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Review article

A learning theory of attachment: Unraveling the black box of attachment development

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ABSTRACT

Attachment is an inborn behavioral system that is biologically driven and essential for survival. During child development, individual differences in (in)secure attachment emerge. The development of different attachment behaviors has been traditionally explained as a process during which experiences with (lack of) responsive and supportive care are internalized into working models of attachment. However, this idea has been criticized for being vague and even untestable. With the aim of unraveling this black box, we propose to integrate evidence from conditioning research with attachment theory to formulate a Learning Theory of Attachment. In this review, we explain how the development of individual differences in attachment security at least partly follows the principles of classical and operant conditioning. We combine observed associations between attachment and neurocognitive and endocrinological (cortisol, oxytocin, and dopamine) processes with insights in conditioning dynamics to explain the development of attachment. This may contribute to the explanation of empirical observations in attachment research that are insufficiently accounted for by traditional attachment theory.

1. Introduction

Attachment development, or the development of children's trust in parents' support and protection during distress (Bowlby, 1969), is considered one of the most important areas of child development (Dixon, 2016). Children's capacity to seek parental support during distress explains a substantial amount of variation in developmental outcomes like mental and physical health, academic success, and social competence (Cassidy and Shaver, 2016). In spite of the impact of attachment theory on developmental research, surprisingly little is known about *how* attachment develops. Bowlby (1969) pointed to experiences with parental sensitivity during distress that, over time, become internalized into Internal Working Models (IWMs). In attachment theory, IWMs are cognitive representations of these caregiving experiences that guide future interpersonal behavior and intimate relationships. Although research supports the link between supportive parenting and attachment development (Verhage et al., 2016), the mechanism explaining *how* these experiences are internalized remains a black box in attachment theory (Thompson, 2016). In the current contribution, we accept attachment theory's claim that attachment development is a species-wide phenomenon embedded in the genetic make-up of every human newborn. We argue that within this biological preparedness of infants to establish attachment relationships with protective parents, individual differences in trust in parental support are acquired, at least partly, according to learning theory's principles of classical and operant conditioning.

We begin by outlining the basics tenets of attachment theory. Then we discuss why a new theory of attachment development is necessary and whether attachment theory and learning theory can be integrated. Third, we introduce the Learning Theory of Attachment. Finally, we will demonstrate how this theory sets a promising new research agenda that may reveal new insights into the development of individual differences in attachment over time.

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2. Attachment theory: A brief introduction of core concepts

The idea that children internalize early parenting experiences in IWMs is a cornerstone of attachment theory because it allowed Bowlby (1969) to explain why care-related experiences have long-lasting effects on later development. Research confirms that differences in the quality of caregiving experiences are linked to differences in children's attachment development (Verhage et al., 2016). Children who consistently experience more supportive parenting in response to distress tend to become more securely attached. They have more trust in the availability of parental support and they more likely seek support during distress (e.g., Cassidy, 2016; Dujardin et al., 2016). Through synchrony with supportive parents, secure children learn that they can act upon the world and achieve competence. They flexibly deploy their attention between caregiver and the environment, striking a balance between (physical or mental) proximity to the parent and exploration of the (social and physical) environment (Bosmans et al., 2019a; Main, 2000).

If experiences with parents are inconsistently synchronized so that high and low levels of support alternate, children show less trust (Ainsworth et al., 1978). They start to focus their attention more exclusively on the parent, leading to more ambivalent or preoccupied attachment. There is distrust in the parent's availability if needed for protection, support or reassurance. This is reflected in a persistent need to be, or feel, in close proximity to the parent (Cassidy, 2016). If children experience parents as consistently unsupportive in times of stress and distress, they tend to re-direct their attention away from the parent to the environment in order to suppress the expression of their negative emotions and to avoid parents' insensitive responses to these emotions. Their lack of trust in the availability of the parent when they need protection or support leads to avoidant or dismissing attachment (Cassidy, 2016). According to Bowlby, individual differences in attachment security start to develop early in infancy, remain open to change particularly during the first five years but also to a lesser extent afterwards, and have lasting effects on cognitive and socioemotional development throughout life "from the cradle to the grave" (Bowlby, 1969, p. 208).

It should be noted that despite the normative connotations of concepts such as secure, resistant, and avoidant attachment (originally labeled with the neutral letters B, C, and A respectively, see Ainsworth et al., 1978), these attentional and behavioral strategies are adaptations to specific caregiving niches. They lead to a functional fit in the short run which might be optimal from the perspective of inclusive fitness (McGlothlin et al., 2014). For example, research in rodents and humans shows that exposure to unsafe environments enhances offspring's memory for threatening stimuli and their cognitive ability to respond to them (Plate et al., 2018; Rifkin-Graboi et al., 2018; Thomas et al., 2016). As a result, children who develop insecure attachment relationships may grow up being better able to protect themselves in a threatening world, safeguarding their procreation (e.g., Simpson and Belsky, 2016). However, these adaptations may increase long term risks, including elevated (mental) health problems due to prolonged distress (e.g., Diamond and Hicks, 2004)

3. Why propose a learning theory of attachment?

Although it is one of attachment theory's core concepts, the IWM is taken for granted in contemporary attachment research and has been subject to incisive critical appraisal (e.g. Thompson, 2016). We will explain why attachment theory has traditionally been opposed to learning theories to account for attachment and its development. Finally, we will demonstrate that there are valid arguments to integrate both theories.

3.1. Internal working models

In a seminal paper, Main et al. (1985) expanded the theory of IWMs by shifting the focus from infant behavioral patterns to the level of adult cognitive representations. They argued that attachment IWMs reflect memories of attachment-related experiences that are organized according to generalized event schemata. The schemata were assumed to structure experiences in terms of the child's behavioral approach to parents and the parents' responses to the child's behavioral intentions. IWMs were supposed to largely exist outside of consciousness with a propensity to remain stable over time, including memories that were stored during pre-verbal stages of attachment development (e.g., Guskjolen et al., 2018). Importantly, IWMs would guide future behavior and the appraisal of novel interactions with parents. Moreover, IWMs are thought to affect the (unconscious) processing of attachment-related information in terms of access to memories, attention to and interpretation of novel interactions. These information processing biases were supposed to act in the service of the stability of IWMs (Bowlby, 1969; Dykas and Cassidy, 2011). Nevertheless, Bowlby (1969) and Main et al. (1985) assumed that intense interpersonal experiences, in particular with significant others, could alter IWMs throughout and after childhood.

