6	18.4–20.7		18.9	17.6–20.2		19.6	17.7–21.6		19.8	17.8–21.7	
Development, <i>M</i>															
Cognitive development	106.54	104.86–108.23		111.25	108.4–114.10		102.79	99.93–105.65		104.88	101.30–108.47		105.58	101.37–109.79	
Language development	99.99	98.19–101.78		104.50	101.26–107.74		97.48	94.67–100.30		97.83	94.14–101.52		95.96	90.45–101.27	
Motor development	101.19	99.48–102.90		106.91	103.93–109.88		98.00	95.57–100.97		97.57	94.17–100.97		97.44	92.8–102.08	
Education, academic, %															
Mother	50.2	44.2–56.2		61.1	51.2–70.9		38.7	28.8–48.6		51.2	35.9–66.5		50.0	34.5–65.6	
Father	49.6	43.6–55.6		57.3	46.9–66.9		45.7	35.7–55.8		45.2	30.2–60.3		46.3	31.1–61.6	
Parent age, years, <i>M</i>															
Mother	34.05	33.37–34.72		33.57	32.56–34.59		34.52	33.43–35.62		34.07	32.52–35.72		34.20	32.52–35.87	
Father	37.11	35.70–38.51		36.67	35.2–38.01		36.96	35.60–38.30		37.52	35.83–39.21		37.71	36.01–39.40	
CI, 95% confidence interval															

Measures

Demographic characteristics. Information on the family's SES was obtained by structured interviews at the first visit to the family. Education, which was used as control variable for all analyses, was grouped in academic and non-academic (high-school education

or less) maternal or paternal education. Gestational age was reported by medical reports and entered the analysis as severity of prematurity (prematurity), objectified by the number of days that the child was born preterm. The assessment age was corrected for prematurity.

Assessment of attachment. The Attachment Q-Sort (AQS; 29) was used to describe the quality of the attachment relationship in a naturalistic setting. The AQS consists of 90 items describing children's attachment behavior in the presence of another person. Each item is rated on a 9 point scale. In the end the specific ratings of a dyad are correlated with the ratings of an ideally securely attached child, providing a score between -1.0 to +1.0. Two trained observers independently rated the parent-child relationship during a two-hour home visit. Inter-rater reliability was $ICC = .91$ for the maternal and $ICC = .94$ for the paternal AQS-score.

Assessment of development. Trained assessors completed the mental, language, and motor indices of the BSID-III (30) for all children during a home visit.

Data analysis

Outlier detection and missing data handling. Outliers can severely compromise the integrity of analysis results (31), hence, a robust, multivariate outlier-detection algorithm (32) was applied. After the exclusion of four children born at term and ten born preterm the remaining 276 cases had an overall missing rate of 3.7%, with maximum of 10.1% on the maternal AQS-score for a single variable. In all further analyses we dealt with missing data by relying on full information maximum likelihood. A control analysis with all cases included changed the results only negligible.

Data modeling. Considering the mother-father-child triangle as an interdependent system both parent-child dyads were analyzed synchronously via path analysis to account for dependency. In order to avoid multicollinearity the BSID-III indices were bundled to a latent factor representing the overall child development status.

Interested in differences between mothers and fathers, but also between families with

children born at term and before we subjected the model to a multi group analysis allowing comparisons of all parent groups. However, the data structure across groups differed. In the preterm group several families contributed two cases, namely the twins, to the analysis. To tackle the resulting within-variance, the base model was reformulated as a two-level model, but the analysis was kept limited to the between-level with the families as subjects. In the term group being a twin did not vary and prematurity varied only irrelevantly, so both effects were fixed to zero in this group. Due to those necessary restrictions chi-square based fit statistics were not computable for the full model. Statistical model comparison was still possible via Wald tests for parameters, and the R^2 value of the parent-child attachments served as an overall fit measure.

To test for mean differences across parents we restricted the model to function similar to a traditional analysis of co-variance with parent gender and birth status as factors and education of the parents and the child's gender and age as co-variates. Development and the extent of prematurity were not included due to their strong correlation with birth status. But, although those characteristics are tautological in a between group comparison, they are informative for explaining the within group variance. To assess differential impact of development and extent of prematurity on attachment in specific parent groups we extended the initial model to include those variables and allowed all co-variates to have varying weights across parents.

All main analyses were carried out with MPlus 7.1 (33) using robust maximum likelihood estimation (MLR) to deal with possible non-normality.

Results

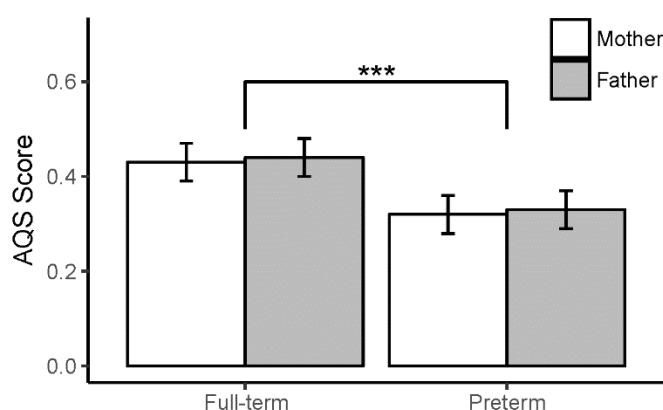
Sample characteristics

After removing the 14 identified outliers the overall sample consisted of 95 singletons and 85 twins born preterm and 96 mature singletons, with 139 boys and 137 girls (see S1 Table) between 12 and 36 months. All families were Austrian middle-class, with 38-61

percent of parents in the subgroups having an academic education.

Mean differences of parent-child attachment

In families with children born at term the estimated marginal mean of the AQS score was 0.43 (SE = 0.04) for mothers and 0.44 (SE = 0.04) for fathers. In families with children born preterm the mean for mothers was 0.32 (SE = 0.04) and for fathers 0.33 (SE = 0.04) (see S1 Fig). This difference due to birth status was statistically significant, $Wald = 13.9, p < .001, d = 0.26$, but no effect of parent gender, $Wald = 0.08, p = .78$, or its interaction with birth status, $Wald = 0.02, p = .89$, was found. Among the co-variates only the child's gender was significantly associated with the AQS scores, $b = 0.14, p = .003$, favoring girls over boys.

