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Abstract

This paper presents a general theory of child development that incorporates interactive learning and identity formation in social interactions with caregivers. The model sheds light on many puzzling aspects of child development. Child learning responds nonmonotonically to caregivers' attention and approval in social interactions. I highlight key parental characteristics associated with child learning, and identity formation. The theory also explains why media devices widen human inequality. Lessons are finally drawn for the design of policies that alleviate human inequality.

Keywords: Human development, Human inequality, Social Interactions, Identity, Parenting, Learning, Intergenerational transmission, Media.

JEL codes: D10, D91, Z10.

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1 Introduction

The literature on child development allowed for significant improvements to our understanding of human inequality.[1] The existing theories of human development, however, are less able to guide our understanding of an increasingly large body of findings pertaining, for example, to the role of attachment to caregivers in shaping child development, or the relatively high significance of traits other than intelligence for child development.[2] As emphasized by Heckman and Mosso (2014), furthering our understanding of human inequality then necessitates not only the formalization of key notions used in other disciplines related to child-caregiver interactions and interactive learning such as attachment, motivation, mentoring, and scaffolding, but also their integration into life-cycle overlapping generational models. This is precisely the objective of this paper.

To this end, I build a general theory of human development, that incorporates interactive learning and identity formation in social interactions with caregivers. Driven by altruism, caregivers interact with their offsprings, as they send them signals on the behavioral patterns they wish them to adopt. They also provide attention and approval to the behavioral patterns they deem appropriate. Grasping attention and approval serves children's rising quest for affective benefits, as they value the relationship they build with caregivers, and can identify "who they are" to the behavioral patterns that caregivers deem appropriate. Children then adjust their understanding and their behavioral patterns to caregivers' guidance, and a reinforcement learning process is triggered. As children adapt their prism of understanding to the attention they receive, they build attachment for caregivers, and form self-reputation concerns that further increase their willingness to learn from caregivers in social interactions.

Many puzzling aspects of child development are explained by a theory of interactive learning where human development reflects the early interaction patterns between children and caregivers. The theory also micro-founds well established findings of related literatures in economics, psychology and education.

First, I show that children's understanding in social interactions is hill-shaped with respect to the attention and approval they receive from caregivers. If caregivers always pay attention and praise a child for the behavioral patterns that he or she adopts, then he or she will not be able to learn, as errors are not internalized. Conversely, when caregivers scarcely grant attention and approval, then not much is established from which the child can learn. In both cases, the child is unable to create a sufficient understanding of his or her social interactions. Caregivers who are neglectful, who reject, who ignore, or who always pay attention and praise their offspring are predicted to make children build weak attachment and low self-reputation concerns. These effects result in various damaging consequences on life-cycle child development, such as early forms of amnesia, depression, emotional detachment, aggressive behavior, and externalizing problems (Bowlby (1980)).

This prediction echoes a series of findings, although existing empirical evidence on the subject are scarce. It indeed provides a theoretical basis for the notion of "good enough mothering" introduced by Winnicott (1965), who suggests that caregivers should not be overwhelming. Responding to the infant's and toddler's

[1] Reviews of the literature are provided for instance by Borghans et al. (2008), Cunha and Heckman (2008), Almlund et al. (2011), and Attanasio (2015) for child development, and Heckman and Mosso (2014) and Elango et al. (2015) for early interventions.

[2] On the significance of traits other than intelligence, see, for instance, the review of Borghans et al. (2008). On attachment and child development, see the recent study of Heckman and Karapakula (2019*b*).

needs, encouraging and praising them for their achievements, and showing interest in their activities set the stage for child development. Furthermore, if small failures in parental responsiveness to the child's needs will lead to disappointment, they are nevertheless essential in order to trigger the child's formation of self-reputation concerns and sense of the external reality. The first prediction above also provides an interpretation grid for the study of parenting. In particular, the notion of authoritative parenting is defined as a balance between parental control and praise of the child's own perception (Baumrind (1966)). In accordance with the first prediction, a large body of research in developmental psychology and education demonstrates that authoritative parenting correlates with higher child development outcomes.[3]

Second, I derive new theoretical foundations and implications on the root causes of human inequality. Key parental characteristics associated with child development include earnings or non-market income, concerns for the child's behavioral patterns, parental social dysfunctions (e.g. depressive symptoms), educational attainments, and knowledge and information about one own influence on child development. Over time, children raised by caregivers with higher earnings, for example, form stronger attachment, and build higher self-reputation concerns. These children are then predicted to adopt more stable and healthy behavioral patterns in the long run.

The theory also explains why the observed gaps in child development are not necessarily related to performance on intelligence tests. Indeed, the abilities leading to higher performance on these tests are not specifically related to the understanding that children acquire in social interactions with caregivers.[4] Additionally, gaps in child development trajectories are generated, because there is a reinforcement learning process. Children adapt their prism of understanding to the attention and approval they receive, build attachment for caregivers, and form self-reputation concerns that further increase their willingness to learn in social interactions. This prediction is consistent with a large body of research, while it also micro-founds the existence of both *self-productivity* and *dynamic complementarity* in child development.[5]

The third key new prediction is that early exposure to media devices, e.g. smartphones and tablets, is expected to widen human inequality. Media devices can now hardly be ignored in a theory of child development, as early exposure to smartphones, tablets, video games, game consoles and other devices has dramatically increased during recent years.[6] Media devices are expected to widen human inequality for three related reasons.

First, I find that there is a substitution between parental time and resources devoted to child rearing on the one hand, and child exposure to media devices on the other. This prediction stems from the observation that caregivers do not face an opportunity cost at exposing their offspring to media devices, while the opportunity cost at devoting their own time to child rearing may be substantial. The second expla-

[3] For additional insights, see the recent book by Doepke and Zilibotti (2019), which reviews and discusses the positive linkage between authoritative parenting and child development in the first chapter.

[4] See, for example, Heckman, Pinto and Savelyev (2013) and Elango et al. (2015).

[5] See, for instance, the seminal work of Cunha and Heckman (2007), as well as the estimation of the technology of skills' formation of Cunha, Heckman and Schennach (2010).

[6] Already in 2007, 90% of children younger than 2 years were using television and DVDs regularly.[7] It is estimated in the United States that 75% of the children below the age of 8 had access to smartphones and tablets regularly by 2013. According to the Pew Research Center, the use of media devices and internet is also exploding in the developing world. In Brazil for example, while 38% of women and 43% of men owned smartphones in 2015, the numbers had increased to 57% of women and 63% of men by 2019 (Taylor and Silver (2019)). The so-called "media divide" in terms of access to media devices and internet is increasingly disappearing (Chassiakos et al. (2016)), as cheap access to media devices and internet are increasingly available. These few motivating items of evidence strike by their magnitude, and show that media devices can now hardly be ignored in a theory of child development.

nation is that the strength of this substitution effect depends on caregivers' characteristics. Indeed, the substitution effect is predicted to be stronger when caregivers exhibit characteristics conducive to lower child development outcomes. These characteristics include lower earnings or income, lower educational attainments, social dysfunctions (e.g. depression symptoms), lower concerns for children, and lower information about one own influence on child development. The final explanation is that media devices do not provide a perfect substitute for child-"human" caregiver interactions, even though interactive devices (e.g. smartphones or tablets) may foster substantial learning. In particular, they cannot substitute for the attachment or the self-reputation concerns that children steadily build through repeated interactions with humans. Media devices are then less efficient in fomenting the acquisition of self-evaluation concerns that cement behavioral patterns that are more *specific* to human interactions, concerns that buffer children from emotional and social distress, foster language development, or satiation feelings to food intakes.

Besides revealing a growing social issue that is inherent to the rapid pace of technological change that accompanies the evolution of our societies, this result corroborates the scarce existing evidence on the positive linkage between early media exposure and delays in language development, aggressive behaviors, externalizing problems, obesity, and cardiovascular risks. It also supports non-genetic explanations for the determinants of cardiovascular problems and obesity.

Several new policy implications can also be drawn from the theory. First, *targeted* interventions for disadvantaged families are predicted to be particularly beneficial in the long run. Second, specific features of early intervention programs may yield substantial returns. In particular, interventions that aim at *supplementing* rather than *substituting* the main caregivers should have significant returns in the long run. Indeed, child development reflects the attachment and self-reputation concerns that children incrementally build in social interactions with caregivers. By *supplementing* the parents, programs foster learning, the building of attachment, and self-reputation concerns. As these effects persist even after the programs end, the model explains why early intervention programs that are more inclusive of the parents – e.g, those that include parental trainings or home visits – have substantial long-term returns.[8] It also supports interventions that aim at rebuilding attachment between the child and caregivers, by promoting routines such as shared meals, shared play-time, and communications that allow the child to build attachment to caregivers. Improved long-term returns are also predicted when early interventions seek to increase parental awareness and knowledge of their own effect on child development, of the effect of media devices on child development, or when such interventions also assist parents with social dysfunction that decrease their productivity for providing attention in child-rearing interactions (e.g. parental addictions to media devices, or depressive symptoms).

1.1 Literature review:

This paper relates to several strands of literature. First, it relates to the literature on child development, and more specifically to the pioneering works of Cunha and Heckman (2007), Borghans et al. (2008), and Almlund et al. (2011), which provide formal models to study human development. My contribution relative to these studies is threefold. First, I incorporate interactive learning in social interactions in a model of child development. The approach to interactive learning in this paper combines elements of *reinforcement*

[8] For a review on the effectiveness of early interventions, see, for instance, Elango et al. (2015).

learning and *scaffolding*, as caregivers provide adapted guidance to their offspring, and spend time and resources in order to provide attention and praise them in social interaction. Incorporating learning and scaffolding are then crucial in the formal demonstrations of the key predictions discussed above. Second, I further open the black box of human development by studying how early social interaction patterns with caregivers shape the child's prism of understanding and the formation of an identity. This complements more specifically Borghans et al. (2008) and Almlund et al. (2011), as the authors study the formation of *personality traits* given a set of constraints, endowments, incentives, and exogenous preferences.[9] My approach then adds to the literature, as it allows to study the role of attachment and self-reputation concerns in human development. I also distinguish between child understanding of social interactions on the one hand, from identity, i.e. the deep motives for the adoption of behavioral patterns on the other. This captures a feature of influential models used in personality psychology, as illustrated by Roberts (2009). Such a distinction is also empirically sounded, as demonstrated by Borghans et al. (2008). It allows to explain why, in the long run, gaps in child development are not necessarily related to measures of intelligence, but rather to behaviors learned in social interactions. Finally, I micro-found key features of the technology of skill formation introduced by Cunha and Heckman (2007). *Self-productivity* and *dynamic complementarity* in the formation of skills are shown to reflect the cross-fertilizing relation between learning in social interactions and identity formation.

Second, this paper naturally relates to the growing literatures on identity and motivated beliefs. In an influential work, Akerlof and Kranton (2010, 2000) develop a general utility model that incorporates identity as a motivation for behavior. This paper complements Akerlof and Kranton (2010, 2000) by advancing micro-foundations for the formation of identity. These micro-foundations reflect both the social context of early development and self-motivation. Indeed, caregivers set behavioral prescriptions in social interactions, which the child progressively learns to recognize. The formation of identity is then *motivated* by the building of attachment to caregivers and a *self-evaluation* process triggered by the attention that children grasp in social interactions. The approach of this paper then closely relates to the seminal theory of *motivated beliefs* developed by Bénabou and Tirole (2002, 2003, 2004, 2011).[10] The key novelty of this paper relative to these works is to study how social interactions foster – through iterative learning – the formation of attachment and self-reputation concerns.[11]

Third, the paper links to the emerging literature on the economics of parenting, recently reviewed by Doepke, Sorrenti and Zilibotti (2019). Indeed, the theory combines various elements of existing studies on parenting, incorporating them into a theory of child development and identity formation. First, caregivers spend time and resources in order to produce attention and to foster child development (Weinberg (2001), Akabayashi (2006), Del Boca, Flinn and Wiswall (2013), and Cobb-Clark, Salamanca and Zhu

[9] Personality reflects "the relatively enduring patterns of thoughts, feelings, and behaviors that reflect the tendency to respond in certain ways under certain circumstances',' according to (Roberts 2009, p. 140) and the theoretical foundations of Almlund et al. (2011). Identity differs from personality, as it reflects the "deep" motives that foment a personality, such as the child's value of the attachment thatt he or she builds for salient others, and the self-reputation concerns, as conceptualized by Bénabou and Tirole (2011), for instance.