In spite of the importance of Bowlby's and Main et al.'s work, many researchers continue to struggle with the IWM construct (e.g., Pietromonaco and Barrett, 2000; Rutter et al., 2014; Thompson, 2016; Waters et al., 2005). The description of the construct and its development remains metaphorical, which makes it hard to study IWMs and the mechanisms underlying their development (e.g., Thompson, 2016). Moreover, research findings could not be fully explained by the theoretical assumptions associated with the IWMs construct. First, supportive parenting only partly explains individual differences in attachment development (Verhage et al., 2016) and it remains unclear how the transfer from parental support to IWMs occurs. Second, attachment appears to be less stable over time than assumed (e.g., Groh et al., 2014; Pinquart et al., 2013), and it remains unclear which factors and mechanisms explain attachment instability (e.g., Sroufe et al., 2005). A Learning Theory of Attachment might help explain part of this incongruence between theory and data.

3.2. Attachment theory versus learning theory

Traditionally, attachment researchers were reluctant to integrate learning and attachment theories. When formulating his theory, Bowlby was heavily influenced by the idea that attachment bonds result from imprinting processes. An important inspiration was the work of Lorenz (1935) who found that geese get attached to the first moving object they encounter after hatching. In keeping with these imprinting processes, Bowlby (1961) wanted to emphasize that attachment is an evolutionarily primed behavior system, not reducible to classical or operant conditioning. Additionally, Ainsworth (1969) explicitly wanted to move away from the reductionistic study paradigms typically relied upon in learning research at the time. When Ainsworth and Bell (1972) found that attachment behavior, more specifically infant crying, did not increase in response to the reinforcing effect of prompt parental support, this eventually resulted in the assumption that attachment behavior is not learned through reward. Thirdly, Rajecki et al. (1978) compared Bowlby's evolutionary attachment theory to learning theories to see which would best explain the establishment of attachment bonds in various species (birds, monkeys, and humans). They reasoned that evolutionary theory fit best with the observation that strong attachment bonds are formed even in the context of maltreatment. Again, this work led to the general appraisal that learning theories were not suited to inform attachment development.

With regard to the development of various attachment behaviors, it has been argued that different (in)secure attachment patterns emerge due to a reorganization of the neurobiological systems in response to differences in the rearing environment. Kraemer (1992) suggested that this reorganization is genetically available to the newborn but that it is triggered only after exposure to specific stimuli. Exposure to an unavailable parent would activate a reorganization of the brain consisting, for example, of changes in synaptic or cortical density in brain areas relevant for the attachment behavioral system and resulting in specific insecure attachment behavioral patterns. This, again, was an argument favoring imprinting processes over learning mechanisms to explain the development of individual differences in attachment development.

3.3. Can attachment theory and learning theory be integrated?

Notwithstanding the apparent antagonism between attachment theory and learning theory, it is important to emphasize that Bowlby continued to believe that the attachment behavioral system is assembled and elaborated in the context of learning experiences (Bowlby, 1961). In his unpublished correspondence, he even expressed enthusiasm about the work of social learning theorists like Bandura[1] . As a consequence of his own reluctance to rely on learning theory to explain attachment development, he mostly left the topic alone. Nevertheless, he occasionally acknowledged that learning processes contribute to elements of the attachment system, such as the development of social smiling in infants (Bowlby, 1969). He also expressed his expectation that the contribution of classical conditioning to the functioning of the attachment system would be part of the reason for its continuities with later parenting styles in adulthood (Bowlby, 1973).

In addition, research demonstrated the need for an integration of attachment and learning theories. First, the design and findings of the Ainsworth and Bell (1972) study on crying was convincingly criticized by eminent operant learning researchers (e.g., Parsley and Rabinowitz, 1975; Gewirtz and Boyd, 1977). In response to this critique, attachment researchers Hubbard and Van IJzendoorn (1987) designed a study that addressed the methodological and statistical issues that were raised. As predicted by learning theorists, Hubbard and Van IJzendoorn (1987) found opposite effects: over time, children cried more if parents quickly provided support to the child when distressed. These findings suggested that the development of attachment behaviors such as crying is affected by learning processes.

Secondly, Waters and Waters (2006) found evidence that a secure IWM consists, at least partly, of a cognitive schema or script regarding care: the secure base script (SBS). This term refers to Bowlby's (1969) description of the parent as a secure base that provides support when children experience distress while exploring their environment. Individuals who develop a SBS expect that they can seek support when feeling distressed, that parents provide emotional and practical support in response to bids for care, and that this support will help to get them back on track. Because cognitive scripts develop as the result of classical and operant conditioning processes (e.g., Bouton, 2000; Coster and Alstrøm, 2001), this further supports the idea that learning theory may explain at least a part of the inter-individual differences in attachment security.

Finally, in other domains of child development attachment and learning theories are increasingly integrated. For example, neonates' imitation behavior, thought to be relevant for the developing attachment relationship, has always been considered an inborn capacity (Meltzoff and Moore, 1992). However, recent research cast doubt on this theory, pointing at learning processes that shape imitation behavior (Oostenbroek et al., 2016). Similarly, parenting research has traditionally been guided by learning theory (Patterson and Stouthamer-Loeber, 1984). However, Dadds and Tully (2019) have argued that improving parenting quality requires understanding the trade-off between learning principles and the child's developing attachment bond with their parents (see also Juffer et al., 2017). Taken together, this suggests that formulating a learning theory of attachment fits with contemporary research and thinking about child development.

4. A learning theory of attachment

In this section, we briefly review the core concepts of classical and operant conditioning. We propose that the development of attachment can be understood as a safety conditioning process. We will show that this safety conditioning hypothesis is compatible with imprinting ideas, bridging learning and attachment theories. Next, we discuss in more detail classical conditioning (explaining the development of IWMs) and operant conditioning (explaining the development of attachment behavior) as components of a Learning Theory of Attachment. Finally, we show that this theory leads to specific, new hypotheses about (in)stability of attachment (in)security over time.