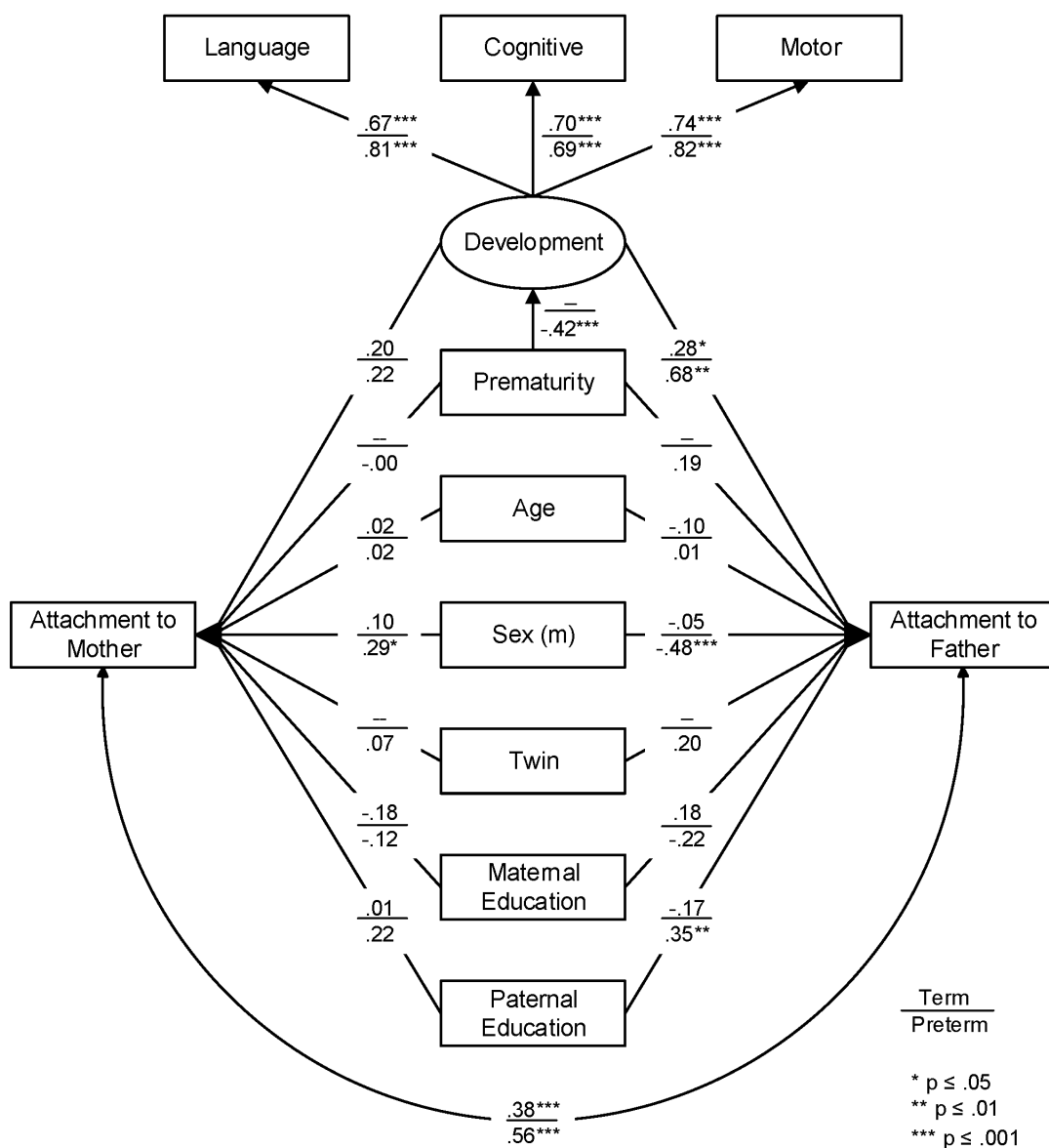


S1 Fig. AQS-score group means of mothers and fathers of children born full-term or preterm.

Functional differences between parents

To test functional differences between mothers and fathers as well as between children born term and preterm a reference model with unconstrained regression path weights for all parent constellations was estimated. As shown in the overview of all path weights (see S2 Table and S2 Fig), the nominally largest effects were found for fathers in the preterm group, while in mothers of children born preterm and in both parents in the term group the effects were much smaller and mostly statistically insignificant. To statistically compare paths, we calculated Wald tests for all differences with at least $\Delta\beta \geq |.2|$ between mothers and fathers

within and same sex parents across birth status groups.



S2 Fig. Multigroup base model of mother-child and father-child attachment in preterm and term children. Note: the weights of the BSID-III differ only due to standardization.

Child and parent characteristics linked to attachment

In the preterm group, three significant predictors for the paternal AQS score, namely development, child's sex, and academic education of the father, were found, whereas for the maternal AQS score only child's sex displayed a significant effect (see S2 Table). In the term group, the maternal AQS score was not significantly associated with any of the predictors,

and the paternal AQS score only with development. Tested for statistical differences the effect of the developmental status on attachment was stronger for fathers than for mothers in the preterm group ($Wald = 4.4, p = .036$), but did not differ between fathers of children born preterm and at term ($Wald = 1.7, p = .20$). Between the preterm and term group only the impact of the child's sex differed ($Wald = 4.0, p = .046$). Whereas children's sex appeared to be irrelevant for father-child attachment in the term group, father-son attachment scores were lower than father-daughter in the preterm group. Being a twin had no effect on attachment to either parent.

Table 2. Standardized Path Coefficients of Unrestrained Base Model.

To	From	Term			Preterm		
		β	95% CI	p	β	95% CI	p
Development	Prematurity	0 ^a			-.42	-.60–.25	<.001
Maternal attachment	Development	.20	-.04–.44	.10	.22	-.08–.52	.16
	Prematurity	0 ^a			-.00	-.24–.23	.98
	Twin	0 ^b			.07	-.16–.31	.54
	Sex of child	.10	-.18–.37	.50	.29	.06–.52	.01
	Age of child	.02	-.17–.20	.87	.02	-.16–.20	.85
	Maternal education	-.18	-.39–.03	.09	-.12	-.39–.16	.42
	Paternal education	.01	-.21–.23	.95	.22	-.06–.49	.12
Paternal attachment	Development	.28	.06–.51	.01	.68	.24–1.00	.002
	Prematurity	0 ^a			.19	-.09–.47	.18
	Twin	0 ^b			.20	-.03–.43	.08
	Sex of child	-.05	-.32–.22	.70	.48	.21–.75	<.001
	Age of child	-.10	-.32–.11	.35	.01	-.24–.26	.97
	Maternal education	.18	-.01–.37	.07	-.22	-.48–.05	.11
	Paternal education	-.17	-.37–.03	.09	.35	.09–.61	.009

^a Fixed to zero because no meaningful effect is expected within the sample's value range

^b Fixed to zero because predictor does not vary within sample

Overall, we found individually meaningful differences between groups only for a few

paths. In sum, however, effects on attachment for fathers of children born preterm were consistently larger than for the three other parent-child constellations. This amounted to a huge difference in explained variance. The predictors for attachment to fathers of children born preterm accumulated to $R^2 = .82$, while for mothers only $R^2 = .19$, for fathers of children born at term $R^2 = .15$, and for mothers $R^2 = .08$ could be explained. Pooling those three together their R^2 is distinctively smaller ($Wald = 17.4, p < .001$) than for fathers of children born preterm.

Discussion

The present study investigated mother-child and father-child attachment in children born preterm and term.

Overall children born preterm showed lower attachment scores than children born full-term. This effect did not depend on with which parent attachment was measured. While there is little to no research on father-child attachment, the result stands in contrast to a number of previous findings (4) on mother-child attachment in smaller samples of children born preterm. Nevertheless lower attachment scores in mother-preterm dyads have been reported before (e.g. 34). Since to our knowledge this is the first study using the AQS on a large sample of healthy singletons and twins born preterm, further research will be needed. Regarding the child factors, the only significant effect for mothers of children born preterm was seen for child's sex, with higher scores for girls. In contrast to previous evidence (5), better development only showed a small but not significant association with mother-child attachment in the present study. This could be due to the use of the AQS, that captures attachment in the child's daily life, instead of the Strange Situation Procedure (35), which measures attachment creating a stressful situation for the child. For mothers of children born at term, none of the child factors or parental education, seemed to have an effect. Research has so far mostly focused on this group and some factors are well established as bases for mother-child attachment (e.g. 36, 37).