[10] A recent review of the literature is provided by Bénabou (2015).

[11] The theory is then consistent with the growing evidence demonstrating that self evaluations are highly predictive of adult behaviors, including wages, employment, job turnover, and accumulated work experience. See for instance Compte and Postlewaite (2004); Heckman, Stixrud and Urzua (2006); Hoff and Stiglitz (2010); Judge and Bono (2001); Weinberg (2009) on self-confidence, or more generally on motivated beliefs, Brunnermeier and Parker (2005); Kahneman, Wakker and Sarin (1997); Loewenstein (2000).

(2019)). Second, parents face a trade-off between parental control and tolerance to the child's own growing perception (Lizzeri and Siniscalchi (2008), Cosconati (2011), and Doepke and Zilibotti (2017)). Doepke and Zilibotti (2017), for instance, formalize parenting styles by relying on the influential classification of Baumrind (1966) in developmental psychology. The rearing practices in this theory can be interpreted along the grid of Baumrind (1966), too, while the model also provides a theoretical ground to study other key related notions developed in psychology, such as "good enough mothering" (Winnicott (1965)) and attachment (Bowlby (1980)). Furthermore, this paper complements Doepke and Zilibotti (2017), as I focus on the effect of caregivers' socioeconomic characteristics on child development, while the authors study the transformation of parenting practices in changing socio-economic environments.[12] Third, there are information frictions in child–caregiver interactions, as in Akabayashi (2006); Lizzeri and Siniscalchi (2008) and Cunha (2015), for instance. Akabayashi (2006) is interested in the emergence of child maltreatment, and demonstrates that parents may adopt such practices when they persistently underestimate the child's effort in acquiring human capital. Lizzeri and Siniscalchi (2008) formalize iterative learning in child–caregiver interactions in order to study the trade-off that parents face between sheltering the child and allowing him to learn from his own mistakes. My focus is rather on the determinants of human development, and the micro-foundation of identity formation in social interactions with caregivers. This more directly links to the study of Cunha (2015), who develops a model where parents lack information, and this affects their propensity to take a more passive role in their child's development.[13]

The rest of the paper is organized as follows. The theory is developed in Section 2, while Section 3 studies the effect of media devices on human development. Section 4 concludes. The mathematical proofs are relegated to the online Appendix.

2 The model

In this section, I present a general model of interactive learning and identity formation in rearing interactions. I restrict my attention to the early stages of human development, and then only consider interactions between a child and a parent. Indeed, there is ample evidence that early socialization by the parents has dramatic consequences on life cycle development.[14] Prenatal parental influences are also now well established.[15] Arguably, however, as a child moves up the developmental ladder, multiple sources of interaction emerge, such as media devices, peers, schoolteachers, and so forth. Section 3 enriches the framework of this section, and considers the joint effect of parents and media devices on human development. Finally, Appendix B.1 sketches an extension of the model in the case of multiple caregivers. Throughout the paper, the pronouns she and he are respectively used for the parent and the child.

There are two rearing periods, $t = 0, 1$. The time index is dropped when unnecessary. In a given period t, I denote $X_{p,t}$ and $X_{c,t}$ the state of the world, as evaluated respectively by the parent and by the child. Upon observing the state of the world, the parent and the child form different beliefs about the

[12] Doepke and Zilibotti (2019) provide an excellent book on the transformation of parenting practices.
[13] The parenting practices in Cunha (2015) are based on the study of Lareau (2003), who distinguishes a "concerted cultivation" parenting strategy where parents engage with the existing institutions in order to foster child development, from a "natural growth" parenting style, that promotes a more passive role in child development.
[14] See, for instance, Attanasio (2015); Cunha and Heckman (2007); Heckman and Kautz (2012).
[15] See, for example, the recent review of Almond, Currie and Duque (2018).

best behavioral pattern a_t^*, which we assume belong to a vector space Ω. I respectively denote $f_p(. \mid X_p)$ the parent's prior density distribution of the best possible behavior in state X_p, which takes support in a set of possible behaviors Ω. Similarly, $f_c(. \mid X_c)$ denotes the child's prior density distribution of the best possible behavior in state X_c.

In each rearing interaction, the parent first observes the state of the world, and "scaffolds" her child, meaning that she provides guidance, tracks his behavior, and may encourage him. In order to model this, I assume that the parent sends a signal $a_{s,t} \in \Omega$ to her child, which is an information about the behavior she wishes him to adopt. Similarly, I denote $a_{c,t} \in \Omega$ the behavior adopted by the child in period t. Let $\delta(a_c) \in [0,1]$ be the probability that the parent is attentive to her child when he adopts behavior a_c. The parameter $\delta(a_c)$ will be referred to as the *level of attention* that the parent pays to her child.[16] Additionally, upon observing the behavior of her child, the parent can reward him by granting approval. In a more complicated version of the model, the parent could be attentive to both "good" and "bad" behaviors, granting approval to the former and punishing the latter. While incorporating both punishment and approval is closer from real parenting experiences, I focus in this paper on the simpler case where the parent only grants approval upon being attentive to the child's behavior. The magnitude of the reward from garnering approval is assumed fixed and normalized to unity. This comes without loss of generality, since the parent can still condition her level of attention $\delta(a_c)$ on the action undertaken by her child, instead of conditioning the magnitude of the reward garnered by the child, or of potential punishments. In the online Appendix B.2, I present a version of the model where both punishment and approval are formalized, and demonstrate that the results established in the paper still hold.

In the rest of this paper, I will assume the following structure for the attention of the parent, conditional of the child's behavior:

Assumption 1 *In any period t, the parent pays attention with probability $\delta_t(a_c) = \delta_t > 0$ to all the behaviors a_c that lie in the interval $[a_s - \epsilon_1, a_s + \epsilon_2]$, and pays no attention otherwise.*

According to Assumption 1, the parent is only attentive to her child's behavior – and praises him – when the behavior of the child belongs to a certain interval of values that contains the signal a_s. Assumption 1 is made for simplicity and is not necessary in order to derive the results. It could be that the parent provides increasingly more attention to the actions that are closer from the signal that she is transmitting, for example. I present a version of the model with such a gradual reward strategy in the online Appendix B.2, and demonstrate that the results established in the paper are robust to such parenting strategies.

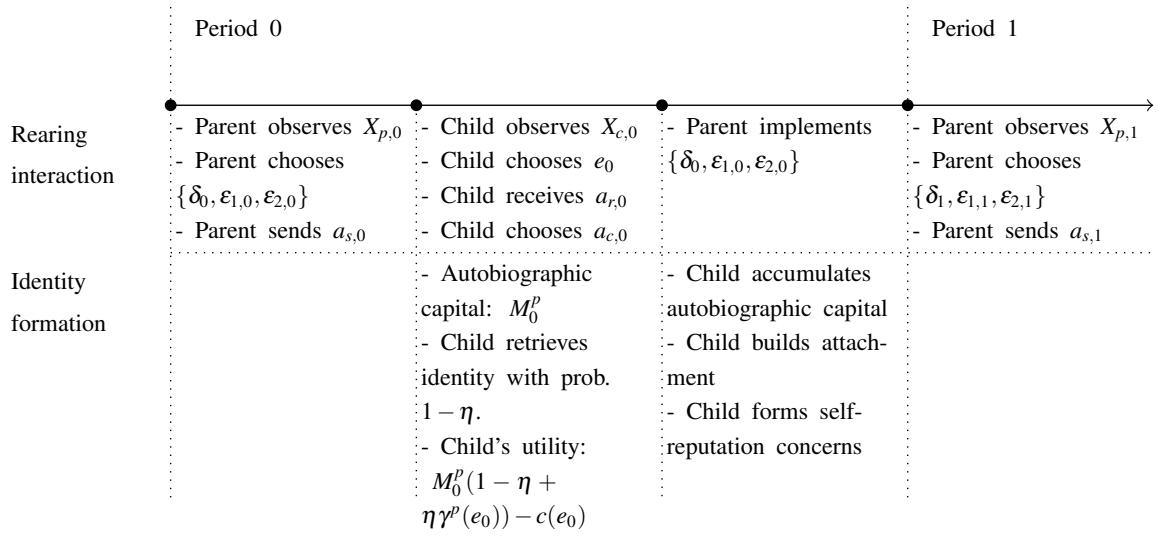
The second dimension of parenting strategies that I consider through the parameters ϵ_1 and ϵ_2 is the *level of permissiveness* of the parent to the child's behavior. The parent is permissive when she provides attention and approval to her child, even when his behavior diverges from the signal. The parameter ϵ_1 reflects the parent's permissiveness to the child's under-estimation of the best behavioral patterns a_s. Similarly, the parent can be permissive to the child's over-estimation of the best behavior, and stays attentive to his behavior as long as a_c stays at a distance ϵ_2 of a_s. A parenting strategy p_t is then a vector that includes the signal, and the levels of attention and permissiveness, $p_t = (a_{s,t}, \delta_t, \epsilon_{1,t}, \epsilon_{2,t})$.

[16] Successful early childhood interventions often seek to increase parental attention. See, for instance, the review of Heckman and Mosso (2014).

2.1 Child's optimization

The signal that the child receives when he interacts with his parent is denoted a_r, and does not necessarily match the signal a_s sent by the parent. In order to grasp the attention of his parent, the child acquires *processing skills*. I denote e_t the processing skills that the child acquires in a given period t, with $e_t \geq 0$.[17] As represented in the upper panel of Figure 1, then, in the initial rearing interactions, the parent first observes the state of the world $X_{p,0}$, chooses the levels of attention and permissiveness $\{\delta_0, \epsilon_{1,0}, \epsilon_{2,0}\}$, and sends a signal $a_{s,0}$ to her child. In turn, the child observes the state of the world $X_{c,0}$, chooses to acquire the processing skills e_0, receives a signal $a_{r,0}$, and chooses to adopt behavior $a_{c,0}$.

Figure 1: Timing of rearing interaction and identity formation



In order to model the strategic decisions made by the child, I assume that his utility in any period t can be written as:

$$u_t^c(e_t, a_{c,t}) = \{1 - \eta + \eta\gamma_t^p(e_t, a_{c,t})\}M_t^p - c(e_t). \tag{1}$$

The function $c(.)$ represents an increasing and convex cost for the child at acquiring processing skills. The parameter $0 < \eta < 1$ refers to the child's imperfect recall of his identity, defined as the deep motives and feelings underlying his behavioral patterns.[18] When the child does not recall his identity, he relies on the attention and approval he grasps from his parent in order in order to evaluate "who he is". The function $0 < \gamma_t^p(.) < 1$ then represents the likelihood that the child garners the attention and approval from the

[17] This could be extended to a vector that also accounts for the time that the child invests in processing the information. For simplicity, I posit that e is one-dimensional. The concept of *processing skills* is similar to the concept of *energy* introduced by Borghans et al. (2008). The preceding authors build a model where both the energy and the time that the child spends with his parent affect the formation of personality traits.

[18] There is extensive evidence that people's recall of their past feelings and true motives is imperfect. Evidence suggest that people tend to judge themselves by their actions, which are shaped by a concern for self-evaluation. See for instance the studies of Bénabou, Falk and Tirole (2018); Bénabou and Tirole (2002, 2011).

parent.[19] From Assumption 1, the function $\gamma_t^p(.)$ can be expressed as:

$$\gamma^p(e_t, a_{c,t}) = \delta_t \int_{a_{c,t}-\epsilon_{1,t}}^{a_{c,t}+\epsilon_{2,t}} f_c(a \mid a_{r,t}; e_t, X_{c,t}) da, \tag{2}$$

Indeed, since the child believes the best action to be $a_{c,t}$ and not $a_{s,t}$ – as his parent – he also believes the attention and praise of his parent to be triggered for an interval of actions centered on a_c. The child then expects to receives a level of attention δ if his behavior lies in the interval $[a_c - \epsilon_1, a_c + \epsilon_2]$. The parameter M_t^p finally denotes the *autobiographic capital* accumulated by the child in the relationship with his parent. It reflects the *attachment* of the child for his parent, and the utility he derives from identifying "who he is" to a distinctive behavioral pattern that is worth the parent's attention and approval.