4.1. Classical and operant conditioning: A brief introduction of core concepts

Classical conditioning (Fig. 1a) refers to the learning process through which stimuli acquire meaning (Pavlov, 1972). Acquired meaning is reflected in changes in the expectation that a stimulus predicts a specific experience. Changes in expectations are typically derived from changes in behavioral responses to exposure to these stimuli. More specifically, the meaning of a neutral stimulus (*conditional stimulus, CS*; e.g., a bell that rings) changes when the CS is associated with the occurrence of a second, meaningful stimulus (*unconditional stimulus, UCS*; food is offered) that automatically elicits an emotionally relevant response (*unconditional response, UCR*; saliva is produced to process the food). Changes in the meaning of the CS can be observed in terms of the acquired expectation (*conditional reaction, CR*; saliva is elicited just by hearing the bell) that the CS will be followed by the UCS. According to learning research, classical conditioning depends on the contingency between the CS and the UCS (De Houwer and Beckers, 2002; Rescorla, 1966). *Contingency* refers to the probability that the CS is followed by the UCS accounting for the probability that the UCS occurs without the presence of the CS (Rescorla, 1966). If contingency is high (the UCS is more likely to occur in the presence of the CS than in the absence of the CS), the CS starts eliciting the CR. Importantly, contingency does not need to be perfect to establish this change in the meaning of the CS (Baeyens et al., 1993).

Operant conditioning (Fig. 1b) refers to the process through which behavior is learned that allows obtaining expected reinforcers (Skinner, 1935). A *discriminative stimulus (Sd*; e.g., a light flashes) elicits a *behavior (R*; pressing a button) aimed at avoiding expected negative consequences (e.g., avoidance of an electro shock) or at achieving anticipated positive effects (e.g., receiving a food pellet). This *reinforces the behavior (Sr)* and increases the likelihood that new exposure to the Sd will elicit the same behavior. Here, it is the contingency between R and Sr that drives conditioning: the frequency of R will increase if the probability of Sr is higher after R than in the absence of R.

Importantly, it has been noted that the mechanisms of classical and operant conditioning largely overlap. The substantial difference between both processes is that in operant conditioning organisms not only learn to attribute meaning to stimuli but that they also acquire control over access to the meaningful stimuli through behavioral strategies. Additionally, research finds that classical and operant conditioning do not occur separately and in isolation, but instead they are constantly affecting each other. This has been demonstrated in research on

[1] In a letter to Henderson (Bowlby, 1973) Letter to Scott Henderson, 30th July 1973, Bowlby Archive Wellcome Collections, PP/Bow/J.9/98) he wrote: "I strongly suspect that the particular form of atypical care-eliciting behaviour selected by a patient is greatly influenced by modelling, the term introduced by Bandura, and roughly equivalent to identification, to describe adopting the same behaviour that one has observed engaged in by others… More and more in work with parents I have been struck by the extent to which they have adopted the same disciplinary procedures towards their children as they themselves were subjected to – often despite their wish to behave quite otherwise."

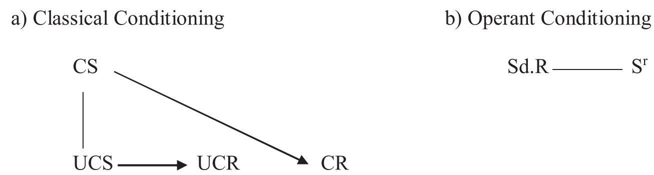

Fig. 1. Classical and Operant Conditioning.
Note: Figure a depicts that if the Conditional Stimulus (CS) gets paired with the Unconditional Stimulus (UCS), which automatically elicits the Unconditional Response (UCR), the CS elicits a Conditional Response (CR). Figure b depicts that a discriminative Stimulus (Sd) elicits a behavioral Response (R) if that behavior is reinforced by increase of positive consequences or decrease of negative consequences (reinforcing Stimulus, Sr). Figs. 2 and 3 will illustrate the application of these schemas to attachment-related constructs.

Pavlovian-Instrumental Transfer. This transfer occurs when the CS becomes associated with a UCS through classical conditioning, after which the CS can elicit behavior that increases access to the UCS, which gets subsequently reinforced through operant conditioning (Talmi et al., 2008).

4.2. Attachment as a safety conditioning learning process

Safety conditioning refers to a learning process through which a cue becomes a predictor that an expected aversive event will not occur. After learning, these cues become potent inhibitors of fear and stress responses. In a similar vein, we propose that the attachment figure can become a safety cue. This proposition is in line with the substantial attention Bowlby devoted to fear coping in the second volume of his trilogy (Bowlby, 1973) where he stated that:

“The behaviour that reduces distance from persons or objects that are treated as though they provided protection is nothing other than attachment behaviour. Viewed in this perspective, therefore, though not in others, attachment behaviour appears as one component among the heterogeneous forms of behaviour commonly grouped together as fear behaviour.” (Bowlby, 1973; pp. 115)

In Bowlby's theory (1973), seeking proximity to the attachment figure serves both to withdraw from fearful/distressing stimuli and to approach a person whose proximity is desired.

In a prototypical safety learning experiment, a neutral tone is followed by an aversive electrical shock, unless when accompanied by a neutral light stimulus. Over trials, conditioned fear reactions will develop to the tone, but not when the tone and light are presented in combination. This is indicative of an acquired tone→shock association that predicts shock occurrence (danger) and an acquired light→no-shock association that predicts absence of the shock (safety). Henceforth, the light stimulus has the ability to turn off fear to any stimulus that was previously paired with the shock. Analogously, a parent can decrease distress in a wide range of situations associated with distress. Applied to attachment development, an example could be a child who has had a conflict at the playground (equivalent to the tone) and a parent who helps the child to feel less distressed about the conflict (equivalent to the light). Research shows that holding the hand of an attachment figure blocks distress responses to stimuli that normally elicit distress (Coan et al., 2006). This suggests that an attachment figure, e.g. a parent, can become a safety cue.

Safety conditioning has an important neurobiological basis which has been well mapped in fear extinction research (for a review, see Sehlmeyer et al., 2009). Such research starts with *fear learning* that a CS is followed by a fear-eliciting stimulus (UCS). The amygdala plays a central role in this process. Sensory information about the CS and the UCS is transmitted from the thalamus (and cortex) to the basolateral nucleus of the amygdala. The plasticity in in the amygdala forms the basis of the CS-UCS association, and connections to the central nucleus of the amygdala, with its own connections to brainstem regions, serve the expression of fear. Other regions that are implicated in fear learning are the dorsal anterior cingulate cortex (presumably related to threat anticipation) and the insular cortex (presumably related to interoception, awareness, and sensitivity to visceral activity).