For fathers of children born at term, attachment was as well not related to child sex or parental education but positively to children's development. This association was also found in preterm children, suggesting that for fathers the interaction with less developed children is more difficult than with well-developed children. Father-child communication is more challenging and associated with more breakdowns (38) than mother-child communication, which could be pronounced in less developed children. Interacting with children born immature, who are less responsive (16), might also lead to more struggling with interpreting cues on the father's side. Therefore, better development could facilitate interaction and the formation of secure attachment. The vulnerable child syndrome seems to have a greater impact on fathers than on mothers, and this matter should be focused in working with fathers in particular. It has been hypothesized that fathers stimulate and destabilize their children, whereas mothers care for and contain them (39). This paternal behavior might seem less appropriate for less developed children, and the lack thereof could affect the relationship. Physical play, which is often mentioned within that context, occurs most often with boys and seems to be especially important for them (40). This finding could be one explanation why a negative association for attachment and male sex for fathers of children born preterm was found. At least at birth, preterm boys are more vulnerable than girls (41), and problems in attachment at toddler-age might be still linked to that gender difference. Affect regulation and emotional communication are more problematic in father-son dyads compared to mother-child and father-daughter dyads (42), which could be a risk for preterm boys, who already show more difficulties in emotional regulation than girls do (6). Being vulnerable is diametrically opposite to the male gender stereotype. Dependent and emotional behavior is discouraged in boys from an early age on (43) and people react negatively to males, who do not confirm gender stereotypes (44). Expectations of men having to be able to handle difficulties independently and always being in control of their emotions could influence the relationship in another way too. Men are believed to suppress emotions, which are

inconsistent with their gender role (45) and are less likely to seek and receive support (43). This poses a challenge for fathers with their own non-gender conform emotions after preterm birth and a child that might not fulfill male stereotypes. In general, fathers are the ones that differentiate more between boys and girls (46). Investment in male preterms could be diminished, since from an evolutionary point of view being strong and physically fit is more desirable in male than female offspring. The effect was therefore also found for mothers of children born preterm, suggesting that gender-expectations play a crucial role in mothers as well. Surprisingly, no significant effect of twin-birth was found on parent-child attachment, suggesting that the relationship is not more challenged by having two premature children compared to one.

For fathers of children born preterm all predictors together added up to 82% of explained variance in attachment, whereas in all other groups it did not exceed 20%. By detecting the relevant predictors of secure attachment for this group of fathers, that is, low paternal education, male sex of the child, and increased problems in development, also the identification of specific risk groups regarding attachment was achieved.

The strengths of this study were (1) the large sample size, including children of different gestational age and twins and singletons. Former studies of mother-child attachment in children born before term have not integrated all these factors. Furthermore, (2) the AQS was employed instead of the traditional Strange Situation Procedure, which has been questioned in its use for children born preterm (5, 47). (3) We investigated mother-child and father-child attachment.

The study presented here has several limitations. The parents within the sample were from middle to high SES and volunteered to participate in this study, which required considerable cooperation. The sample was selected retrospectively and we only included families, where both parents were living together with their healthy biological child. The present study is, therefore, just based on a specific subsample of families and we do not know

whether the results can be generalized to families with lower SES. Because gender-typed behavior seems more common in less educated families (48), differences between mothers and fathers but also effects of the child's sex might be pronounced in samples with less educated participants. A further limitation might be the oversampling of twins within the target population. However, we carefully accounted for the effect of being a twin in the model and found it to be non-significant. Hence, we believe this has no negative impact on the generalizability. Overall, we cannot be certain whether the observed effects are persistent over time, or whether attachment within the preterm group becomes more secure with increasing child age.

Conclusion

The present results emphasize the importance of paying special attention to parents of children born preterm and especially highlight the vulnerability of father-child attachment to child factors. Health professionals working with families of children born preterm are advised to create specific conditions for fathers and provide ongoing support to accommodate their particular needs. With regard to attachment, the combination of fathers without a non-academic education and low developed sons was identified as a risk group that will need increased attention in the future. It will be important to create interventions focusing on gender-specific developmental pathways in children born preterm in order to enhance especially the quality of attachment in father-son dyads. Gender-typed expectations or ideas about children's development and behavior should be addressed as part of the work with both parents but in particular with fathers.

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Study IV

Piskernik, B., & Ahnert, L. (2018). What does it mean when fathers are involved in parenting? *Manuscript submitted for publication*. [status: under review at *Monographs of the Society of Research in Child Development*]

Status: under review at *Monographs of the Society of Research in Child Development*

Abstract

The present study examines fathers' direct engagement with children using experience-based sampling methods with 190 fathers in two-parent families in Austria with 1- to 5-year-old children. Father-child activities were sampled at random times over one week and three home visits were conducted to gather interview, questionnaires, and observational data. Latent Class Analysis uncovered three different profiles of father-child activities: (1) *Enriched* (2) *Balanced* and (3) *Restricted*. Boosted Classification Trees explored the associations between these profiles and the quality of father-child relationships and family functioning. Fathers who showed enriched, as opposed to restricted activities with the target children formed close attachments with them, displayed better interparental relationships and were more likely to be exposed to low family stress, underlining paternal involvement as being most vulnerable to relationship dynamics in the family.

What Does it Mean When Fathers are Involved in Parenting?

The nature of father involvement has become a central focus of research on fatherhood (e.g., Cabrera, Tamis-LeMonda, Bradley, Hofferth, & Lamb, 2000; Hofferth & Lee, 2015; Hook, 2006). Fathers' direct engagement with children, defined as interactions and engagement activities with the child, as well as passive supervision and control, has received considerable research attention as a central component of father involvement (Budig & Folbre, 2004; Fagan, Day, Lamb, & Cabrera, 2014; Pleck, 2010). The present study views paternal involvement as a complex nonlinear dynamic system (see Hastings, Hom, Ellner, Turchin, & Godfray, 1993) that is affected by a multitude of (interdependent) factors, which, in turn, are affected by paternal involvement. Similar to other systems and transactional frameworks guiding this monograph (Chapter 1, Cabrera et al., 2014), in these self-organizing complex systems, small changes in one part of the system lead to large effects in another part, and vice versa (Barton, 1994). Consequently, the complexity of these dynamic systems, and the interrelations among variables may be obscured and misinterpreted if treated in a linear fashion, thus calling for nonlinear dynamic modeling strategies. In the current study, we applied this conceptual perspective to the assessment of paternal involvement with a focus on father-child activities and the relations between father-child activities and the family environment. To capture paternal involvement and to identify interrelations with the family environment, the present study focused on father-child activities performed throughout a typical week and then adopted a person-centered approach (Bergman & Trost, 2006) that investigated patterns among the father-child activities to extract different groups or classes of fathers and children based on weekly activities. Once these classes were uncovered, a non-parametric supervised learning method of if-then-else decision trees was applied using features of fathers and their families to predict the different classes.