The child chooses a behavioral pattern $a_{c,t}$ and acquires processing skills e_t so as to maximize his utility (1). It is then direct that the child adopts the behavior that maximizes the likelihood of grasping attention and approval (2), which is the action he believes is best in state $X_{c,t}$.

Additionally, the acquisition of processing skills e_t by the child in rearing interactions plays a dual role. First, they allow the child to better understand the information he receives from his parent, and hence affect γ_t^p, the likelihood of grasping attention and approval. I posit in Assumption 2 below that the higher the processing skills e that the child acquires in a rearing interaction, the lower the standard deviation of the distribution of the signal a_r he receives. In other words, the higher the processing skills e, the higher the likelihood - for the child - that the received signal is close from the best possible behavior.[20]

Assumption 2 *For any action $a \in R$, the likelihood of observing a signal a_r given that the best behavior is $a \in \Omega$ is given by $f_c(a_r \mid a; e, X_c)$. The standard deviation of the distribution of the signal a_r decreases with the processing skills that the child acquires in the rearing interaction e.*

Second, grasping the attention and approval serves the child's quest for affective benefits, as he values the relationship he builds with his parent, and can identify "who he is" to a distinctive behavioral pattern that is worth the parent's attention and approval. The capital that the child values is *autobiographic*, because it is made of a collection of memories of past behaviors that allowed him to please the parent. This capital is valued by the child for at least two reasons. First, the child may wish to identify "who he is" through the behaviors that are worth parental approval, because he is emotionally *attached* to his parent and values the relationship with her. Second, the autobiographic capital may be valued, as the child forms *self-reputation* concerns when he identifies "who he is" to the specific behavioral patterns transmitted by the parent.[21]

[19] One could argue that the child still has a second inference process to make. Indeed, maybe the parent is rewarding the child to motivate him, but he did not "performed well". Rewards may crowd-out effort in this case. Those considerations do not play a role here, since the parent is not more informed than the child on "who the child is". Instead, "who the child is" *has meaning only in the interaction with his parent.* The principal needs to be more informed than the agent for crowding out effects to exist in equilibrium, as demonstrated by Bénabou and Tirole (2002).

[20] The likelihood of observing some signal a_r is, moreover, assumed to belong to the same family of distribution as the prior $f_c(.)$. This is because the child has unique information processing capabilities, which he uses in both understanding his environment and the signals he receives from his parent. The distribution $f_c(. \mid e, X_c)$ is linked to the child's highest order mental processing. The processing skills e that the child acquires in rearing interaction are linked to trait-specific cognitive abilities, which mold the mental information processing technology in the rearing interactions involving the parent.

[21] Bénabou and Tirole (2011) uses the concept of *relational capital* instead of *autobiographic capital*. The two concepts are similar. I use the latter in order to emphasize that the capital built by the child, through social interactions, relates to autobiographic memories.

Finally, the child's acquisition of processing skills allows him to please the parent, and then to accumulate a collection of memories of past behaviors that achieved that precise goal. Therefore, I assume that as of period 1, the autobiographic capital of the child can be written as:

$$M_1^p = e_0 + M_0^p, \tag{3}$$

with e_0 the processing skills acquired in the initial period, and $M_0^p \geq 0$ the autobiographic capital that the child initially possesses in the relation with his parent. M_0^p could be above zero for biological reasons, as relatedness may create attachment between the parent and the child.[22]

Before turning to the parent's optimization, the child's identity formation is summarized in the lower panel of Figure 1. The child's strategic decisions in the initial rearing interaction represented in the upper panel depends on his autobiographic capital M_0^p, and on the probability $1-\eta$ that he is able to retrieve his identity from his memory. The child then derives a utility that is provided in (1). The processing skills he acquires in the rearing interaction finally allow him to accumulate an autobiographic capital, or equivalently to build a stronger attachment to the parent, and to form higher self-reputation concerns.

2.2 Parent's optimization

The parent derives utility during the two periods of childhood from her private consumption, while she also cares about the child. Her value function in any period t is given by:

$$v_t^p = u(c_t) + \alpha v_t^c(\delta_t, \epsilon_{1,t}, \epsilon_{2,t}) + \lambda \tilde{v}(a_{c,t}) + \beta v_{t+1}^p, \tag{4}$$

with c_t her private consumption in period t, $u(c_t)$ her utility from private consumption and $v_2^p = V_2$, so the parent cannot affect her child's welfare after the two rearing periods ($t = 0, 1$).

The parent derives utility from her child in two different ways. First, she cares about the utility of her child, and internalizes that by being attentive in rearing interactions, she would positively affect his utility. The parent then displays *altruism*, and $\alpha > 0$ denotes the weight of the child's welfare in the parent's objective. The function v_t^c in (4) denotes the indirect utility of the child, given that he chooses an optimal behavior $a_{c,t}$ and acquires processing skills in period t. Second, the parent cares about the consequences of the actions that are undertaken by her child. Indeed, the parent values the child adopting certain behavioral patterns for reasons that are not directly apprehended by the child. For instance, the parent may value the child's long-term success. As a simple example, many parents push their children to finish their homework before they can actually play. The parameter $\lambda > 0$ denotes the weight of the *paternalistic motives* in the parent's objective. The function $\tilde{v}(a_{c,t})$ is the utility that the parent derives from her child adopting behavior $a_{c,t}$.[23] Finally, the parent cares about the future, and $\beta > 0$ denotes her time preference.

[22] I could introduce a dependency of M_1^p on e_1, as well, meaning that the autobiographic capital in period 1 depends on the processing skills acquired in that period. This would model an *anticipatory utility* for adopting behaviors that are consistent with the parent's expectations. Accounting for this would only strengthen the incentive of the child to accumulate autobiographic capital. For a theory with anticipatory utility, see, for instance, Bénabou and Tirole (2011).

[23] This assumption has been labeled *imperfect empathy* in the seminal work on cultural evolution of Bisin and Verdier (2001). For a review of this literature, see Bisin and Verdier (2011), for example. On the economics of parenting, Doepke and Zilibotti (2017) uses a similar approach that combines altruistic motives and paternalism in inter-generational transmission.

I assume that attention is produced by the parent with time and market goods. Attention requires both time invested by the parent, and various inputs, such as toys, a bedroom, food, and so forth. As a simple illustration, Del Boca, Flinn and Wiswall (2013) demonstrate that both parents' monetary investments and time inputs are important for the cognitive development of their children, particularly when the child is young. Following the formalism introduced by Becker (1965), I assume that producing one unit of attention requires t_δ units of time, and b_δ units of market goods.[24] The budget constraint of the parent can then be written as:

$$c_t + (p_\delta b_\delta + w t_\delta)\delta \leq wT + W. \tag{5}$$

The parent divides her time T between productive activities – with w her wage – and child rearing. $W > 0$ denotes the non-market income. The "full-income" (Becker (1965)) of the parent $wT + W$ is then used to consume, and to buy the market goods that will allow her to provide attention to her child, while $wt_\delta\delta$ is the foregone income from devoting time to child rearing. It is finally assumed in (5) that when the parent is willing to provide a level δ of attention to her child, she necessarily buys an amount $b_\delta\delta$ of market goods at price p_δ, and does not work during a time period $t_\delta\delta$. These investments in child rearing are finally made by the parent, even if she ends up not rewarding the child with her attention and approval. This assumption then guarantees that the parenting strategy is credible in the eyes of the child.[25]

2.3 Results

In any period t, the parent seeks to maximize her objective (4) by choosing the signal she sends to her child as well as the time and the resources she devotes to child rearing. In turn, the child maximizes her objective (1) as he decides to adopt a certain behavior in rearing interaction, and to acquire processing skills. In the rest of this section, I collect results related to the optimal decisions of the child, of the parent, and to the joint determinants of parenting and child development.

When the prior distribution of the child $f_c(. \mid X_c)$ belongs to the exponential family, which is a set of probability distributions, the child's optimization can be solved by applying the *conjugate prior* theory of Diaconis and Ylvisaker (1979). The exponential family includes the Bernoulli, the Beta, the Uniform, the Multinomial, the Poisson, the Gamma, and the Normal distributions. While the model could potentially be developed with various distributions within the previous set, I will restrict my attention to the case of a prior that is normally distributed. Indeed, the normal distributions allow to solve analytically, while this may not always be feasible for the other distributions in the exponential family. I additionally develop the case of Beta and Uniform distributions in the online Appendix B.3, and show that in a case where it can be analytically solved, the child's optimization leads to similar results.

Let $f_c(. \mid X_c)$ be a normal density centered on X_c with precision s_c. Similarly, I assume that $f_p(. \mid X_p)$ is a normal density centered on X_p with precision s_p. The precision of a distribution is the inverse of the variance. I will rather use this concept, because it gives straight interpretations for the parenting strategy,

[24] See, for example, Heckman (2015) for an introduction to Becker (1965) and to its influence.

[25] Commitment problems could indeed plague the child–parent interaction, when the parent chooses a rearing strategy p_t that is not credible. Frictions on the labor market could also explain why the parent cannot work during the time she intended to devote to child rearing. Similarly, the parent may have to make the monetary investments in child rearing before the interactions take place – e.g. to buy toys and furniture – so that she cannot condition the investments on the behavior of the child.

as shown next. Finally, given that the child acquires an amount e of processing skills in the interaction with his parent, he receives from her a signal a_r that is drawn from a normal distribution centered on a_s – the signal sent by the parent – with precision e. From the maximization of the child's objective (1) the following properties are deduced for the processing skills that the child acquires in rearing interactions:

Proposition 1 ***Child's acquisition of processing skills in rearing interactions:***

- *The child chooses a behavior that maximizes his posterior distribution for the best possible behavior.*
- *There exists self-productivity in the child's acquisition of processing skills.*
- *The child's acquisition of processing skills in each rearing interaction increases with the level of attention provided by the parent δ, and decreases with the probability that the child recalls his identity $1-\eta$.*
- *The child's acquisition of processing skills is hill-shaped with respect to the levels of permissiveness ϵ_1 and ϵ_2. When the parent pays attention to small behavioral mistakes, i.e. when she observes behaviors that are below a standard deviation distance from her signal a_s, then higher permissiveness levels increase the child's acquisition of processing skills. By contrast, when the parent pays attention to larger behavioral mistakes, i.e. when she observes behaviors that are above a standard deviation distance from her signal a_s, then higher levels of permissiveness decrease the child's acquisition of processing skills.*

Proof. The proof is available in Appendix A.1. ■

The child chooses the behavior that maximizes his posterior distribution for the best possible behavior, because such a behavior maximizes the likelihood of grasping attention and approval. Additionally, there exists a *reinforcement learning* process that explains the *self-productivity* in the child's acquisition of processing abilities. Indeed, a higher acquisition of skills in the initial period e_0 increase the child's propensity to further acquire skills in the second period. The intuition is that as the child acquires processing skills in the initial interaction with his parent, he accumulates an autobiographic capital. The child then builds attachment and forms self-reputation concerns, so he has more to lose in the second period if he does not behave as is expected of him – by his parent – but also *by himself*, since he identifies "who he is" to the past behaviors he adopted in rearing interactions.

When δ increases, the parent pays more attention to her child, and the child acquires more processing skills, since the child values the attention he receives. Alternatively, if the child becomes better able to retrieve his memories about who he is, i.e. if $1-\eta$ increases, he has a lower incentive to create processing skills in the interactions with his parent.