In *fear extinction*, the CS that was previously associated with the UCS is no longer followed by that UCS (Milad and Quirk, 2012). During extinction learning, additional brain regions are recruited, such as the hippocampus and the ventromedial prefrontal cortex (vmPFC). Where the vmPFC serves to inhibit activation of the central amygdala and thereby reduce fear expression, the hippocampus is known for its role in computing a unitary representation of complex stimuli, such as contexts and safety cues (CS_{safety}). Arguably, the hippocampus signals in reaction to the CS_{safety} that the vmPFC should activate the inhibitory influence on the amygdala, resulting in decrease of the overt fear reaction.

Safety conditioning also reflects endocrinological processes at the level of the UCR. Many hormones can have a reinforcing effect fostering conditioning (e.g., Skvortsova et al., 2020). For example, cortisol responses to a $UCS_{negative}$ increase the likelihood that a CS acquires a negative meaning and elicits avoidance behavior (e.g., Merz et al., 2013). However, if the expected $UCS_{negative}$ does not occur when being paired to a new CS, this elicits a feeling of relief (Leknes et al., 2011) and the new CS becomes a safety cue (CS_{safety}) after conditioning. The dopamine system also plays a critical role in fear extinction and is important for safety conditioning. More specifically, dopaminergic neurons in the Ventral Tegmental Area (VTA) are known to respond to better-than-expected outcomes, in this case the surprising omission of an aversive event. These VTA neurons then release dopamine in the Nucleus Accumbens which stimulates learning (e.g., Luo et al., 2018). After repeated learning trials, the dopamine response to the CS_{safety} occurs earlier in time, even before the actual safety is offered (Schultz, 2013) and the CS_{safety} starts inhibiting the distress normally elicited by the stressor. Although this neural circuit and these endocrinological processes have not been tested directly in other safety conditioning procedures, there is no reason to assume that these are specific to fear extinction only. We hypothsize that they also apply to safety conditioning in the context of attachment development.

4.3. Preparedness: A conceptual bridge between learning theory and attachment theory

It is well documented in learning research that the conditioning of fear itself depends on the type of stimuli involved in the learning situation. Certain biologically prepared stimuli promote the conditioning process so that an association is both more quickly acquired and more persistent (Mineka and Öhman, 2002). Human research shows that, after being paired with an aversive electrical shock, pictures of snakes and spiders more quickly elicit conditioned fear reactions than pictures of flowers and mushrooms. This effect even occurs in individuals who show no initial fear of snakes or spiders. Once acquired, these conditioned fear reactions are also more resistant to extinction and less amenable to cognitive control. This work suggests that humans are genetically prepared to learn to fear spiders and snakes. As a result of this inborn preparedness, fewer learning episodes are needed to install persistent fear. This has obvious survival value (Mineka and Öhman, 2002).

It is currently unknown whether humans are also genetically prepared to learn safety associations with certain classes of stimuli. However, we tentatively propose that parents fulfil the role of prepared safety stimuli to a child: parents do not automatically provide safety, but the child seems to need only a few safety learning experiences to associate them with safety in a persistent manner. This proposal is in line with the observation that babies show an attentional preference for their parent in comparison to other figures within a few hours after being born, maybe through the sound of their voice or the smell of their bodies (e.g., Cecchini et al., 2011). Preparedness could explain why positive experiences during distress and distress relief become associated with the parent, and not to random stimuli (food), objects

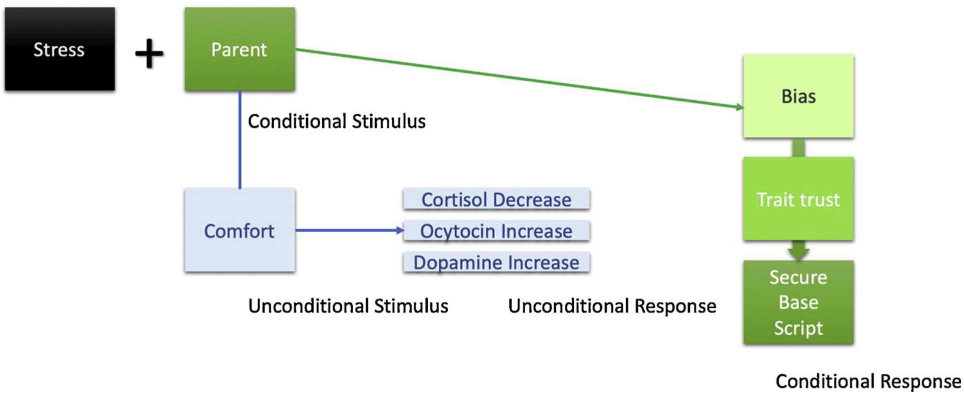

Fig. 2. Classical component of the Learning Theory of Attachment.
Note: This figure depicts how the parent can become a safety signal that predicts coping with stress. If children are distressed and a parent (Conditional Stimulus; CS) provides comfort (Unconditional Stimulus; UCS), this has immediate endocrinological effects (Unconditional Response; UCR). If the CS and UCS get paired, the parent will start eliciting a Conditional Response (CR), starting with shifts in the processing of attachment-related information (Bias), resulting in increased trust at the trait level (Trait trust), and finally resulting in increasing knowledge about the Secure Base Script.

(chairs), or other persons (visitors) that happen to be around. This preparedness idea strongly corresponds with Bowlby's (1969) imprinting-like view on attachment development, and suggests that attachment and learning theories can indeed be integrated. We propose in our Learning Theory of Attachment that children are wired to become attached to protective parental figures, which provides the basis for learning safety CS-UCS contingencies.

Interestingly, it seems reasonable to assume inter-individual differences at the level of children’s biological preparedness to establish attachment bonds with parents. This could have an impact on how easily CS-UCS contingencies affect safety learning (and therefore attachment development). For example, it seems plausible that child factors like temperament could influence attachment development. However, research has failed to find robust evidence that such child factors causally impact attachment development (Groh et al., 2017). Approaching attachment development from a safety learning and preparedness perspective could introduce child factors that more robustly influence attachment development. For example, it is known that children with autism, who are more often insecurely attached (Rutgers et al., 2004), have difficulties with social attentional focusing (Willemsen-Swinkles et al., 1998). In a similar vein, children with callous unemotional traits, who are also more often insecurely attached (Pasalich et al., 2011), show deficits in the processing of faces (Dadds et al., 2006). It might be that the origins of these children's more insecure attachment development might be at least partly traced back to basic differences at the level of neurobiological preparedness for attachment-related safety conditioning. This could make it harder for parents to promote these children's secure attachment development.