The Nature of Paternal Involvement

Past heuristic models of father involvement focused on the amount of time fathers spent with their children (quantity), with little attention paid to how fathers were engaged and what they were doing with their children (Cabrera et al., 2014; Palkovitz, 1997). Although there are multiple disciplinary perspectives, paternal involvement from an anthropological perspective is often viewed as more voluntary than maternal involvement (Geary, 2008), and the quality of the interparental relationship between mother and father may be important for determining paternal engagement. Family systems perspectives view fathers as parents (Cabrera, Volling, & Barr, 2018), and underscore that intrafamilial and extrafamilial factors play a role in determining father involvement. Prior research has demonstrated that fathers are more engaged in families with harmonious marital relations, but less engaged in families with high levels of maternal gatekeeping (Schoppe-Sullivan, Brown, Cannon, Mangelsdorf, & Sokolowski, 2008). Some studies have found that fathers used more negative and intrusive parenting in families with more marital conflict and less positive marital relations (Belsky, Youngblade, Rovine, & Volling, 1991; Cox, Paley, Payne, & Burchinal, 1999; Cox, Payne, & Margand, 1995), but others have not (Cabrera et al., 2007; Chapter II this volume). Paternal involvement was also related to overall relationship dynamics in the family (Volling, Blandon, & Kolak, 2006; Volling et al., 2014) where the relationship quality may strengthen paternal involvement (e.g., Brown, Mangelsdorf, & Neff, 2012), and family distress may hinder active fatherhood (e.g., Yoo, Adamsons, Robinson, & Sabatelli, 2015). Given the many family factors that covary with father involvement, it is necessary to consider these various family factors in predicting patterns of father involvement, and the activities fathers engaged in on a weekly basis with their children.

Aims and Hypotheses

Based on Fagan et al.'s (2014) suggestion "to take a step back and reassess how fathering is measured" (p. 391), the present study was based on a novel means of conceptualizing and analyzing paternal involvement. The first aim of the study focused on the activities that fathers do with their children in everyday life and used a person-centered approach (latent class analysis) to find different groups of fathers that varied on activity engagement. The second aim was to focus on different features of fathers and their families to predict variability in classes by examining fathers' personality and attitudes; marital relationship quality, family relationship dynamics, and family stress. After controlling for sociodemographic characteristics, we hypothesized that in families with highly involved fathers there would be better interparental relationships, more balanced relationship dynamics in the family, and less family stress than in families with less involved fathers.

Method

Participants

A sample of 200 two-parent families was recruited in Austria as part of a study by the Central European Network on Fatherhood (CENOF Research Study (see *author citation blinded for review*). Ten non-biological fathers were excluded from analyses so the final sample consisted of $N = 190$ families with two biological parents having 1.8 ($SD = 0.8$) children. The target children (99 girls) averaged 33.0 ($SD = 16.5$) months, and range from 12 months to five years. Nearly two thirds (60.5%) of the children went to public childcare centers for 27.2 h/wk on average. Fathers were 38.5 ($SD = 6.0$) and mothers 35.6 ($SD = 5.0$) years of age, on average. In 41.1% of the families, both parents had a master's degree or above; in 29.4% of the families, one parent had completed university, and in 29.5% of families, neither parent had a university degree. All fathers were in the paid labor force and worked, on average, 42.3 ($SD = 9.0$) h/wk. Only 56.3% of mothers were employed and

worked 23.3 (SD = 11.7) h/wk, on average. Families lived in the city of Vienna (53.2%), or in the surrounding towns.

Procedures

Three home visits were conducted by two research assistant within two weeks to gather information from families. During the *first* visit, sociodemographic characteristics of the families were collected, and the families were interviewed about daily routines in order to individually tailor the sampling scheme for the paternal activities assessment. By one research assistant, finally, the child's attachment to one, randomly chosen parent, was observed using the Attachment Q-Sort (Waters, 1995). During the second visit, the father was introduced to the experience sampling procedure to assess father-child activities, which would begin the following day. Fathers were given a package of questionnaires on parental relations, relationship dynamics in the family, and family stress either to complete it during the visit or to return it at the third visit. During the third visit, the child's attachment to the other parent was observed by one research assistant (AQS method). The Parent Development Interview was carried out with the fathers, and the remaining questionnaires were gathered.

Measures of Paternal Involvement

Timetable interview. In order to tailor the paternal activity assessments for each individual father, fathers and mothers were interviewed on the first visit regarding their everyday routines throughout an entire week. To calculate the total time fathers were accessible to the child, the following time frames were excluded from consideration: father's paid working hours, the child's out-of home hours (e.g., in childcare), and sleeping hours, leaving only overlapping time frames in which father and child were available to engage in activities with one another.

Experience sampling procedure. The software movisensXS (2014) was employed for experience sampling on the Android operating system, and installed on either the father's

own smartphone or on a provided device. Fathers were instructed to carry the smartphones everywhere and to respond reliably to a set of questions. These questions were to be answered across the individualized time frames derived from the timetable interview. Eight to 15 sets of questions were sent out randomly per day. The sets needed to be short and concise to prevent interruption of the normal flow of routines. Csikszentmihalyi and his colleagues (e.g., Hektner, Schmidt, & Csikszentmihalyi, 2006; Kubey, Larson, & Csikszentmihalyi, 1996) demonstrated high ecological validity showing that subjects go about their normal everyday activities, during experience sampling with very few thoughts about the fact that they will be asked to report on a small sample of their randomly-selected daily experiences.

Questions on father-child activities. Four different sets of questions were used during different times of the day. Each was kept as short as possible (less than half a minute), so as to not interfere with the father's ongoing activities. The *main set* was sent out multiple times over the entire time frame to obtain detailed information on a father's immediate location, anyone in his vicinity, and his current activities. The stylized questions of this survey were organized hierarchically, worded generally at first and then followed by increasingly detailed questions regarding father's activities. For example, Where are you? - at home/in the street/ shopping/etc. - Is someone with you? (1 = yes, 0 = no) - if yes: Who? (partner/<name of child>/etc. - if child: Are you doing something with <name of child>? (1 = yes, 0 = no) - if yes: What are you doing? - supervising/caretaking/cuddling/playing/RTP/watching TV/etc. - if playing: What are you playing? - ball, sports/building blocks/etc.. These activities were later categorized into seven generalized father-child activities: *supervision, basic care, joint play, rough and tumble play (RTP), cuddling, scaffolding-teaching-encouraging (STE), and watching television* (with the target child). In addition, three short sets of questions were used at key times of the day: (a) the *morning set* was sent out in the morning at 9:34 am on average, $SD = 91$ min, and asked whether the father had engaged

in *night care* (Were you called by your child last night? 1 = yes, 0 = no); (b) the *noon set* was sent at 11:58 am, on average, $SD = 82$ min, and asked whether father and child had a shared breakfast (Did you have breakfast with your child? 1 = yes, 0 = no); and finally (c) the *evening set* inquired at 9:12 p.m., on average, $SD = 70$ min, whether father and child had a shared dinner (Did you have dinner with your child? 1 = yes, 0 = no). Finally, fathers were asked to move a slider control as part of the phone app to indicate how typical the day was (1 = typical to 100 = atypical).