The effect of the parameters ϵ_1 and ϵ_2 on the child's acquisition of processing skills reflects the key intuition of the learning model above. The permissiveness of the parent with respect to both under-estimations ϵ_1 and over-estimations ϵ_2 has a non-monotonic effect on the child's acquisition of processing skills. Indeed, as a simple intuition first, if the parent always pays attention and praises the child for the behavioral patterns he adopts (i.e. ϵ_1 or ϵ_2 are large), then he or she will not be able to learn, as errors are not internalized. Conversely, when the parent scarcely grants attention (i.e. ϵ_1 and ϵ_2 are low), then not

much is established from which the child can learn. Following a similar reasoning in a more general case, if a parent only pays attention to small behavioral mistakes, then higher permissiveness levels from the parent increase the benefits at acquiring processing skills for the child. Learning is beneficial, as it increases the likelihood of grasping attention and approval. By contrast, if the parent also pays attention to large behavioral mistakes, then higher permissiveness levels *decrease* the benefits at acquiring processing skills. Learning is an inefficient waste of resources for a child who has a high likelihood of grasping attention and approval.[26]

Turning to the parent's optimization, I posit that the parent's utility from her child adopting a behavior a_c is given by:

$$\tilde{v}(a_c) = -\mathbb{E}_{a_r}[\mathbb{E}_{a^*}(a^* - a_c)^2 \mid a_r]. \tag{6}$$

The paternalistic motive then relates to the expected magnitude of the mistake made by the child when he chooses behavior a_c. This mistake is evaluated from the parent's perspective, i.e. given that the best possible action a^* is drawn from a normal distribution centered on X_p with precision s_p. Since the parent sets the parenting strategy at the beginning of any period t, she does not know the realization of the signal received by the child a_r, hence the expectation is over both a^* and a_r (see Figure 1 for the timing). By relying on the properties of the normal distribution, we find that:

$$\tilde{v}(a_c) = -\frac{1}{s_p} - \frac{e + s_c^2(X_p - X_c)^2 + \{e^2(X_p - a_s)^2 + 2es_c(X_p - X_c)(X_p - a_s)\}}{(s_c + e)^2}. \tag{7}$$

If the parent was to act instead of her child, her expected loss will simply be $-1/s_p$, i.e. the variance of her own prior. But the parent is not acting; she is instead transmitting a signal a_s, hoping that her child will understand it correctly. Therefore, the parent internalizes that there is an additional loss, because her child has a different belief and needs to acquire processing skills in order to understand the signal he receives. Indeed, the difference between the belief of the parent, and that of the child can be reduced, if the child pays more attention to his parent. The parent then has an incentive to set a parenting strategy that spurs the child's acquisition of processing skills as much as possible in order to reduce the loss due to her paternalistic motives. Finally, the utility of the parent negatively depends on the different between her own prior X_p, and the signal a_s she sends to her child.

The parent sets her parenting strategy $(a_{s,t}, \delta_t, \epsilon_t)$ so as to maximize her value function (4) subject to the budget constraint (5). We deduce the following result.

Proposition 2 ***Parenting strategy:*** *In any period t, the signal sent by the parent maximizes her prior $a_{s,t} = \arg\max_a f_p(a \mid X_{p,t})$, and there exists a unique optimal strategy (δ_t, ϵ_t) such that:*

- *A parent with higher income W tends to be both more permissive and more attentive to her child. Similarly, a parent with higher earnings w is more permissive and more attentive as long as the productivity of the time devoted to child rearing is sufficiently high (i.e. t_δ is sufficiently low).*

[26] The fact that the threshold in the proposition corresponds exactly to a standard deviation is linked to the shape of the density of a normal distribution. More specifically, it is a consequence of the property that the curvature changes – for the normal distribution – precisely one standard deviation away from the mean. This property does not hold for other distributional forms, even in the exponential family.

- *An increase in the altruistic motive α, in the productivity of the market goods used in child rearing (i.e. a lower b_δ) and in the time used for child rearing (i.e. a lower t_δ), tend to increase both the level of attention and the level of permissiveness of the parent.*

- *An increase in the paternalistic motives of the parent λ, and in her time preferences β, have an ambiguous effect on both the levels of attention δ and permissiveness ϵ.*

Proof. The proof is available in Appendix A.2. ■

The parent has no incentive to send a message that differs from what she thinks is the best behavior in state $X_{p,t}$, as such a signal minimizes the expected mistake made by the child when he optimally chooses a behavior. In this case, bracketed term in (7) is then reduced to zero.

Additionally, when choosing her level of attention δ, the parent trades-off a lower amount of time devoted to productive activities – and hence lower levels of private consumption – with a higher welfare for her child. The first-order condition associated with the maximization of (4) with respect to δ_0 is:

$$-(wt_\delta+p_\delta b_\delta)u'(c_0)+\alpha(1-\eta)r^pM_0^p\int_{-\epsilon_0}^{\epsilon_0}\sqrt{\frac{s_c+e_0}{\pi}}e^{-1/2(s_c+e_0)a^2}da+\lambda\frac{\partial e_0}{\partial\delta_0}\{\frac{\partial\tilde{v}(a_{c,0})}{\partial e_0}+\beta\frac{\partial e_1}{\partial e_0}\frac{\partial\tilde{v}(a_{c,1})}{\partial e_1}\}=0, \tag{8}$$

with $c_0 = w(T - t_\delta\delta_0) - p_\delta b_\delta\delta_0$.

The marginal cost at devoting attention to the child is modeled by the first term in the LHS of (8). The marginal benefit of the parent is made of three different incentives. First, the parent internalizes that by being more attentive, she will increase the utility of her child, that values garnering attention and approval. This effect is modeled by the second term in the LHS of (8). Second, the parent anticipates that devoting attention to her child improves his behavior in the current period. Indeed, the initial behavior of the child $a_{c,0}$ tends to be closer from the optimum of the parent a_p when the child pays more attention to his parent. This effect is modeled by the third term in the LHS of (8) above. Finally, the parent also anticipates that more attention in the initial period allows the child to create attachment and a sense of self that will incentivize him to acquire processing skills in the next period, $\partial e_1/\partial e_0 > 0$. Hence, higher parental attention in the first rearing period makes the child adopt better behavioral patterns in the second period. This last effect - modeled by the last term in the LHS of (8) - provides an additional incentive for the parent to provide attention to her child.

The first-order condition with respect to the level of permissiveness ϵ_0 writes:

$$2\alpha(1-\lambda)r^pM^p\delta\sqrt{\frac{s_c+e_0}{2\pi}}e^{-1/2(s_c+e_0)\epsilon^2}+\lambda\frac{\partial e_0}{\partial\epsilon_0}\{\frac{\partial\tilde{v}(a_{c,0})}{\partial e_0}+\beta\frac{\partial e_1}{\partial e_0}\frac{\partial\tilde{v}(a_{c,1})}{\partial e_1}\}=0. \tag{9}$$

When setting her level of permissiveness ϵ, the parent trades-off a higher welfare of the child with a lower willingness – from him – to acquire processing skills in the two rearing periods. On the one hand, the child benefits from having a more permissive parent, since he values the attention of his parent. This effect is modeled by the first term in the LHS of (9). On the other hand, however – and as discussed after Proposition 1 – beyond a certain point, paying more attention to the child makes him less willing to acquire processing skills ($\frac{\partial e_0}{\partial\epsilon_0} < 0$), since the child grasps the attention of his parent even when his behavior is "bad". This effect is modeled by the second term in the LHS of (9). Finally, a forward-looking

parent foresees that more permissiveness in the initial period also negatively affects the accumulation of an autobiographic capital, and hence the child's future acquisition of processing skills. This effect is modeled by the last term in the LHS of (9).

This optimization problem necessarily admits a unique interior solution, where permissiveness and parental attention are complement. Indeed, in any given period, higher levels of attention allow the parent to be more permissive. She knows that by being attentive, she incentivizes the child to acquire a sufficient amount of processing skills in the interaction, so she can indulge herself in being more permissive.[27] Reciprocally, when the parent is more permissive, she should be more attentive in equilibrium, as well, so as to prevent her child from disinvesting their relationship (Proposition 1).

The complementarity between permissiveness and attention is crucial in order to understand the comparative statics of Proposition 2. Indeed, first, a parent with a higher income W will devote more attention to her child, as she has a lower marginal cost from doing so. By complementarity, then, she will also be more permissive. A higher W could stem for instance from higher earnings from the parent's partner in the household, who specializes in productive activities, while the parent under scrutiny is more involved in child rearing.

Alternatively, it is not obvious that a parent with higher earnings w necessarily has a lower marginal cost at devoting attention to her child. Indeed, on the one hand, higher earnings create an *income effect*, which tends to increase the time spent by the parent at providing attention to her child. Inversely, there is a *substitution effect* as the foregone earnings at devoting time to child rearing are higher. The parent may then choose to work more. Which effect dominates cannot be determined a priori. In the Appendix, it is shown that when the productivity of time devoted to child rearing is sufficiently high, then the income effect necessarily dominates. This result stems from the observation that when the parent is more productive at devoting time to child rearing, then the foregone earnings from being attentive to the child are low. I assume that the parent's productivity of time in child rearing is sufficiently high in this paper, as parental attention may not always compete with market time (child rearing then costs less money per unit of time than taking few hours off during the work day).

Similarly, a parent with higher altruistic motives is more attentive and permissive, since she gets greater enjoyments from seeing her child garnering her attention and approval. When the productivity of the market goods used for child rearing increases (i.e. when b_δ decreases), then the marginal cost at providing attention to the child decreases, from (8). The effect of a higher productivity of time in child rearing is similar. We should then expect, in both cases, the attention provided by the parent to increase. The permissiveness increases as well, by complementarity.

Finally, paternalistic motives and time preferences have similar effects on the parenting strategy. Paternalistic parents value their child making fewer mistakes in any period. Parents with higher time preferences seek to reduce the mistakes of their child, too, as they internalize that higher early levels of attention create a sense of identity, which allow the child to adopt "good" behaviors in the future. Both paternalistic motives and time preferences then aim at increasing the child's acquisition of processing skills. The parent can achieve this either by increasing her attention to her child δ, or by being less permissive, i.e. by decreasing

[27] This effect presupposes, however, that the cost function of the child $c(.)$ is sufficiently convex. Indeed, in this case, permissiveness decreases significantly the cost at acquiring processing skills in the relationship, and hence incentivizes the parent to increase her level of attention. See Appendix A.2.

ϵ. Hence, the effect of higher time preferences or more paternalistic motives is ambiguous in the general case. It could be that higher levels of attention are achieved with significantly higher levels of attention, and hence also higher levels of permissiveness. By contrast, it could be that being less permissive is so crucial in order to achieve higher levels of processing skills that the parent also reduces his attention to her child when λ or β increase.

As sketched in the previous discussion, parenting strategies – and the parental characteristics underlying them – have tremendous consequences on the child's acquisition of processing skills and accumulation of autobiographic capital. The results pertaining to the effects of parental characteristics on child development are summarized in the following proposition.

Proposition 3 ***Child development and parenting strategy:***

- *A child from a parent with lower earnings w or a lower income W acquires fewer processing skills and accumulates less autobiographic capital over time.*
- *A child from a parent with lower time preferences β or with lower paternalistic motives λ tends to develop fewer processing abilities in rearing interactions, and to accumulate less autobiographic capital. This effect is amplified when the parent is poorer (i.e. when w is lower).*
- *A child from a parent with a lower time-productivity t_δ for child rearing develops fewer processing abilities and accumulates less autobiographic capital. A child from a parent with higher altruistic motives α does not necessarily develop more processing skills and autobiographic capital.*

Proof. The proof is available in Appendix A.3. ■

It is not clear a priori that higher earnings, or higher income would necessarily make the parent set a rearing strategy that increases her child's acquisition of processing skills and autobiographic capital. Indeed, on the one hand, the parent has paternalistic motives, so she wants her child to adopt behaviors that are close to what she transmits in rearing interactions. In face of higher earnings then, a paternalistic parent would devote more resources and time for child rearing, so that her child develops more processing skills. On the other hand, the parent also has altruistic motives, so she cares about the welfare of her child, independently from the behavior he adopts. In face of higher earnings, then, the parent could become more involved in child rearing, without necessarily fostering the child's acquisition of processing skills.