Individual differences in preparedness might also be linked to differential susceptibility theory (Ellis et al., 2011). According to this for-better-and-for-worse model, more susceptible children are more affected by negative experiences with parents than their more resilient counterparts, but at the same time they benefit most from positive experiences with parents. The finding that susceptibility is reflected in, amongst others, (epi-)genetic variation in dopamine-related genetic pathways associated with reward sensitivity, punishment sensitivity, emotional reactivity, and ability to be comforted is highly relevant for the Learning Theory of Attachment (Bakermans-Kranenburg and Van IJzendoorn, 2015; Belsky and Van IJzendoorn, 2017; Hammen et al., 2015). For example, the extent to which parental support is more or less intensively experienced as helpful might contribute to the number of trials children need to learn that a parent is a CS_{safety}. Although no studies investigated this link from a learning perspective, both genetic and epigenetic studies suggest that (epi-)genetic variation in these systems explain part of children's attachment development.

At the level of genetics, Bakermans-Kranenburg et al. (2008) found that a parenting intervention particularly affected children with the DRD4 7-repeat allele which regulates the dopamine system and reward sensitivity. At the level of epigenetics, animal research has shown that normal expression of genes can be suppressed if organisms are exposed to, for example, high levels of stress in absence of parental care (Fish et al., 2004; Van IJzendoorn et al., 2011), pesticides (Collotta et al., 2013), or unhealthy food (McGowan et al., 2008). This can dysregulate genes responsible for the endocrinological processes relevant for conditioning and therefore impair attachment learning. Indeed, Bosmans et al. (2018) found that low levels of maternal support only predicted increases in children's insecure attachment when their *NR3C1* gene showed more methylation. As the epigenetic methylation of this gene translates into reduced stress-regulatory capacity, this again suggests that variation at the level of the biological mechanisms underlying attachment learning can explain variation in attachment development.

In the following paragraphs, we describe in more detail how the classical conditioning component of the Learning Theory of Attachment explains the development of secure and insecure attachment IWMs and how the operant conditioning component explains the development of attachment-related behavior. In addition, we demonstrate how this leads to new, testable predictions about the development of individual differences in attachment over time.

4.4. Classical conditioning and the development of attachment internal working models

Learning theory would consider each interaction with the parent after children’s exposure to distress as a ***single learning event*** (see Fig. 2). During each single learning event, if a parent (CS) notices the child’s distress, helps to alleviate distress, and provides care and support ($UCS_{support}$), this provides a sense of relief and comfort (UCR_{pos}). With regard to the alleviation of distress, the parent becomes associated with the decrease of the distressing state (UCR_{neg}) over multiple learning trials in which the presence of the parent (CS_{safety}) is followed by a decrease of the UCR_{neg}.

The Learning Theory of Attachment predicts that the UCR reflects endocrinological changes in the child that translate into attachment-related psychological states (see Fig. 2). First, research shows that support decreases cortisol levels ($UCR_{neg\_decrease}$; e.g., Hostinar et al., 2015) which translates into a sense of relief (McQuaid et al., 2016). Second, support is supposed to increase oxytocin (UCR_{pos}; e.g., Feldman and Bakermans-Kranenburg, 2017) translating into a sense of felt security and comfort (Waters and Sroufe, 1977). This has been described as a secure attachment state (e.g., Gillath et al., 2009) or as state trust (Bosmans et al., 2014a, b). Finally, oxytocin in turn activates the reward system and the secretion of dopamine (UCR_{pos}) which motivates future affiliative behavior (Love, 2014) and which plays a role in the conditioning process itself (Schultz, 2013).

No research has directly tested the idea that the development of individual differences in attachment security is under control of endocrinological mechanisms. In support of that idea, Stroobants et al. (2020) used a mouse model that was haploinsufficient for the *NBEA* gene. This means that one of the two *NBEA* alleles had a loss-of-function mutation. Because this gene regulates the traffic of hormones from inside to outside the cell, this manipulation reduces the release of hormones. This study found that this manipulation disrupted normal mother-offspring attachment development. Moreover, human experimental research shows that a CS can indeed become paired with (UCR) oxytocin release and that this learning process results in the excitation of oxytocin as a CR (Skortsova, Veldhuijzen, Pacheco-Lopez et al., in press). These studies provide some first, preliminary support for the idea that endocrinological responses play a role in attachment-related classical conditioning.

Furthermore, pertinent studies on the reinforcing effect of psychological states on attachment-related safety learning are still absent. However, one study found that children's state trust decreased when they did not receive support after exposure to distress. Moreover, their original state trust level was restored if they subsequently received support (Vandevivere et al., 2018). This pattern of state trust changes following parental support ($UCS_{support}$) versus lack of support ($UCS_{no\_support}$) is in line with predictions derived from learning theory.

Finally, the Learning Theory of Attachment predicts that the CS-UCS contingency determines whether a parent can become a CS_{safety}. If the contingency or the probability that the parent (CS) successfully comforts the child during distress ($UCS_{support}$) is high over multiple single learning events, this will change the meaning of the CS and will result in the expectation (CR) that the parent will provide safety, relief, and comfort when exposed to distress. This will eventually be reflected in secure attachment IWMs consisting of more secure base script knowledge. If CS- $UCS_{support}$ contingency is low, insecure attachment IWMs will develop. With regard to the effect of contingency on attachment development, research is largely lacking. However, in a recent set of experiments, Bosmans et al. (2019b) found that manipulating CS_{helper} – $UCS_{succesful\_support}$ contingency affected levels of trust in the helper. This finding suggests that contingency might play a crucial role in attachment development.

In what follows, we will discuss specific Learning Theory of Attachment predictions about the development of secure and insecure attachment IWMs.