Data aggregation on father-child activities. Response rates were calculated from the number of questions sent out within the individually determined time frames as the proportion of responses based on total questions asked (% of responses). Because the time frames varied in length, the response rates also yielded a duration time relative to the timeframe in which they occurred. As a result, each father-child activity yielded a measure of probability of occurrence, as well as of duration (in minutes), which were later aggregated separately for workdays and days off work (see Yeung, Sandberg, Davis-Kean, & Hofferth, 2001). Days with response rates lower than 25% or those categorized by the father as atypical (cut off criterion > 90 on the slider control) were excluded (5.9%). Preliminary analyses revealed bimodal distributions with excess zeros and non-occurrence of certain father-child activities (see Table 1).

Characteristics of Fathers and Families. Characteristics of the fathers (e.g., parental characteristics) and their families (e.g., sociodemographics, family stress) were extracted from interviews, questionnaires and observations of father-child and mother-child interactions. Two trained observers observed one parent during home visits conducted for at least two hours, and then completed the Attachment Q-Sort independently. Resulting scores represent correlations with a criterion sort of the hypothetically most secure child and range from -1.00 to +1.00, with higher scores indicating a more securely attached child. Interrater reliability yielded $ICC = .93$ for the maternal AQS and $ICC = .94$ for the paternal AQS scores; mean

scores were calculated across observers and used in analyses. Table 2 provides details of the AQS and other assessments of the fathers and the family environments).

Table 3. Descriptives of Father-Child Activities.

Father-child activities	Workdays			Days off		
	Non-occurrence	<i>M</i>	<i>SD</i>	Non-occurrence	<i>M</i>	<i>SD</i>
Supervision [time]	51	0:35	0:29	48	1:55	1:13
Basic care [time]	21	0:58	0:37	28	2:09	1:19
Joint play [time]	29	0:40	0:29	28	2:13	2:08
RTP: Rough-and-tumble play [time]	72	0:24	0:15	74	1:01	0:28
Cuddling [time]	63	0:25	0:14	77	0:56	0:28
STE: Scaffolding-teaching-encouraging [time]	77	0:25	0:16	81	1:37	1:11
Watching television [time]	82	0:23	0:13	89	1:32	0:11
Night care [rel. frequency]	55	52	30	74	78	26
Shared meals [rel. frequency]	05	61	26	06	83	24

Note: Non-occurrences were omitted for *M* and *SD*. Non-occurrence reflects percentages. Means and standard deviations of the time represents hours:minutes or the relative frequencies in percentages.

Plan of Analysis

The first analysis involved a latent class analysis (LCA), a person-centered strategy to model separate profiles of paternal involvement. Model fit was assessed by relative entropy, *E*, ranging from 0 to 1, with values closer to 1 indicating a better separation of the patterned profiles (Celeux & Soromenho, 1996). The optimal number of profiles (classes) was fixed by the *bootstrapped likelihood ratio test* (BLRT) (see McLachlan & Peel, 2000), which was given priority over criteria like AIC or BIC, as recommend by Nylund, Asparouhov, and Muthen (2007). BLRT assessed whether the *k* class solution fits the data significantly better than the *k*-1 class solution ($p < .05$). To investigate the second aim of how the different characteristics of fathers and the family environment predicted paternal involvement profiles, the *gradient boosted classification tree* (BCT) machine learning technique (Friedman, 2001)

Table 4. Features of Fathers and Family Environment: Assessments, Descriptions, and

impacts. Note: VI = Variable Importance; IR = Importance Rank;

Assessments	Descriptions of features	Reliability	VI	IR
<i>Parental relations and characteristics</i>				
AQS: Attachment-Q Set (AQS: Waters, 1995): with father	Degree of child's attachment quality towards the parent, e.g., ranging from feelings of closeness and trust to feelings of being left alone and mistrust	ICC = .93	1.00	1
with mother		ICC = .94	.64	4
RSA: Relationship Assessment (RAS: Hendrick, 1988)	Degree of satisfaction with child's mother, love, and realistic positive expectations	α = .87	.41	9
Maternal Gatekeeping (Fagan & Barnett, 2003)	A mother's tendency to supervise (or even restrict) the father's involvement	α = .92	.67	3
BFI: Big Five Inventory (BFI: John, Donahue, & Kentle, 1991):				
Extraversion	Extent of seeking stimulation in the company of others	α = .82	.53	7
Agreeableness	Tendency to be compassionate and cooperative	α = .59	.63	5
Neuroticism	Degree of responding worse to stressors, and interpreting ordinary situations as threatening	α = .71	.25	15
Openness	Degree of intellectual curiosity, creativity, and preference for novelty	α = .69	-	-
Conscientiousness	Tendency to be organized and dependable	α = .68	-	-
Work Centrality: (Carr, Boyar, & Gregory, 2008)	Importance of work compared to family: Higher scores reflect a stronger emphasis on work	α = .82	.25	16
RF: Reflective Functioning (Slade, Aber, Berger, Bresgi, & Kaplan, 2003)	Ability to understand internal states and how they influence behaviors and emotions of the child and oneself (coded from the Parent Development Interview)	Kendall's Tau-b = .82	-	-
<i>Family stress</i>				
PSI: Parental Stress Index (PSI: Abidin, 1995):				
Role restriction	Degree of restrictions in maintaining former freedom and identity	α = .81	.30	11
Competence	Degree of lack of practical knowledge and management skills of parenting	α = .78	-	-
Isolation	Tendency to feel social isolation due to child-rearing responsibilities	α = .61	-	-
Adaptability	Child's inability to adjust to environmental changes	α = .69	.45	8
Demandingness	Child's tendency to insist	α = .63	-	-
Mood	Child's display of negative emotions	α = .75	-	-
BSI-18: Brief Symptom Inventory (BSI-18: Derogatis, 2000)	Extent of overall psychological distress (Global Severity Index)	α = .82	.60	6
MSI-R: Marital Satisfaction Inventory (MSI-R: Snyder, 1997):				
Family history of distress	Degree of severe family disruptions in the father's family of origin	α = .78	.90	2
Dissatisfaction with children	Degree of disappointment in child-rearing, and overt conflicts with the child	α = .43	-	-
Conflicts over child rearing	Extent of conflicts over child-rearing between the parents	α = .72	-	-
Role orientation	Father's tendency towards more egalitarian attitudes	α = .76	-	-
<i>Socio-demographic characteristics</i>				
Agas: Father/Mother		-/.13	-/.13	-/.20
University degree (Y/N): Father/Mother		-/-	-/-	-/-
Working hours: Father/Mother		.24/.30	.24/.30	17/10
Income (Father)		.15	.15	19
Children in household (number)/Siblings of the target child (Y/N)		-/-	-/-	-/-
Age/Gender (Target child)		.27/.26	.27/.26	12/14
Grandparents' support (Y/N)/Target child's out-of-home care [hours/week]		.22/.27	.22/.27	18/13