In Appendix A.3, it is demonstrated that the paternalistic motives necessarily dominate, meaning that higher earnings or income increase the child's acquisition of processing skills and autobiographic capital. This outcome obtains for two reasons.

First, there is a complete separability in the utility of the parent (4) between her paternalistic and altruistic motives. Considered separately, the altruistic motives have absolutely no effect on the child's acquisition processing skills. Indeed, if the parent is only altruistic, then she will necessarily set ϵ, the level of permissiveness, to infinity; hence the child will have no incentive to invest in the relationship. In other words, the child's incentive to acquire processing skills in the rearing interaction entirely stems from the parent's paternalistic motives. Therefore, higher earnings will necessarily increase the resources devoted to child rearing in such a way that the child develops more processing skills and accumulate more autobiographic capital.

Second, as higher earnings or income will increase the child's initial acquisition of processing skills, they will also increase the child's willingness to acquire processing skills in the future period. From the existence of *self-productivity* in the technology of human development then (Proposition 1), sizable gaps in the acquisition of processing skills – and the accumulation of an autobiographic capital – are created between children raised by parent with different earnings or income. The *self-productivity* of skills also triggers a virtuous cycle between child development and parental time and resources devoted to child rearing, a property known as *dynamic complementarity* in the literature (e.g. Cunha, Heckman and Schennach (2010)).

Relative to the second point of the proposition, a parent with lower time preferences values her child's forming an identity trait less over time, and hence puts less value in her child's early adopting of a behavior consistent with what she teaches. Therefore, the child will acquire fewer processing skills over time. Interestingly, this negative effect is amplified at lower income or earnings levels. A poor parent with higher time preferences could substantially increase her child's development, if she were to value more her child's future welfare. A marginal increase in the parent's time preference leads to large changes in rearing strategies – and in the child's acquisition of processing skills. The effect of more paternalistic motives λ is similar, as it raises the child's acquisition of processing skills. A poor parent with higher paternalistic motives could also substantially increase her child's development, if she were to value more the child's adoption of specific behavioral patterns.

Finally, a child from a parent with a lower time-productivity t_δ for child rearing will necessarily develop fewer processing abilities and accumulate less autobiographic capital. By contrast, higher altruistic motives will not necessarily lead to more investment of the child in acquiring processing skills. Indeed, altruism aims at fostering the child's welfare, independently from the behavioral patterns he adopts. Hence, it could be that a more altruistic parent becomes so much permissive that she makes her child less able to cope with the external world and to build his own identity.

2.4 Empirical predictions and Policy Implications

Empirical predictions:

Attachment theory: In the model, the parent's attention and approval allow the child to acquire processing skills, and to build an *identity* – a sense of "who he is" – that will guide his future behaviors. Permissiveness and parental attention are the key determinants of the child's acquisition of processing skills, and accumulation of an autobiographic capital in the interactions with his parent (from Propositions 1 and 2). I have also predicted that when the parent is less involved in child rearing for the various reasons detailed in Proposition 3, then the child is less able to acquire processing skills and to build self-representations.

The theory above then provides a theoretical ground for what is known in developmental psychology as the *attachment theory*. According to the attachment theory, the formation of a sense of self reflects the interaction patterns between the child and his or her attachment figures. In the words of (Harter 2007, p. 518), "attachment theory [...] highlights the critical role [for child development] of care, sensitivity and feedback from socializing agents." This dates back to the seminal work of Winnicott (1965) of "good enough mothering", which suggests that responding to the infant's and toddler's needs, encouraging and praising

them for their achievements, and showing interest in their activities allow for positive self evaluations, and sets the stage for child development. Conversely, parents who ignore, reject or abuse children cause them to negative self-evaluations, which have various damaging consequences on child development, such as early forms of amnesia, depression, and emotional detachment (Bowlby (1980)).

The results established above then echo a series of findings related to the *attachment theory*, although existing empirical evidence on the subject are scarce. First, based on clinical cases, Briere (1992) suggests that neglected or abused children tend to hold the belief that "they are bad" and that they deserved to be punished. They tend not to be able to positively describe capabilities, and to take pride in one's accomplishments. This low self-esteem is interestingly correlated with the quasi absence of construction of an *autobiographical capital*, as the children also tend not to be able to describe one's past life story. This study then accords with the mechanisms set in this paper. Similarly, Harter (2007) uses the concept of *impoverished self* in order to describe the weak acquisition of autobiographical capital of children from families where they are neglected. An impoverished self also adopts disorganized behaviors (Harter (2007)).

On the empirical side, to my knowledge, no study explores both the role of attachment to caregivers, and the formation of self-reputation concerns in the process of early human development. However, in a recent study, Heckman and Karapakula (2019*b*) find that once reaching adulthood, the treated children of the Perry program report having been closer to their parents relative to the untreated (especially treated women reporting closer attachment to their biological fathers before age 15). These findings demonstrate that attachment may be an important dimension for explaining the long-term effects of early intervention. More broadly on the link between child–caregiver interactions and child development, neglected children are shown to struggle when looking at human faces to correctly identify different emotions (National Scientific Council on the Developing Child (2012)). This suggests that they lack basic processing skills in social interactions. They also have significantly lower scores on language skills, higher behavior problems in early childhood, and greater odds at engaging in criminal activities according to Spratt et al. (2012).

Parenting strategy and child development: From Proposition 1, I have demonstrated that a parent should *scaffold* her child in order to foster learning, and the building of attachment and self-reputation concerns that will be an anchor for the long-term behavioral patterns adopted by the child. Scaffolding aims at understanding the child's own learning capabilities, while providing guidance and devoting attention and approval. It also entails for the parent to know to withdraw her attention and affection when the child's behavioral patterns are not good enough.

Such a complex task resembles the parenting strategy labeled *authoritative* in the seminal work of Baumrind (1966) that is a foundation stone of the developmental psychology literature. Indeed, according to (Baumrind 1966, p. 891), "both autonomous self-will and disciplined conformity are valued by the authoritative parent". Based on Baumrind (1966)'s theory of parenting, a therapy labeled "Parent-child interaction therapy" (PCIT) has been created more than 40 years ago. It was first intended to treat disruptive behavior problems in children aged 2 to 7 years. It involves two phases; the first intends to increase what has been labeled in the model the level of *attention* of caregivers and includes praise, verbal reflection, imitation, behavioral description, and enjoyment. The second phase aims at finding an efficient level of *permissiveness* by increasing the parent's control over the child's behavior while maintaining communication and parental attention. Empirical evidence on the effect of this therapy on cognitive outcomes and on the child's formation of self-representations are reviewed by Lieneman et al. (2017). In

accordance with the prediction of the theory, most of the existing studies – including meta-analysis – find positive effects of the therapy on externalizing problems for children with disruptive behavior disorders.[28] Also consistent with Proposition 1, the positive linkage between *authoritative* parenting and higher levels of child development is documented in several studies reviewed by Doepke, Sorrenti and Zilibotti (2019). It finally remains ambiguous, according to the theory, whether mild spanking necessarily correlates with negative child outcomes, as it could be a consequence of misbehavior, and incorporated to an authoritative parenting strategy that fosters learning, rising attachment, and self-evaluation concerns (see Baumrind and Larzelere (2010)).

Financial constraints and child development: Relative to the effect of financial constraints on child development, I have shown above that a child of a parent with lower earnings or a lower income acquires fewer processing skills and accumulates less autobiographic capital (Proposition 3). Furthermore, this effect is amplified by the *self-productivity* in the child's acquisition of processing skills and formation of an autobiographic capital (Proposition 1), by the *dynamic complementarity* between parental investments in child rearing and child development, and by the cross-fertilization between identity formation and the acquisition of processing skills in social interactions (Proposition 1).

These results have been jointly documented in the literature, as gaps in developmental outcomes between children raised in advantaged and disadvantaged families open up early. Well established evidence demonstrate that children growing up in more advantaged families have better achievement.[29] Once adults, children of parents with higher socio-economic status are also more likely to be employed, have higher earnings, and enjoy better health and longer lives.[30] Furthermore, the dynamic complementarities in the acquisition of processing skills as well as the complementarity between parental investments in child rearing and child development, are empirically supported by various studies. Cunha et al. (2006), for instance, establish both the *self-productivity* of skills and the existence of a dynamic complementarity between child development and parental investments in child rearing.[31] The cross-fertilization between various measures of skills highlighted above is also documented in the empirical literature.[32]

The result above also accords with the series of evidence on the long-term effect on child development of programs that foster stable family relationship in disadvantaged families. Such programs include the Parent-Child interaction therapy (PCIT), the Abecedarian project, the Perry Preschool program, Head Start, or Project STAR. These programs typically affect a child's development of cognitive and personality skills. Heckman et al. (2010) and Conti, Heckman and Pinto (2016) show, for instance, that the Perry program conducted in the mid-1960s and the Carolina Abecedarian Project (ABC) conducted about a decade later significantly enhanced adult outcomes including education, employment, earnings, marriage, and participation in healthy behaviors and reduced participation in crime.[33] Heckman, Pinto and Savelyev

[28] These studies are reviewed by Lieneman et al. (2017).

[29] Contributions on the subject include for instance Agostinelli and Wiswall (2016); Akee et al. (2010); Bernal and Keane (2011); Cunha and Heckman (2007); de Neubourg et al. (2018); Hair et al. (2015); Rubio-Codina, Attanasio and Grantham-Mcgregor (2016).

[30] See for instance Duncan et al. (2012); Duncan, Ziol-Guest and Kalil (2010); Heckman, Pinto and Savelyev (2013); Knudsen et al. (2006).

[31] On the self-productivity of skills, see Heckman and Kautz (2012) and Agostinelli and Wiswall (2016), for example.

[32] See, for example, Heckman, Stixrud and Urzua (2006) and Heckman and Mosso (2014).

[33] In a recent study, Heckman and Karapakula (2019*b*) present evidence of the positive effect of the Perry program while implementing a statistically conservative inferential procedure in order to account for the limitations inherent to the data. Similarly, Gertler et al. (2014) report substantial effects on the earnings of participants twenty years after a randomized

(2013) have found that the long-run effects of the Perry school program are not essentially consequent of higher IQ levels. Alternatively, a sizable portion of the adult treatment effect is explained by differences in personality and motivation. Over their life cycles, the treatment group was far more successful, as the participants were less antisocial and aggressive, and they also adopted less rule-breaking behaviors and developed higher academic motivation (especially the treated girls). This confirms the key role of social interactions the formation of an identity that cements behavioral patterns in the long run (Propositions 1, 2, 3). The theory also explains why the observed gaps in child development are not necessarily related to IQ, which is typically measured by performance on intelligence tests, so it relates to skills not specifically acquired in social interactions with caregivers.

Parental characteristics and child development: In the second point of Proposition 3, it is demonstrated that parents' time preference and paternalistic motives positively affect the child's acquisition of processing skills and autobiographic capital. Similarly, in the third point of Proposition 3, we have shown that parents' productivity for generating attention to their children also predicts higher child development outcomes.

Parental education is arguably associated with a higher time horizon, higher paternalistic motives, and a higher productivity in child rearing.[34] Accordingly, the three predictions above support the well-established evidence that the parental educational attainments are key predictors of child development.[35] Maternal education also strongly predicts family structure and the absence of maternal depression, which are other important determinants of child development (Jackson, Kiernan and McLanahan (2017)).

Another potential channel for the effect of education on child development is linked to the differences in the content that is transmitted in the interactions by parents with different educational attainments. Lack of education can indeed be a constraint on the content that is feasibly transmitted by the parent. Some parents may, for example, be better at learning the noisy signals they receive from their child (in the model, s_p could be lower for educated parents). This could follow the superior parenting that the parents themselves have received. Accordingly, it is shown, for instance, that educated mothers use longer utterances and more different words when they talk to their children. In turn, their children also have larger vocabularies (Hoff (2003)). Similarly, Schady (2011) shows that in a longitudinal study of relatively poor children in Ecuador, the schooling and vocabulary levels of mothers were strong predictors of the cognitive development of the young children.[36]

The values of the parameters λ and β also reflect the parents' knowledge about the impact they have on child development.[37] The results established in Proposition 3 then corroborate recent evidence on

intervention conducted in 1986–1987 that gave psychosocial stimulation to growth-stunted Jamaican toddlers (see as well Walker et al. (2011) for the Jamaican data and Campbell and Ramey (1994) and Campbell et al. (2014) for the Carolina Abecedarian Project).