4.4.1. Secure attachment IWM development

One prediction is that a secure IWM develops after consistently high levels of contingency over single learning events that associate the parent with endocrinologically driven relief, comfort and a secure attachment state. As this association gets established, the theory predicts that the meaning of the parent will gradually change into a trait-like expectation that the parent is consistently available for support during distress (CR). According to learning theory, over great numbers of learning trials in which the CS co-occurs with both UCS and UCR, the initial CS—US association will gradually transform into a direct CS—UCR association that is more persistent and elicits the response in an automatic-like manner (Unger et al., 2003). This may underlie the learning of trait-like expectations (CR) of the stress relieving effects (UCR) of the support of a parent (UCS). The shift from CS—UCS to CS—UCR learning should be observable in attachment development at different levels of information processing.

First, higher CS- $UCS_{support}$ contingency should result in more automatic processing of the CS. Indeed, research shows that secure attachment is related to increased access to positive memories about care by the attachment figure, an increased likelihood that children encode positive information regarding the parent, and a positive interpretation of information regarding the parent (e.g., Zimmermann and Iwanski, 2015). Second, these information processing biases should affect the way children appraise their parent in terms of how much they can trust his/her availability for support during distress. Indeed, research shows that training children to interpret their parent's responses to distress in a supportive way and training children to orient their attention to the parent during distress significantly increases their self-reported trust in maternal support (Bosmans et al., 2019a; Verhees, Ceulemans and Bosmans, 2019). Third, high CS- $UCS_{support}$ contingency implies that children are repeatedly exposed to single learning events that share common elements typical for secure base interactions. The Learning Theory of Attachment predicts that these elements get more interconnected in the brain and get simultaneously activated as a secure base script when children encounter distress or when they are exposed to stimuli that activate thinking about the attachment figure as a source of support. Indeed, research shows that the longitudinal development of secure base script knowledge is linked with secure base experiences over multiple domains of support (Steele et al., 2014; Waters et al., 2017).

4.4.2. Insecure attachment IWM development

If the contingency between the parent (CS) and the experience of parental support ($UCS_{support}$) is low, the Learning Theory of Attachment would predict that it becomes harder to establish an association between the parent and care-related experiences. In such circumstances, the parent can be experienced as ignorant about the child's distress ($UCS_{no\_support}$), or even rejecting ($UCS_{rejection}$), which maintains and even increases distress (UCR_{neg}). This elicits a sense of frustration because of the child's innate need for support (La Guardia et al., 2000) and leads to an insecure attachment state (UCR_{neg}). Over repeated negative learning experiences, the processing of attachment information will be biased towards the negative, and appraisals will become more negative until they translate into more trait-like insecure attachment. As a result, this will create difficulties to develop a coherent secure base script. Instead, the Learning Theory of Attachment predicts that these children develop alternative schemas and scripts to help them adapt the interactions with their parent to the relational dynamics they experience as unsupportive and insecure. There is a rich clinical literature that defines such schemas as so-called Early Maladaptive Schemas, thus emphasizing that, in spite of their adaptive character, these schemas come at a long term mental health cost (Young et al., 2003). These schemas reflect expectations such as need for subjugation or self-protection to safeguard a relationship with an unresponsive parent. Supporting the idea that these schemas emerge in individuals with low trust in maternal support, research has shown that Early Maladaptive Schema's are associated with insecure attachment-related appraisals (Bosmans et al., 2010) and with lack of secure base script knowledge (McLean et al., 2014).

4.5. Operant conditioning and the development of attachment behavior

In line with the theory of Bowlby (1969) and Ainsworth (1969), the Learning Theory of Attachment assumes that the attachment behavior system is innate and is elicited automatically during distress to achieve stress-reduction and a sense of felt security. Hence, at birth, attachment behaviors like crying in response to distress are not learned behavior. However, as children's brains and bodies mature, their behavioral repertoire becomes increasingly complex. When infants encounter stress and have access to their parent (Sd), they develop new proximity and support seeking behavior (R) if this behavior is reinforced (Sr) by stress reduction and increased secure state attachment (see Fig. 3). New support seeking behavior that serves both the function of escaping negative outcomes and approaching positive outcomes is more likely to be repeated during subsequent distressing episodes. For example, older children seek support by calling their parent on the phone instead of seeking his/her physical proximity (e.g., Mayseless, 2005).

Reinforcers determine whether or not behavior will be repeated in the future. Behaviors that are positively reinforced are rewarded by a positive outcome or by the avoidance of negative outcomes. In such cases, the probability increases that the behavior will be repeated in the future. If the behavior is not rewarded, it will not become part of the learned behavioral repertoire of an individual. Behavior can also be punished when it is followed by a negative, painful consequence. Learned behavior may also cease to be rewarded, which is considered a punishment because the absence of an expected reward leads to

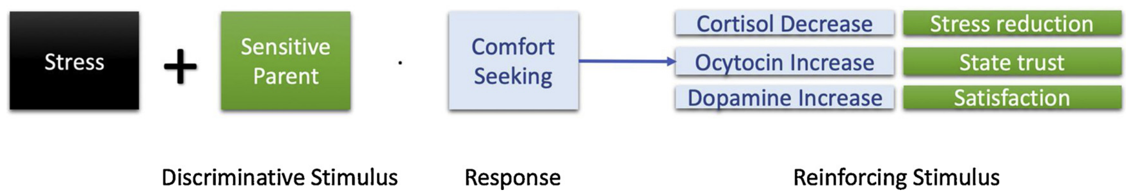

Fig. 3. Operant component of the Learning Theory of Attachment.
Note: Children who learned that they can trust in their parent's sensitive support during stress, when they are distressed and have access to the parent (discriminative Stimulus; Sr) will more likely seek parental comfort (Response; R) which will be reinforced (reinforcing Stimuli; Sr) by decrease of (anticipated) negative states reflected in cortisol decrease and stress reduction, and by increase of positive states reflected in oxytocin and state trust-related increase, and in dopamine and satisfaction-related increase. These reinforcers increase the likelihood that comfort seeking (R) will occur in similar contexts (Sr) in the future.

frustration, and frustration is aversive (Amsel, 1992). If behaviors are consistently followed by punishment, they will not be repeated.