was applied. BCT can discriminate between important and irrelevant predictors, and handles nonlinear relationships very well, while producing easily interpretable results (Aertsen, Kint, van Orshoven, Ozkan, & Muys, 2010). It combines multiple classification trees to an ensemble (see Breiman, Friedman, Stone, & Olshen, 1984). Each tree in the ensemble is built on the basis of the principle of recursive partitioning, where the feature space is recursively split into regions containing observations with similar response values (Strobl, Malley, & Tutz, 2009). In contrast to other ensemble methods, gradient boosting does not just combine parallel trees, but iteratively adds trees while reweighting the data to focus on the remaining classification errors while ignoring already correctly classified cases (Schapire, 2003). To avoid overfitting of the data, randomly selected 75% of available data (training sample) were used to train the model, while the remaining 25% were used to evaluate out of sample model quality. Following Breiman and Spector (1992), a five-fold cross-validation, in which the training sample was split into five equal parts, was performed to learn the optimal hyper parameters (i.e. model specifications such as number and depth of trees). Models were learned on four parts of the training sample with a given set of hyper-parameters and evaluated on the remaining part. Hyper-parameters that performed best in all splits were finally applied to the entire training sample. Once defined, this model was then verified on the remaining 25% of the data (test sample). To assess model quality, the *area under the curve* (AUC_m) of the *receiver operating characteristic* (ROC) was calculated in its multiclass generalization (see Hand & Till, 2001) in the training and the test sample. Values of AUC_m between .5 and 1.0 indicated model fits from “better than chance” to “perfect fit”.

Results

Profiles of Paternal Involvement

Because of the large proportion of fathers who did not engage in some activities, the data were dichotomized into those fathers engaged in an activity and those not engaged (see Table 1). Using this binary information, LCA was carried out in Mplus 7.1 (Muthen &

Muthen, 2012). Missing data were handled with *full information maximum likelihood* (FIML); only information about shared meals was omitted from analyses because it hardly varied. As a result, BLRT indicated a three-class solution for paternal involvement (3 vs. 2 classes, $p = .006$; 4 vs. 3 classes, $p = .526$) with a relative entropy $E = .762$. This justified good discrimination of three paternal involvement profiles with similar sizes of $n = 57, 63$, and 70 . The three profiles of paternal involvement were labeled *Enriched*, *Balanced* or *Restricted* based on significant differences across certain father-child activities. All differences between the displayed occurrence probabilities that were greater than .2 proved to be significant according to the Benjamini-Hochberg α -correction (Hochberg & Benjamini, 1990) with a *false discovery rate* of $FDR = .05$. As seen in Figure 1, the *Enriched* paternal involvement class had high probabilities on *basic care* and *play* on fathers' workdays and days off; *scaffolding-teaching-encouraging (STE)* on fathers' days off, and more affection (*cuddling*) than the other two classes. The *Balanced* class resembled the *Enriched* class with respect to *basic care* and *play*, but fathers in the *Balanced* class supervised children more than the other classes on both workdays and days off, and were lower on cognitively stimulating activities and *cuddling* on their days off. Finally, the *Restricted* class was low on most father-child activities, but relatively higher on *supervision*, *basic care*, and *play* than the other activities.

Paternal Involvement: Versatility and Duration of Father-Child Activities

To describe the versatility of father-child activities, the number of different activities per profile was analyzed with a generalized linear model adequate for Poisson distribution based on the occurrence of father-child activities. The three profiles were treated as between-group factors and the workday-day-off distinction as a within-group factor. Results revealed the *Enriched* class engaged in more activities than the *Restricted* class, $b = -0.34$, $p = .002$, but fewer activities than the *Balanced* class, $b = 0.32$, $p < .001$. The number of father-child activities did not differ on workdays as compared to days off, $b = 0.07$, $p = .50$, in general, but did differ based on class. On workdays off, fathers in the *Enriched* class engaged in more

activities than fathers in the *Balanced*, $b = -0.38$, $p = .004$, and the *Restricted* classes, $b = -0.32$, $p = .048$. (see Table 3).

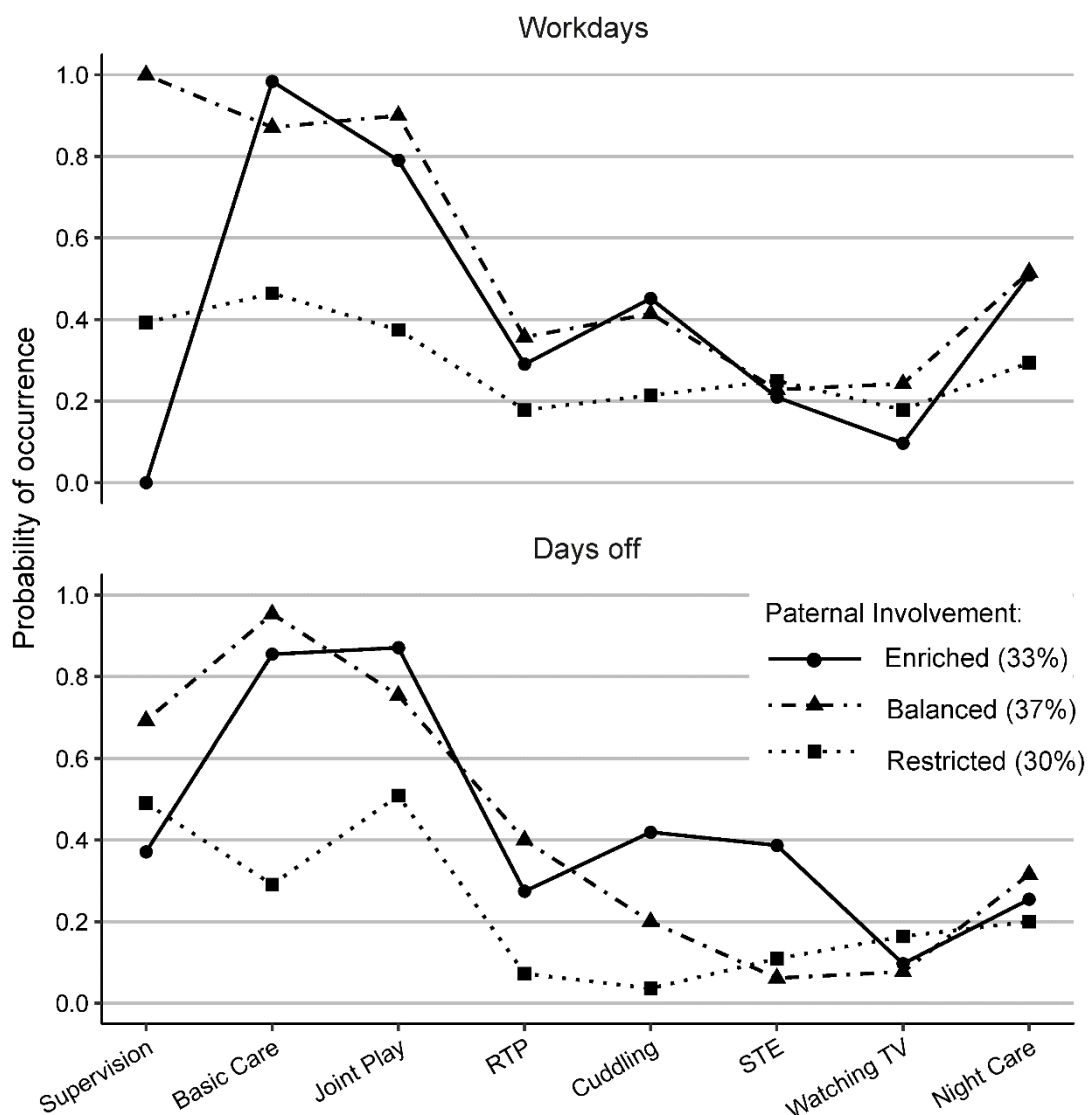


Figure 2. Father-child activities in different paternal involvement profiles. Note: All differences greater than .2 are statistically significant. RTP = Rough and Tumble Play; STE = Scaffolding-Teaching-Encouraging.