[34] On parental education and time preference, using the Global Preference Survey (GPS), a survey data set from 80,000 people in 76 countries, Falk et al. (2018) find that patience is significantly related to educational attainment. On parental education and paternalistic motives, as argued by (Doepke and Zilibotti 2019, p. 41) for instance, "in a society where education and effort are highly rewarded and where people with little education struggle, parents will be highly motivated to push their children hard". Finally on parental education and higher productivity in child rearing, Kalil, Ryan and Corey (2012) show that educated mothers are more efficient in their parental time investments.

[35] For example, Currie and Moretti (2003) estimate that maternal education improves infant health. Education also increases the probability that the mother is married, reduces parity, increases use of prenatal care, and reduces smoking.

[36] Other related evidence are reviewed by Cunha (2015).

[37] From the first-order conditions (8) and (9), a lower value of λ also means that the parent does not foresee the effect of her own attention in child rearing on the child's effort $\frac{\partial e_0}{\partial \delta_0}$. In turn, when λ is low, the parent does not foresee how her attention

the effect of the knowledge and information of the parents on child development. For instance, Cunha, Elo and Culhane (2013) have interviewed a sample of disadvantaged pregnant African-American women. They find that the median significantly underestimates the elasticity of child development with respect to maternal investments in child rearing. They report as well that remediations could have tremendous effects, since if the disadvantaged women of the sample were to correctly estimate their influence on the development of their offspring, their investments will go up 4 to 24%, and the stocks of cognitive skills at age 24 months would increase between 1 and 5%. The important magnitude of the effects is also consistent with the predictions of Proposition 3, where it is demonstrated that parent's awareness of their effect on child development (either through an increase of λ or β) has large effects at the bottom of the income distribution.[38]

Besides being associated with lower educational attainment, a lower productivity of the parents in child rearing also correlates with parents' dysfunctions (e.g. depressive symptoms). Indeed, depressed parents show deficits in interactions with their children, and this has detrimental effects on child development. Existing evidence in developmental psychology indeed tends to corroborate both this prediction and the theoretical mechanism that generated it, although empirical evidence on the subject is limited. As discussed by Harter (2007) for instance, when children of depressive parents come to therapists, they lack self-concepts. As a result they also have disorganized behaviors. In a large-scale empirical study using data from the Avon Longitudinal Study of Parents and Children, Hanington, Ramchandani and Stein (2010) find that maternal and paternal depressive symptoms induce adverse behavioral and emotional outcomes in offspring. In their study, the authors also address the reverse causality issue and show that child's outcomes have little effect on the parents' depressive symptoms. I also predict that any parental dysfunction that decreases the parents' productivity at creating attention to her child will have detrimental effects on both the child's acquisition of processing skills and self-representations.

Finally, the effect of parental characteristics on child development is also attested by the recent study of Heckman and Karapakula (2019*a*), who demonstrate that the children of the treated participants of the Perry Preschool Project have fewer school suspensions, higher levels of education and employment, and lower levels of participation in crime relative to the children of untreated participants. The authors then demonstrate that the childhood neighborhoods of the children of the treated participants are no better than those of the children of the control participants. These results strongly support the prediction of Proposition 3, as they highlight the crucial role played by the modification in the characteristics of the parent – through the intervention – in explaining child development relative to the neighborhood.

changes both the current and the future actions of her child. Similarly, a low value of the parameter β could be interpreted as a weak knowledge of the parent of the effect of her current parenting strategy on the child's future behavior.

[38] Similarly, Rowe (2008) argues that gaps in the early home language environment exist because poor, uneducated mothers do not know about the role they play in determining the language and cognitive development of their children. Finally, Aizer and Stroud (2010) have tracked the smoking habits of educated and uneducated pregnant women before and after the release of the 1964 Surgeon General's Report on Smoking and Health. Before the release of the report, educated and uneducated pregnant women smoked at roughly the same rates. After the report, however, the smoking habits of educated women decreased and a ten percentage point gap in pregnancy smoking rates between educated and uneducated women was observed. This study, too, confirms the effect of knowledge – and education – on child-rearing behavior.

Policy implications:

Several policy implications can also be drawn from the theory. First, the mechanism of the theory, as well as the predictions in Propositions 1, 2, and 3, provide a theoretical ground that support the claim that successful childhood interventions should – as early as possible – scaffold children and help them create *secured attachment* by *supplementing* parenting.

There is now ample evidence that programs that strengthen home environments in lasting ways have significant and durable effects on child development. Elango et al. (2015) review and analyze the existing literature on early childhood education and childcare. They conduct a robust analysis of the effects of various programs implemented in the United States, Canada, and Norway. In particular, they study four early childhood programs targeted to disadvantaged families in the United States: the Perry Preschool Project (PPP), the Carolina Abecedarian Project (ABC), the Infant Health and Development Program (IHDP) and the Early Training Project (ETP). All programs have positive effects on early measures of IQ, as well as various measures of cognitive and noncognitive skills.

Elements in the curricula of these programs may be particularly important in explaining the preceding results according to Proposition 3. First, these programs often reduce the market cost from providing attention to the child b_δ. Indeed, diapers and child-care goods are subsidized, while child health-care is also provided, for example. As per Proposition 2, we should expect such subsidies to decrease the cost for the parent at "producing" attention for their children. This should then have a positive effect on children's acquisition of processing skills and identity formation (Proposition 3). Similarly, the PPP, the ABC, and the ETP programs also offer counseling and parenting instruction. This can have several effects, such as increasing the parents' time-productivity in child rearing t_δ. The parenting instruction can also affect the parents' awareness and information about the effects they have on their child development (hence increasing λ and β). As discussed already, this could explain a sizable portion of the treatment effect of these programs. These programs also aim at supporting the level of attention provided to the child without necessarily involving the parents. Indeed, professionals provide home visits to the children. Activities in the programs' centers also promote play-based and child-directed learning, emphasis on language development, and on developing non-cognitive and problem-solving skills. These activities foster the child's acquisition of processing skills, as children are subject to higher *attention levels* relative to their home environments.

Furthermore, the model also buttresses the fact that such early interventions may be particularly efficient if they are made early, and if they are primarily targeting the bottom of the income distribution (Proposition 3). Early interventions are more efficient than later remediations, because skills are *self-productive*. "Skills beget skills", while also triggering a virtuous cycle between child development and parental involvement in child rearing.

Importantly, the model highlights the novel prediction that for the effects of early interventions to be durable, the inclusion of the parents in the program is paramount. Indeed, early interventions aiming at affecting child development in the long-run should tend to *supplement* rather than *substitute* parenting. By doing so, programs foster a virtuous cycle where children engage more in the interactions with their parents (i.e. they acquire more processing skills) and build a more secured attachment and stronger self-reputation concerns with them (i.e. the program helps children acquire an identity by making them accumulate more autobiographic capital in the interactions with their parents). The programs also permanently boost the

parental investment in child rearing, as the parents complement the higher efforts that their children invest in the relationship.

The model also provides a possible explanation for why we may observe a fadeout phenomenon on the effect of early interventions programs on IQ, as recently shown by Heckman, Pinto and Savelyev (2013) and Elango et al. (2015) in the case of the Perry program. During the program, the child acquires processing skills in his interaction with professionals. Such processing skills are not complemented – after the program – by the building of an *autobiographic capital*, as the interactions with professionals stop. These skills may then stagnate, and the untreated children eventually "catch up" with schooling.

The theory also predicts that early interventions are particularly efficient if they affect the bottom of the income distribution.[39] This too accords with the results established by Elango et al. (2015) that early interventions that are not targeted at disadvantaged families have only limited effects. This may be because – as suggested by the preceding authors – the quality of these universal interventions program is lower than the outside options available for more affluent families. It could also be more directly related to the prediction of Proposition 3 that treatment effects are substantially larger at the bottom of the distribution.

One key aspect of the four early programs described previously is that they emphasis on language development. With increasing language facilities, children come to take a more active role in the construction – mediated by their parents – of an autobiographic capital M^p. This part of the curricula may then be particularly important in initiating a virtuous cycle between parental investments in child rearing, and further acquisition of processing skills and autobiographic capital by children. Other methods that foster the building of an autobiographic capital have been used in therapies for children with *impoverished selves* such as building scrapbooks with items like photos, school pictures, or child's drawings that make memories salient (Harter (2007)). Parents may also establish routines and family rituals in order to recreate joint memories of past experiences, which may help for both the child's and the parents' further investments in the relationship.

Finally, inequality in child development begins at home (Heckman (2011)). Policy interventions may then primarily aim at tackling the root cause of these inequalities, and various reasons that explain why some early interventions are particularly successful in increasing child development were suggested. Interventions at the school level as well may have significant effects on child development (Agostinelli (2018)), although these are beyond the scope of the paper.

3 Media Devices and Child Development

As the child moves up the developmental ladder, other sources of support and interaction emerge. In particular, the time that young children spend using digital devices has dramatically increased for the past decades. Television, tablets, smartphones, video game consoles, and other portable devices are used to stream videos (YouTube, Netflix etc), play games, search the Internet, learn, or engage in communication. In the United States, more than 90% of children younger than 2 years were using television and DVDs regularly already in 2007 (Zimmerman, Christakis and Meltzoff (2007)). As for smartphones and tablets,

[39] Duncan and Sojourner (2013) show for instance that the IHDP program may completely eliminates the income-based gap at age 3, and may reduce substantially the age gap at age 5 and 8.

in the United States, 52% of children under the age of 8 had an access by 2011, while up to 75% had access by 2013 according to the national surveys conducted by the Kaiser Family Foundation (Rideout (2013)). This impressive trend is not specific to the United States, or to developed economies. Recent evidence from the Pew Research Center shows that more than 90% of the adults aged 18 to 49 own a smartphone in most of the advanced economies, while the use of smartphones is growing tremendously in developing economies, especially among young people (Taylor and Silver (2019)). These changes in the adult population often correlate with the use of media devices by young children, as parent's screen time on media devices is strongly associated with child screen time according to recent evidence.[40]

Media exposure may displace other activities crucial for child development, such as interactions with parents or peers, and play time. It may also expose children to unappropriated content, or to less stimulation than other types of interactions. Accordingly, the American Academy of Pediatrics (AAP) recommends, since 1999, no screen time for children younger than 2 years. This recommendation is, however, largely ignored, as attested by the discussion above. Only a few empirical studies have examined the effects of traditional media on child development. Even fewer have been focusing on mobile devices. Still, and given that media devices absorb a considerable amount of time during child development, they can hardly be ignored in a theory of child development and identity formation. In this section, I extend the model of the previous section and seek to study the effect of media devices on child development. We will then discuss the existing empirical evidence, as well as generate new empirical predictions and policy implications.

In his "social interaction" with a smartphone, a tablet, or a television, the child develops processing skills and an autobiographic capital specific to this interaction. Indeed, the content of the media devices is interactive and sometimes requires social engagement (e.g. on video games or social media). Children then develop "deep beliefs" about who they are from such "personalized interactions" with contents they create, or with their avatar on video games for example.[41]

Both the parent and media devices simultaneously send signals to the child about the behavior he should adopt. The child observes a signal a_r from his parent, and b_r from media devices. I assume that on average, the signal sent by media devices does not perfectly match what the parent transmits himself, and we denote $\mu = b - a_p$ the spread between the parent's own signal a_p and the average signal sent by the technology b.[42] Several characteristics of media devices make them clearly different from human caregivers, such as the impoverished visual and auditory array. The image also provides a limited selection of cues for the perception of depth. The content the child is exposed to may also diverge from the parent's own teaching.

I still denote $f_c(. \mid X_c)$ the child's prior density. Let e be the processing skills acquired by the child in his interaction with the parent, and x the processing skills acquired when interacting with media devices. As for e, x play a dual role. First, it allows the child to better process the information he receives from the technology. Second, the processing skills acquired by the child in his interaction with the technology

[40] This result is demonstrated by Lauricella, Wartella and Rideout (2015), with a sample of 2300 parents of children aged 0–8 in the United States.