Another important factor in operant conditioning is the reinforcement schedule. This refers to the likelihood that a behavior is followed by a reinforcer. The more consistently positive reinforcers follow a given behavior (continuous reinforcement versus partial reinforcement), the more likely this behavior will be learned and repeated (Catania, 2013). One specific type of partial reinforcement with a strong effect on the development and persistence of behavior is intermittent reinforcement. Intermittent reinforcement refers to the duration before a behavior is reinforced or to the number of behavioral responses (ratio) it takes to elicit a positive reinforcer. Intermittent reinforcement that occurs at variable duration or at a variable ratio has the strongest effect on the development of behavior (Ferster and Skinner, 1957; Miltenberger, 2008). Through intermittent reinforcement, behavior increases in frequency and becomes highly resilient to extinction.

Following these theoretical premises, the Learning Theory of Attachment predicts that secure or insecure behavioral patterns will emerge depending on the combination of environmental factors (which behaviors are rewarded and which are punished) and child factors (sensitivity to punishment and reward). Supporting the idea that child-related factors explain part of the mechanism why some children develop more ambivalent versus more avoidant attachment patterns, Kochanska (1998) showed that maternal support uniquely predicted secure versus insecure attachment, while children's fearful responses to unfamiliar stimuli explained ambivalent versus avoidant attachments. Based on this data, it seems reasonable to assume that understanding the development of different insecure attachment behavioral patterns depends partly on the reinforcement schemas and partly on children's differential susceptibility to these schemas.

In the next section, we discuss the predictions of the Learning Theory of Attachment on the development of the three main attachment behavioral patterns: secure, avoidant, and anxious-ambivalent attachment patterns.

4.5.1. *Secure attachment behavior development*

When children consistently experience that support seeking behavior is rewarded, they will likely rely on this behavior whenever they need support as a resource to cope with distress. Supporting this part of our learning theory is Hubbard and Van IJzendoorn’s (1987) abovementioned observation that immediate responsivity to infant crying behavior is linked to increased crying behavior over time. Also, in Bosmans et al.'s (2019b) contingency experiments, results showed that increasing the likelihood that help was successful stimulated help seeking behavior in subsequent trials. This supports the claim that the development of attachment-related support seeking behavior is under control of reinforcing stimuli. If only support seeking behavior is reinforced, children might become dependent on their parents (Ainsworth, 1969) and will not learn to use them as secure base to explore the wider social and physical environment. Thus, when circumstances permit, sensitive parents also stimulate exploration by modulating children’s feelings of stress and reinforcing their feeling of competence in acting on the world around them (e.g., Waters and Cummings, 2000). As Bowlby (1988) argued; “all of us, from the cradle to the grave, are happiest when life is organised as a series of excursions, long or short, from the secure base provided by our attachment figures.”

4.5.2. *Avoidant attachment behavior development*

Children who experience little to no reward after support seeking will likely become avoidantly attached because they will not develop a behavioral repertoire aimed at support seeking. Avoidant attachment behavior can also be expected from children who experience that their attempts to seek support are consistently responded to in a hurtful way. As a result, they will avoid using support seeking behavior when feeling distressed.

However, both cases refer to extreme situations that will be rarely found in the population. The Learning Theory of Attachment assumes that all children have experienced some positive reinforcement following support seeking behavior. The mere fact that they survived as a baby demonstrates that at least some innate attachment behavior (like crying when hungry) must have been responded to with care (they were fed, otherwise they would not have survived).

In less extreme situations, the Learning Theory of Attachment would predict that children’s sensitivity to punishment will determine the extent to which children develop avoidant behavior. Children who are more sensitive for punishment might be more motivated to avoid seeking the unsupportive attachment figure’s support during distress. Avoidant attachment behavior will then be reinforced because it prevents the frustration of not receiving the desired care or because it prevents the painful experiences linked with parents’ defensive, rejecting, or child-blaming responses to their communication of distress. Our theory would predict that this is an adaptive behavioral adjustment to the caregiving environment that only backfires when distress cannot be autonomously regulated.

This prediction, derived from learning theory, corroborates Main's (1990) contention that avoidant attachment is an adaptive strategy conditional upon the child's developmental niche (Super and Harkness, 1986). Indeed, psychophysiological attachment research has demonstrated that avoidant children and adolescents show a stronger psychophysiological response to emotional stimuli (Bosmans et al., 2016; Dozier and Kobak, 1992) and to mother-child conflict discussions (Beijersbergen et al., 2008). Taken together, it seems that several research findings align with the hypothesis that avoidant attachment behavioral patterns are typical for individuals whose attachment behavior is consistently not reinforced and who are more prone to experience negative emotions.

4.5.3. *Anxious-ambivalent attachment behavior development*

Children who experience intermittent positive reinforcement of support seeking behavior and a lack of reinforcement of exploratory excursions into the social or physical environment will likely become anxiously-ambivalent attached. Due to intermittent positive reinforcement, children will heighten their proximity seeking behavior as their only way to attract the parent's attention and protection. The resistance against extinction of intermittently reinforced behavior could further explain why these children continue to seek support in spite of the punitive experiences during single learning events in which bids for support are repeatedly ignored. In line with such claims, there is one study in adults that tested the effect of intermittent reinforcement of help-seeking behavior (Beckes et al., 2017). They found that intermittent reinforcement elicited a pattern of implicit and explicit anxious-like attachment expectancies and behaviors.

4.6. Learning Theory of Attachment and changes in attachment (in)security over time

Shifts in Attachment IWM Development. Once the $CS\text{-}UCS_{support}$ or the $CS\text{-}UCS_{no\_support}$ associations are established, no new learning occurs as long as the CS remains a good predictor of the occurrence of the UCS/UCR. For attachment development, this means that the child develops a stable expectation that the parent will provide care or no care during distress. However, learning research also shows that new learning can occur during experiences in which the predictive value of the CS decreases. This has been referred to as prediction error, or the extent to which the outcome is better or worse than expected (Rescorla and Wagner, 1972). Research suggests that the impact of prediction error on new learning is at least partly dampened by biases in the attentional processing of the CS (e.g., Boll et al., 2013). However, once prediction error elicits surprise and activates a dopamine response to the new UCS/UCR (Collins and Frank, 2016), learning gets updated and the meaning of the CS can change (Schultz, 2016). Hence, attachment can at best only become a trait-*like* feature that remains subject to changes in the environment that affect the CS-UCS contingencies.