The estimated durations of the father-child activities were subjected to an analogous mixed-effect ANOVA model (See Table 4), which revealed that fathers, in general, spent more time engaging with children on days off than on workdays, $F(1, 187) = 312.2$, $p < .001$, *generalized eta-squared effect size* (η^2_G) = .42; a large effect for mixed models (Bakeman,

2005). Furthermore, fathers of the *Enriched* and *Balanced* classes spent more time overall with their children than those of the *Restricted* class, $F(2, 187) = 6.9, p = .001, \eta_G^2 = .04$. No significant interaction between the profiles and type of day was found.

Table 5. Variety of Father-Child Activities in the Paternal Involvement Profiles.

Profiles	Workdays			Days Off		
	Count	2.5% CI	97.5% CI	Count	2.5% CI	97.5% CI
<i>Enriched</i>	3.3	2.9	3.7	3.5	3.1	4.0
<i>Balanced</i>	4.5	4.0	5.0	3.3	2.9	3.8
<i>Restricted</i>	2.3	2.0	2.7	1.8	1.5	2.2

Note: Count = Estimated marginal mean counts.

Table 6. Durations of father-child activities in the paternal involvement profiles.

Profiles	Workdays		Days off	
	M	SD	M	SD
<i>Enriched</i>	2:09	0:16	6:28	0:16
<i>Balanced</i>	2:25	0:15	5:57	0:15
<i>Restricted</i>	1:42	0:17	4:54	0:17

Note: M = Means; SD = Standard Deviation (in h:mm).

Paternal Involvement: Relations with Characteristics of Fathers and their Families

BCT analyses were conducted with the R package *gbm* v2.1.1 (Ridgeway, 2012). The training sample fit well with $AUC_m = .71$, and when this model was applied to the test sample, AUC_m stayed at .72, indicating excellent generalizability and good overall prediction quality. The 35 different variables representing fathers and the family environment were used in the BCT analyses to test their impact in predicting the three paternal involvement class. Only 20 of the available variables were predictive, with the highest variable importance ($VI = 1.00$), relevance of the variable per tree averaged over all trees, for the security of the father-child

attachment (see Table 2). The variable importance for father-child attachment served as the benchmark for comparing all other environmental features. Interparental relations also had relatively high variable importances of .67 (*maternal gatekeeping*) and .41 (*fathers' satisfaction with child's mother*). Others included the variable importance of .64 (*mother-child attachment*), and medium variable importance of *fathers' personalities* (agreeableness .63, extraversion .53, and neuroticism .25). Family stress had variable importance of .90 (*family history of distress*), .60 (*perceived distress with difficult children*), and .54 (*fathers' manifested distress*). Many sociodemographic characteristics had lower impact scores, *mother's weekly working hours* (.30), *age of child* (.27), *child's weekly hours in out-of-home care* (.27), *child's gender* (.26), *fathers' work centrality* (.25), *father's weekly working hours* (.24), *grandparents' support* (.22), *father's monthly income* (.15), and *age of mother* (.13) – see variable importance and ranks for all predictive variables in Table 2.

The four factors with the highest variable importance in predicting the classes were *father-child attachment* (1.0), *family history of distress* (.90), *maternal gatekeeping* (.67) and *mother-child attachment* (.64). Figure 2 shows in greater detail how these variables predicted the three father involvement classes. The *Enriched* profile was more likely when father-child attachment security was higher, regardless of mother-child attachment security and maternal gatekeeping. Fathers' with lower family histories of distress were also more likely to be in the *Balanced* class. In contrast, there was a greater likelihood of being in the *Restricted* profile, when father-child attachment security was low and mother-child attachment security was high, there was a higher incidence of a family history of distress. Interestingly, father-child attachment security did not appear to be related to the *Balanced* class; rather the *Balanced* class was more likely when mother-child attachment security was low and maternal gatekeeping was high.