[41] The theory could also be developed when media devices are "consumed", and this creates a craving for further consumption (Becker and Murphy (1988)).

[42] We could argue that the signal sent by media devices is drawn from a distribution that is centered on b.

allow him to accumulate an *autobiographic capital* that is specific to this interaction.[43] As of period 1, the autobiographic capital of the child can be written as:

$$\begin{cases} M_1^p = e_0 + M_0^p \\ M_1^n = x + M_0^n, \end{cases} \tag{10}$$

with $M_0^n \geq 0$ the autobiographic capital that the child initially possess for media devices.

The child's processing skills e and x are finally assumed *specific* to the interactions they are built for.[44] More specifically, the processing skills e that the child acquires when interacting with his parent can not help him better apprehend his interaction with media devices. Reciprocally the skills x cannot help the child better understand his parent. It does not mean, however, that the two processing skills do not participate to the same reality *in the eyes of the parent*, and therefore cannot be in opposition with each other. A child may need to adopt violent actions in a video game, while learning with his parent that such a behavior is bad.

The utility of the child can then be expressed as:

$$u_t^c = (1 - \eta + \eta\gamma^p)M_t^p - c(e) + (1 - \eta + \eta\gamma^n)M_t^n - c(x), \tag{11}$$

with $(\gamma^p(a_c), \gamma^n(b_c))$ the child's beliefs about "who he is".

As before, the *level of attention* of the parent in the child rearing interactions is "produced" with time and market goods, e.g. child care goods and toys. Furthermore – adapting again the formalism introduced by Becker (1965) – I assume that the parent can delegate to media devices the production of another type of attention for the child. Indeed, I denote δ_n the level of attention that media devices provide to the child. The interactivity of new media via, for instance, their touchscreens allows the content to react to the child's actions in games or in educational applications. The level of attention that the media provide to the child can also be related to a video that is played *for* the child, although this may be less stimulating than a smartphone (once the video is started, it does not "respond" to the child's further actions). I assume that the "attention" of media devices toward the child is produced with market goods (an item of hardware, e.g. a smartphone, tablet, television), and the time during which the child is exposed to media devices. I denote t_n the time-productivity of media devices for producing attention, while it is assumed for simplicity that the "hardware" is completely free.[45] Therefore, for media devices to produce a level of attention δ_n, the child needs to use it during a period $\tau = t_n\delta_n$.

One key difference with the main framework is that the parent controls τ, the time during which the child is exposed to media devices. The parent then delegates to media devices the "production" of a level δ_n of attention. Furthermore, the parent is still producing attention for his own interactions with the child

[43] The signal that the child receives from media devices could be much more noisy than the signals from the parent. This could be modeled by assuming that when the child acquires an amount x of processing skills in his interaction with media devices, he receives a signal with a precision kx, with $k < 1$. In the extreme case where $k = 0$ for example, then the child cannot learn from the signal. When $k = 1$, by contrast, the child can learn from media devices as easily as from a parent.

[44] Borghans et al. (2008) build a theory of child development, where the skills acquired by the child are assumed specific to the personality trait they are built for. We explain the difference between personality traits and identity in Footnote 9.

[45] This assumption is made for simplicity. We will discuss how this assumption affects the results established in the extension in the discussion. Observe that a smartphone or a tablet may have a higher time-productivity for producing attention for the child, as they are more interactive and require more action from the user.

δ, by devoting resources and (his own) time to child rearing. In any given period t, the parenting strategy then consists of (i) a signal, (ii) a level of attention δ, (iii) a level of permissiveness ϵ, and (iv) the length of the period during which the child is exposed to media devices τ.

3.1 Child's optimization

As for the child's interactions with his parent, by being exposed to media devices, the child builds attachment to the devices, and self-reputation concerns, from adopting behaviors that are worth attention. The accumulation of an *autobiographic capital* through early exposure to media devices also depends on the processing skills that the child acquires in the related interactions. Indeed, the child has to understand sufficiently well the video he is watching in order to define himself as someone that "likes this type of videos". Also, the child needs to be sufficiently good at a game in order to be "rewarded" by that game and to identify himself as a gamer. Accordingly, I introduce the *level of permissiveness* of media devices ϵ_n, which relates to the minimum level of understanding that is necessary in order to gain the "approval" of media devices. I assume ϵ_n to be fixed (although this, too, could be under the control of a parent who wisely adapts the content of the media to the emerging skills of her offspring). We can then write the belief γ^n that the child identifies "who he is" to the behaviors promoted by media devices:

$$\gamma^n(x, \delta_n) = \delta_n \int_{b_c-\epsilon_n}^{b_c+\epsilon_n} f_c(b \mid b_r; x, X_c)db, \tag{12}$$

with $t_n\delta_n = \tau$, while the belief γ^p that the child identifies to the behaviors transmitted by his parent is still:

$$\gamma^p(e, \delta, \epsilon) = \delta \int_{a_c-\epsilon}^{a_c+\epsilon} f_c(a \mid a_r; e, X_c)da, \tag{13}$$

In any given period, conditional on the parenting strategy $(\delta_t, \epsilon_t, \tau_t)$, the child chooses both the processing skills e and x. There is complete separability in (11) between the utility from identifying with the behavioral patterns transmitted by the parent on the one hand, and those transmitted by the technology on the other. Therefore, the results established in Proposition 1 relative to the child's acquisition of processing abilities in rearing interactions hold. Furthermore, it is straightforward to establish that the child now invests an increasing amount of processing skills specific in his interaction with media devices, the higher the time he is exposed to it.

3.2 Parent's optimization

We can now turn to studying the parental strategy. As before, the parent derives utility during the two periods of childhood from her private consumption, while she also cares about her child. The value function writes as (4):

$$v_t^p = u(c_t) + \alpha v(\delta_t, \epsilon_t, \tau_t) + \lambda \tilde{v}_t^c(\overline{a}_c) + \beta v_{t+1}^p, \tag{14}$$

with $v_2^p = V_2$, and

$$c_t + (p_\delta b_\delta + wt_\delta) \leq wT + W. \tag{15}$$

The key difference relative to (4) is that the utility of the child now accounts for both the interaction with his parent and the interaction with media devices Furthermore, the parent cares about the behavior of the child, once he internalizes what he learned from her and from media devices. Therefore, the parent cares about the divergence between the best possible action a_t^*, and $\overline{a}_c$, the *ex-post* behavior of the child, with:

$$\overline{a}_c = \arg\max_a f_c(a \mid a_r, b_r; e, x, X_c). \tag{16}$$

As a simple illustration, the child may learn to be violent in a video game in order to succeed (i.e. he "plays" behavior b_c). Yet the parent teaches the child not to adopt such a behavior during the rearing interaction, and the child adopts behavior a_c. The parent internalizes both her own influence and that of the video game on the child's understanding, and hence on the behavior he will adopt. She then cares about $\overline{a}_c$, the behavior that maximizes the posterior distribution of the child once he internalizes the signals from both his parent and media devices. In this example, the parent may then put an extra effort into child rearing in order to make her child understand that violence is not an answer to conflict.

3.3 Results

As in the preceding section, I rely on normal distributions for $f_c(. \mid X_c)$ and $f_p(. \mid X_p)$ and derive the results in this specific case. After detailing the child's and the parent's optimization problems, we deduce the following results:

Proposition 4 ***Child development, parenting, and media devices:*** *Given that the difference μ between the prior of the parent a_p and what is transmitted by media devices b is sufficiently large:*

- *The negative effect of a lower income V or lower earnings w on the acquisition of processing skills and autobiographic capital in rearing interactions is amplified when media devices are used in child rearing, as a poor parent substitutes her own attention more in child rearing with the child's exposition to media devices.*
- *A child from a parent with lower time preferences β or with lower paternalistic motives λ tends to be more exposed to media devices. The child develops fewer processing abilities and autobiographic capital in the interactions with his parent.*
- *A child from a parent with a lower time-productivity t_δ for providing attention in child rearing tends to be more exposed to media devices. The child develops fewer processing abilities and autobiographic capital in the interactions with his parent. By contrast, an increase in the time-productivity of media devices t_n has an ambiguous effect on child outcomes.*

Proof. The proof is available in Appendix A.4. ■

When choosing the time that her child is allowed to use media devices in period 1, the parent faces the trade-off described by the following first-order condition:

$$\alpha(1-\eta)r^n M^n \frac{1}{t^n}\sqrt{\frac{s_c+x}{2\pi}}e^{-1/2(s_c+x)\epsilon^2} + \lambda\frac{\partial\tilde{v}}{\partial x_1}\frac{\partial x_1}{\partial \tau_1} = 0. \tag{17}$$

On the one hand, the child benefits from interacting more with media devices, which provides him "attention". The parent then indirectly benefits from it too, as she cares about the welfare of her child. On the other hand, however, exposure to media devices makes the child form deep beliefs about "who he is", which promotes behaviors that may be substantially different from the identity that the parent is trying to transmit. The parent lets her child use media devices for a period that equalizes the magnitude of these two effects. If μ is sufficiently high, this period is necessarily finite, as the identity that the child forms by interacting with media devices differs from that transmitted by the parent.

When the parent has a lower income or lower earnings, then she has a higher marginal cost at devoting resources and her own time to produce attention for her child. Hence, *ceteris paribus*, the parent is *less* attentive. Relative to the preceding section, however, there is now also a *substitution* between the parent's own time devoted to child rearing and the time the child is allowed to use the media devices. Indeed, since the parent is less attentive, then the marginal cost at letting the child use media devices is also lower. The parent can then increase the welfare of her child by letting him use media devices, since it appears as less problematic for her to see her child behave in a way that is different from her own teaching. The negative effect of lower income or earnings on the acquisition of processing skills and autobiographic capital uncovered in Proposition 3 is then amplified, because a poorer parent substitutes more her own attention with that provided by media devices. Finally, in a more complex version of the model, the substitution effect could also be affected by the relatively noisier signals that the child receives from media devices relative to the signals he receives from his parent.

A parent with lower paternalistic motives or time preferences values her child acquiring processing skills in rearing interactions less, while she also suffers a lower cost from letting her child "interact" with media devices. Hence, a child from a parent with lower time preference β or with lower paternalistic motives λ tends to develop fewer processing skills and autobiographic capital in the interactions with his parent.

Interestingly, if the time-productivity of the parent t_δ for producing attention is low, then it is costly for the parent to provide attention to the child. This creates a substitution between the parent's own time devoted to child rearing and the time the child is exposed to media devices. Therefore, the negative effect of a lower time-productivity of the parent in child rearing of Proposition 3 is amplified, because a less efficient parent substitutes her own attention with that provided by media devices.

Finally, the effect of a higher time-productivity of media devices is ambiguous, so it is not clear whether we should expect smartphones and tablets to be used more intensively in child rearing that traditional media with a lower time-productivity for generating attention such as televisions. Indeed, a higher time-productivity of media devices for generating attention leads to both a lower attention of the parent δ *for a given level of permissiveness* ϵ, and to a higher level of permissiveness ϵ *for a given level of attention* δ. Since parental attention and permissiveness are complement along the equilibrium path, the overall effect of the time-productivity of media devices on the equilibrium rearing strategy is ambiguous. It could be that a higher early exposure to a smartphone relative to a television makes the parent less permissive, and then less attentive in child rearing by complementarity, although the exact opposite could obtain. This ambiguity – and rapidly changing patterns of media consumption – call for more empirical studies on the effect of media devices on parenting and child development.

3.4 Empirical predictions and policy implications

In this extension, I discuss various empirical predictions and policy implication that could inform the debate on media devices and child development.

Substitution effect: One key prediction in Proposition 4 is the existence of a *substitution* effect between parental investments in child rearing and child use of media devices.