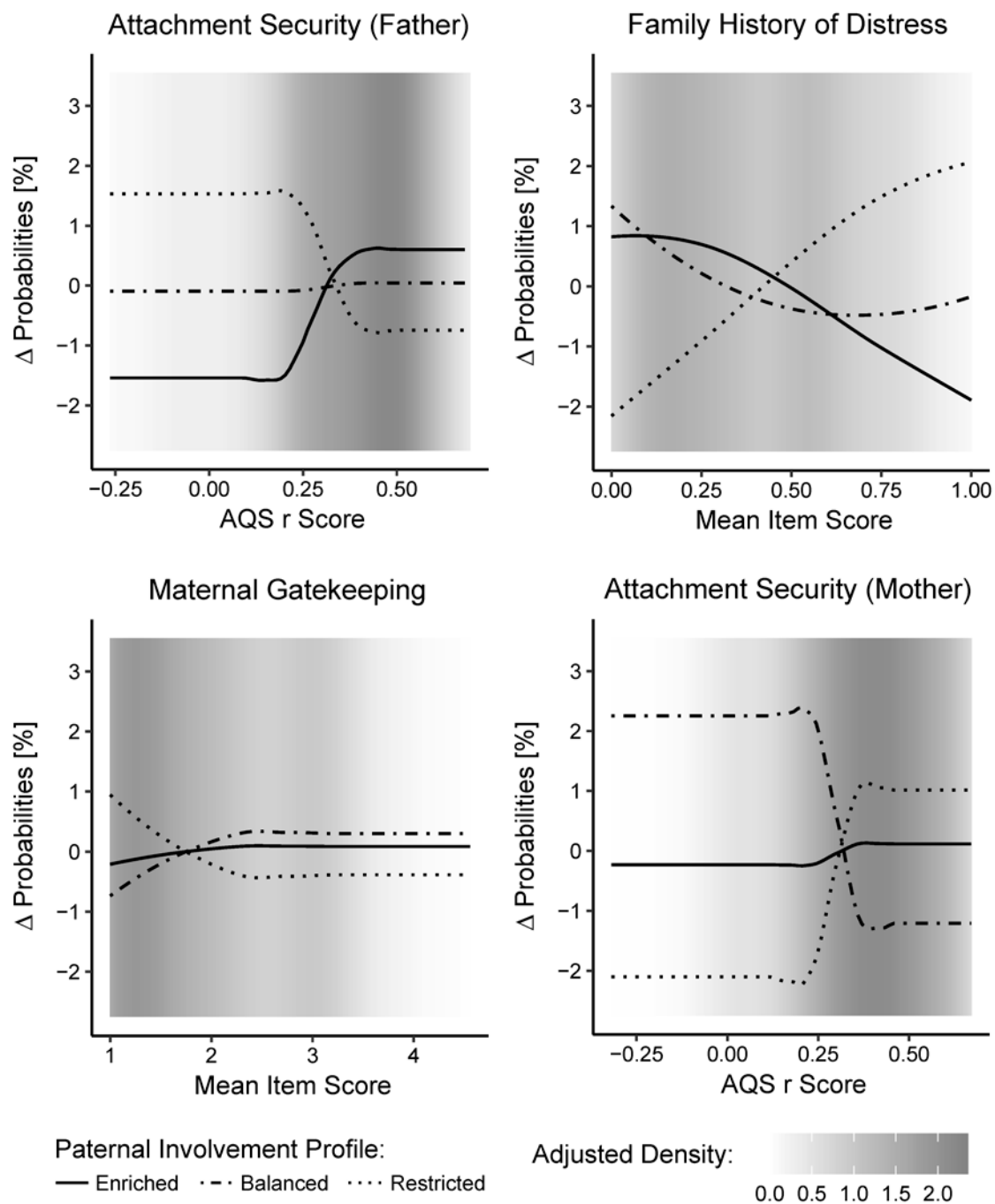


Figure 3. Paternal involvement profiles as related to selected characteristics of the fathers and their families. Note: The curves are LOESS-smoothed (see Cleveland, Grosse, & Shyu, 1992) for better legibility. The background gradient indicates how dense the respective feature is distributed along the scales (density adjusted for the scale's amplitude).

Discussion

The present study conceptualized paternal involvement as a nonlinear dynamic system, comprising an enormous variety of father-child activities that were associated with a

multitude of factors characterizing fathers and their families. Father-child activities were collected using experience-based sampling to obtain ecologically valid assessments of daily activities. These activity data were then analyzed to obtain profiles of fathers' direct engagement in different activities with their children. Moreover, a wide array of variables characterizing fathers and their families, including marital relations and family dynamics, were evaluated for their prediction of the different classes of father involvement.

The current study was inspired by the mathematical field of nonlinear dynamical systems (Barton, 1994; Hastings et al., 1993) which provided a novel means of describing father-child activities within a high dimension feature space. First, father-child activities were operationalized as person-centered descriptions of father involvement (see Bergman & Trost, 2006). As suggested by Pleck (2010), various types of father-child activities comprise father involvement, including supervision and basic care to playing, scaffolding, teaching, and encouraging children. These activities were then classified into three types of paternal involvement profiles or classes (*Enriched*, *Balanced*, and *Restricted*) using LCA, which revealed qualitatively different patterns of father involvement. These profiles were based on the occurrence of father-child activities on workdays and days off, but also on the different types of activities and the time invested in those activities. The *Enriched* class was characterized by high involvement in basic care and play, and a focus on education and affection, particularly on fathers' days off from work. This profile was characterized by the amount of time made for parenting in general, and contained the greatest versatility of father-child activities among the assessed fathers. The *Balanced* class of paternal involvement was similar to the *Enriched* class in terms of basic care and play, but with higher levels of supervision, and lower frequencies of cuddling and affection. The *Restricted* class was lower on all father-child activities, with higher involvement in basic care, play and supervision, suggesting that fathers spent less time in activities with their children overall. These findings

provide strong support for the variability among fathers and the many activities in which fathers can and do engage in with their children.

Predicting Father Involvement Profiles from Characteristics of Fathers and Families

The present study also explored characteristics of fathers and their families in predicting the father involvement profiles. In this regard, gradient boosted decision trees, an innovative data mining approach mainly applied in technical science, was applied to investigate many simultaneously acting and interdependent nonlinear impacts. Recent studies have demonstrated how multiple facets of fathers and family functioning predict fathering behaviors (Cabrera, Fitzgerald, Bradley, & Roggman, 2014; Caldera & Lindsey, 2006; Jain, Belsky, & Crnic, 1996; Lickenbrock & Braungart-Rieker, 2015; Schoppe-Sullivan et al., 2006; Wong, Mangelsdorf, Brown, Neff, & Schoppe-Sullivan, 2009), but the data mining technique allowed us to explore systematically the impact of multiple father and family characteristics obtained from interviews, questionnaires, and observations to predict the three paternal involvement profiles. The impact of various predictors was differential for the individual profiles. For instance, the *Enriched* profile was more likely when father-child attachment security was high, independent of mother-child attachment, whereas, the *Restricted* profile was more likely with low father-child attachment security, yet high mother-child attachment security. In contrast, the *Balanced* profile seemed to be unrelated to father-child attachment security, but more likely when mother-child attachment security scores were low and maternal gatekeeping high. Other correlates were also more probabilistically related to the profiles. For example, distress in the fathers' family of origin was less likely for fathers in the *Enriched* and *Balanced* profiles than those in the *Restricted* profile. Overall, security of the father-child attachment relationship was central in predicting the different father-child activities profiles, with other variables reflecting the dynamics of families coming into play, particularly the quality of the interparental relationship (e.g., marital satisfaction, maternal gatekeeping), mother-child attachment security, and a past history of family distress.

Limitations

These results must be interpreted with regard to their limitations. Experience-based sampling provides a novel means of assessing day-to-day activities between fathers and children, but low frequency activities such as scolding or praising the child are difficult to capture with an experience-based sampling method. Thus, the profiles are based on activities that occurred often enough to be included in analyses. These other activities could have enhanced the description of paternal involvement by yielding additional insights into the quality of paternal involvement. For example, fathers who cuddle a lot with their children may also be more sensitive and use more praise, so even these brief activities, due to their covariance with cuddling, could complete the present profiles. Second, fathers' and mothers' working hours, children's time spent in out-of home care, and father' income played a subordinate role in the prediction of paternal involvement profiles. Perhaps the homogeneous sample, which only involved Austrian fathers from intact two-parent families of primarily middle class, obscured the effects of these other variables.

Future Directions

Father-child activities and their correlates in other demographic groups and cultures may also differ, as prior research has indicated that different societal structures can either hinder or facilitate men's family and parenting time (e.g., Boll, Leppin, & Reich, 2014; Gauthier & DeGusti, 2012) and future research should examine activities between fathers and children from other family backgrounds. The present study focused only on activities fathers did with children while accessible and available. A growing body of literature underscores the effects of spillover from men's work to family life (see e.g., Bumpus, Crouter, & McHale, 2006), with significant impacts on parenting behavior. Understanding these experiences in men's lives may be worth including in future research on fathering. Finally, the present study focused on paternal activities, but given that fathers and mothers parent in a complex system

of relations (see Chapter 1), future research would benefit from utilizing experience-based sampling with mothers, as well as fathers.

Conclusion

The current paper used a novel, person-centered approach to transform the quantity of time fathers spent with the children into qualitative patterns of father-child activities that uncovered three different classes of paternal involvement. By focusing on different types of father-child activities, including supervision, basic care, play, educating and cuddling the child, different patterns were associated with time spent in these activities. Thus, different profiles reflect both the quality of activities and the quantity of time spent in these activities. Finally, embracing a wider view that embraces the ecology of fatherhood allowed us to predict the different profiles. In this regard, the security of the father-child attachment, as well as current and past family relationships emerged as particularly influential.

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Education

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