To my knowledge, one study has specifically examined the existence of a substitution effect between media devices and child rearing interactions. Indeed, Christakis et al. (2009) collected data on a sample of 329 children aged 2 to 48 months. The children wore a digital recorder on random days for up to 24 months, and the sounds the children were exposed to were analyzed by the authors. They find that television is associated with decreased exposure to discernible human adult speech and decreased child vocalization. The authors then suggest that such a decrease in the interaction with parents may be important in predicting the association between infant media exposure and delayed language development.

Media devices and child development: In the model above, the identity transmitted by the parent differs from what is transmitted by the media devices. We should then expect behavioral patterns transmitted by parents to be weaker in children who are more exposed to media devices. In the theory, the "sense of self" of a child who is more exposed to media devices includes less autobiographic capital built in the interactions with his parent. This may have important repercussions on child outcomes, as various evidence suggests.

First – to the extent that language is included in the set of identity traits transmitted by the parents – the preceding result explains why the substitution between parental investments in child rearing and child media exposure is associated with delayed language development. This prediction is documented in the literature. For instance, by studying a sample of 110 Hispanic infants and toddlers participating in an Early Head Start program, Duch et al. (2013) find that children who watch over 2 hours of television per day had increased odds of low communication scores.[46]

Second, to the extent that parents also transmit an identity – and behavioral patterns – that buffers children from social and emotional distress, we should expect the substitution between parental investments and media exposure to also decrease the acquisition of such an identity, which seems essential for social inclusion and mental health. Tomopoulos et al. (2007) has followed the media exposure of a cohort of 99 Latino mother-infant dyads when the toddlers are 21 and 33 months old. Their analysis shows an association, at both 21-months and at 33-months, between media exposure and aggressive behavior and externalizing problems. An alternative channel for the effect of media exposure on aggressive behavior and externalizing problems may be more directly associated to the content to which the children are exposed. Evidence indeed show that exposure to noneducational content has a worse effect on child outcomes than exposure to education content, though the effects are not entirely driven by content (Tomopoulos et al. (2007) and Duch et al. (2013)).

Third, the observed association between early media exposure and obesity and cardiovascular risk may as well be linked to the substitution between parental investments in transmitting an identity that promotes healthy behaviors and child media exposure. Heavy media exposure in preschool years is indeed associated with an increase in BMI that sets the stage for greater weight gains. The long-run effect of early media

[46] See, as well, the survey-based study of Zimmerman, Christakis and Meltzoff (2007) for similar evidence.

exposure on BMI at later stages of the life cycle suggests that the correlations are not entirely driven by a substitution between television viewing and other activities that involve physical efforts. Rather, it may indicate the lack of early interactions where children build – with their caregivers – a self view that incorporates more healthy behavioral patterns. Taveras et al. (2013) have collected data on 1116 mother–child pairs in the United States (63% white, 17% black, and 4% Hispanic). They show that after adjusting for childhood risk factors such as poor feeding practices and too much television viewing in early childhood, minimal differences in BMI exist between whites, blacks and Hispanics. This evidence then accords with the prediction that early risk factors associated with lack of parental investments in child rearing may be important explaining factor for obesity and cardiovascular risk over the life cycle. The study of Taveras et al. (2013) supports the claim that the correlation patterns between BMI and ethnicity cannot be explained by genetics alone, as parenting practices may play an important role.[47]

Media devices, child rearing, and financial constraints: Proposition 4 predicted that gaps in developmental outcomes between children raised in advantaged and disadvantaged families widen when media devices are used in child rearing. This result obtains because poorer parents are predicted to substitute more their own time and investments in child rearing with media devices.

The prediction of Proposition 4, that media devices are *inferior goods* when it comes to child rearing, has not been systematically studied in the literature.[48] Indeed, the use of media devices, as well as cheap access to the internet and smartphones are all recent phenomena. Only a few instances of evidence exist and tend to indirectly confirm Proposition 4. With data on 350 children aged 6 months to 4 years seen at a pediatric clinic in an urban, low-income and minority community, Kabali et al. (2015) find that most children had their own media device by the age of 4. The patterns of use suggest frequent and independent use. Most 2-year-olds used mobile devices on a daily basis, and most 1-year-olds assessed had already used a mobile device. Although this study does not compare disadvantaged with more affluent families, it still shows that the average use of media device by young children is high in a sample of low-income households. As another illustration, focusing on television, Rideout and Hamel (2006) use a national survey in the United States of 1,051 parents of children ages 6 months to 6 years old to point toward positive correlations between lower income or earnings and higher time of television watching for young children.

Media devices, parental characteristics, and child development: In Proposition 4, it is demonstrated that parental characteristics such as paternalistic motives λ, time horizon β, and time-productivity in child rearing t_δ are key determinants of child exposure to media devices and child development.

Using a nationally representative survey of 1,463 parents of children age 8 and under in the United States, including an over-sample of African-American and Latino, Rideout (2013) find that lower-income children are far more likely than higher-income children to be exposed to educational content on mobile devices. Comparing families that own a mobile device, the author finds that 59% of higher-income children

[47] The effect of genetics on BMI is studied, for instance, by Locke et al. (2015).

[48] The result also obtains if the cost of media devices is not prohibitively high, for the following reason. Imagine that media devices have a cost p_n. The budget constraint that the parent faces is then $(wt_\delta + p_\delta b_\delta)\delta + p_n + c_t = wT + W$. As before, there will be a substitution between parental investments and time devoted to child rearing on the one hand and child exposure to new technology on the other. It could then be that the monetary benefits from a lower level of child rearing exceeds the cost of media devices p_n, so that the marginal cost of child rearing decreases with media devices. If p_n is prohibitively high, then the substitution can never allow the parent to decrease her marginal cost of consumption, so she will not use media devices, which constitute then a *normal good*. If p_n is not prohibitively high, then the substitution effect can actually successfully decrease the marginal cost of consumption; hence, media devices are used in child rearing. Poor households use them more intensively for the reasons established in Proposition 4.

are exposed to educational content, while the figure drops to 45% for lower- and middle-income children whose families own such a device. Similar gaps are found for exposure to educational video games. Such a difference may be related to parent's characteristics rather than wealth directly, as media devices offer a wide array of free educational content. Several channels uncovered in Proposition 4 could then explain these correlations. First, the educational attainments of the parents could explain a sizable portion of the results. As argued already in the last section, educational attainments are positively related to the time horizon β, the paternalistic motives λ and the time-productivity in child rearing t_δ. Second, the results could be related to the parents' knowledge about the impact of media devices on child development. Again, information and awareness can be interpreted as higher values of the parameters λ and β.

Finally, parental dysfunction, such as depressive symptoms or addictions (e.g. to media devices), may decrease their ability to generate attention in child rearing, i.e. it should decrease their time-productivity t_δ in the model. Hence, parental dysfunctions are predicted to lead to more child exposure to media devices, although this prediction is not investigated by the existing literature.

Policy implications:

Further empirical research on the effect of media devices on life-cycle development is needed. However, from the prediction of the theory, several policy implications can be derived.

First, from Proposition 4, the bottom of the income distribution is more susceptible to rely on media devices for rearing purposes. Furthermore, given the repercussion that early media exposure has on language development, externalizing problems and health, the theory strongly supports the claim that the rate of return of early intervention programs is substantially larger if disadvantaged families are targeted. The evidence provided by Elango et al. (2015) accord with this prediction, although the effect of media devices on child development is not systematically investigated in the literature.

Second, as before, if early programs tackle the root cause of child exposure to media devices, then they may substantially increase their rate of returns.[49] Early interventions may then promote higher parental awareness and information about how early child media exposure affects child development. We should expect such trainings to strengthen home environments in lasting ways.

Finally, the model not only calls for more awareness of the damaging effects of early child media exposure; it also calls for awareness on the effects of parents' own exposure to media devices, as it may substantially alter the patterns of child rearing interaction. As of 2019, in the United States, only 16% of pediatricians ask families about their media use, while 29% of the parents report relying on their pediatrician for advice about their own use of social media (Schmidt et al. (2012)). Parents' own exposure constitutes an additional risk factor for child exposure to media devices that may then affect child outcomes by decreasing their ability to provide attention, although this prediction is not investigated in the literature so far.

[49]Several studies have tried to evaluate the rate of returns of early intervention programs. See, for instance, García et al. (2016).

4 Conclusion

This paper presents a general model of interactive learning and identity formation in social interactions with caregivers. I demonstrate that fostering child development is a complex task that caregivers face. It aims at understanding the child's own learning capabilities and devoting an adequate amount of time and resources in rearing interactions, while praising the child for his achievements. Even harder, fostering child development also entails for the caregivers to know to withdraw their appraisal and affection when children misbehave. Child rearing interaction are crucial not only because they create the condition for learning, but because they also cement attachment and the formation of self-reputation concerns, which will be an anchor for the long-term behavioral patterns adopted by the child.

The paper explains why sizable gaps in human development open up between children raised by caregivers with differences in key socio-economic characteristics. In particular, children raised by caregivers with higher earnings or non-market income, higher concerns for the child's behavioral patterns, lower social dysfunctions, higher educational attainments, and higher knowledge and information of their influence on child development form increasingly stronger attachment to caregivers, and tend to build higher self-reputation concerns. These children are then predicted to adopt more stable and healthy behavioral patterns in the long run.

The pace of technological change is rapid, making media devices cheaper, smarter, and hence increasingly attractive substitutes for caregivers own time and resources devoted to child rearing. This substitution effect is even stronger when caregivers have socio-economic characteristics conducive to lower developmental outcomes, such as lower earnings or educational attainments. Media devices are then expected to widen human inequality, as they expose current and future generations to the building of a weaker sense of attachment to human caregivers, and to the formation of weaker self-reputation concerns for the adoption of behavioral patterns that are the hallmark of human interactions. Media devices – by profoundly changing the patterns of human development – may then constitute key risk factors for delays in language acquisition, aggressive behaviors, externalizing problems, obesity, and cardiovascular risks.

Policy wise, I demonstrate that interventions that aim at supplementing rather that substituting the main caregivers are likely to have substantial returns in the long run, as they foster the building of attachment, and of self-reputation concerns with caregivers. Similarly, interventions that aim at rebuilding attachment – e.g., that include home visits or parental trainings – may have substantial returns. I finally demonstrate that interventions that aim at increasing parental awareness of their influence on child development may have significant returns.[50]

Going further, several aspects of child development may deserve special attention in future research. First, the issue of the formation of multiple identity traits is not fully exploited in this paper, as I only consider a case where the child learns from a parent and media devices. Yet children are exposed to a variety of social interaction settings with their parents, friends, schoolteachers, and media devices. Each interaction setting participates to the child's rising understanding of his external world, and to the building of attachment and self-reputation concerns.

Various interesting issues are left aside in this paper. More specifically, the multiplicity of human identity may deserve special attention in future works. This theory may, for instance, be applied to the

[50] On the rate of returns of early interventions, see, for instance, García et al. (2016).

study of adopted children or in foster care. Prior to the adoption or to the state intervention, such children have built – maybe in troubled homes – attachment, social understanding, and self-reputation concerns over behavioral patterns that may not turn out to be useful in their new home(s), or in society at large. Going further, the role of the state as a "corporate parent" may seem an impossible task in allowing children raised in foster care to build attachments to caregivers, and self-reputation concerns that allow them to transition to adulthood in favorable conditions.[51] Relatedly, this theory may also enlighten the literature on immigration and child development or on endogenous peer selection and child development.[52]

This theory may also be a first step toward increasing our understanding of *over-parenting* practices, and their supposedly deleterious consequences on child development.[53] Indeed, since it reduces the diversity of early social interaction settings, over-parenting has been blamed for reducing independence, creativity, or imagination. It may also be a key risk factor for early depression and other mental health problems (Lukianoff and Haidt (2018)).

Finally, this paper may provide a starting point for future studies able to comprehend the complexity of the human understanding of social interactions, which mirrors the complex patterns of attachment and consciousness of the self that defines identity.

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[51] On foster care and child development, see, for instance, the work of Courtney (2009).

[52] See, for instance, Agostinelli (2018) on endogenous peer selection and child development, and Washbrook et al. (2012) on immigration and child development.

[53] See for instance Doepke and Zilibotti (2019) for a discussion on various instances of over-parenting.

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