Such a model of attachment stability versus instability is obviously in line with the available longitudinal research showing that attachment is only partially stable over time (Waters et al., 2019). To further test the (in)stability-related predictions of the Learning Theory of Attachment, longitudinal research is needed on the associations between state attachment variability and changes in trait attachment development. Such research is largely lacking, but several diary studies found that day-to-day variability in state attachment was linked with conflicts with the mother, and that this effect was attenuated when children scored higher on trait trust in the availability of the mother (e.g. Bosmans et al., 2014a, b). This result supported the idea that trait attachment-incongruent experiences get assimilated and (at least initially) do not affect normative secure attachment development. However, if changes in CS-UCS contingency get processesd, substantial catch-up of secure attachment is expected. This catch-up has been observed in children who are adopted after having lived in severely depriving caregiving environments, (Van IJzendoorn and Juffer, 2006). These findings all seem to fit well with the proposed mechanisms of stability and change, but need to be more thoroughly investigated.

Shifts from secure to insecure attachment can occur as the result of major life events, such as parental divorce or family conflict, and have been labeled 'lawful discontinuities' (Sroufe et al., 2005). These events have been considered before as causes for attachment instability (e.g., Groh et al., 2014). Adding to existing theory, the Learning Theory of Attachment points at more subtle and more frequently occurring causes of decreased secure attachment. For example, contingency might also be affected by daily hassles that (temporarily) reduce parental sensitivity. Our theory would predict that this causes prediction error with initially limited impact on trait attachment development due to the existing secure attachment information processing biases. However, humans are also born with a heightened sensitivity for negative (social) information due to which negative information can have more impact on development in the service of harm avoidance (e.g., Vaish et al., 2008). Consequently, the Learning Theory of Attachment predicts for securely attached children that repeated exposure to mildly unsupportive single learning events will negatively affect the processing of caregiving experiences. This should set off a negative cascade during which changed information processing biases affect children's appraisals about the availability of the parent. This should result in the development of Early Maladaptive Schemas (e.g., McLean et al., 2014).

Shifts from insecure to secure attachment can occur as the result of positive major life events, like a transition from institutional care to family care or the resolution of family conflict. Again, the Learning Theory of Attachment also points at subtler and more frequently occurring causes of increased secure attachment. For example, improved daily living circumstances in a family can increase the contingency between the parent and positive care-related experiences. This presumably causes prediction errors with initially limited impact on trait attachment development due to the existing insecure attachment information processing biases. As a result, objective improvements of supportive parental behavior will initially have little effect on children's trust in the parent. This assumption is in line with a typical problem foster families are confronted with: children coming from adverse rearing circumstances have difficulties to trust new, more supportive foster parents (Dozier and Bernard, 2019). However, parental proximity during distress retains a stress regulatory effect on insecurely attached children (e.g., Dujardin et al., 2019). Consequently, the Learning Theory of Attachment predicts for insecurely attached children that over time repeated exposure to supportive learning events will positively affect the processing of caregiving experiences. This should set off a positive cascade during which more positive information processing biases positively affect children's appraisals about the availability of the parent. This should result in the acquisition of more Secure Base Script knowledge.

Repeated attachment shifts can be theoretically predicted because learning research has demonstrated that what is once learned, can never be unlearned (e.g., Bouton, 2000; Uner and Roediger, 2018). At best, what is once learned can be deactivated and replaced by novel knowledge until the moment that the old knowledge gets reactivated by related contextual cues (Tulving, 1974). Following the logic of the Learning Theory of Attachment, this should be true for those children who shifted from secure to insecure trait attachment and vice versa. For example, for children who are insecurely attached early in life and become securely attached later in life, exposure to contextual cues associated with insecure attachment learning could reactivate the negative memories of those early experiences and induce an insecure attachment state. If exposure to these cues endures, the secure attachment expectations and knowledge could be deactivated and the prior insecure attachment expectations and knowledge could be reactivated.

In the same vein, Kobak and Bosmans (2019) proposed that repeated miscommunication between the members in a dyad can set off an insecure interaction cycle. During an insecure cycle, insecure attachment states are increasingly activated during interactions with the parent, leading to attempts to control fear for rejection. If these attempts further elicit negative responses in the parent, the contingency between the parent and successful support during distress further decreases. As a result, a securely attached child can gradually become more insecurely attached at a trait-like level. In the opposite direction, the Attachment Security Enhancement Model (Arriaga et al., 2018) proposes that increases in secure attachment states over time eventually translate into increased trait secure attachment. In support of these predictions, priming research shows that reactivating secure versus insecure memories of interactions with attachment figures has a direct effect on attachment states (e.g., Bosmans et al., 2014a; Gillath et al., 2009).

Adding to the models of Kobak and Bosmans (2019) and Arriaga et al. (2018), the Learning Theory of Attachment provides predictions about the interplay between state and trait attachment. So far, state attachment research has ignored the theoretical issues regarding how state and trait attachment relate to each other. However, if attachment were only volatile, it would not predict long term developmental outcomes. It would not get under the skin and change basic biological processes nor be embedded in brain structure and functioning, and it would be merely contingent on a potentially volatile environment. Instead, the Learning Theory of Attachment, predicts that shifts of attachment at trait-level occur after a transition period during which cues (re)activate attachment states that are incongruent with the active attachment trait. Thus, this transition period is characterized by increased state attachment variability over single learning events. Scheffer et al. (2009) have argued that variability is an early warning sign that tipping points occur in complex dynamical systems. Similarly, from the perspective of the Learning Theory of Attachment one could expect that increased state attachment variability is a predictor for changes at the trait attachment level. This idea has not yet been tested, but in line with this prediction, some studies have found that children high on trait secure attachment vary less in their state attachment across days (Bosmans et al., 2014a, b) or across distressing situations (Verhees, Ceulemans, Van IJzendoorn et al., 2019).

5. Towards a new research agenda

In the current contribution, we proposed a Learning Theory of Attachment that assumes attachment to be a species-wide phenomenon embedded in the genetic make-up of newborns, and that provides a straightforward and testable set of predictions on how individual differences in attachment develop over time. This theory sets a new research agenda that could help unravel the dynamics of attachment development within individuals over time and reveal how these dynamics interact with (changes in) the environment. Although more empirical work is needed, we demonstrated that existing attachment research provides preliminary support for (parts of) the theory. These studies suggest that a Learning Theory of Attachment could be useful to help move the field forward as it provides a more detailed and testable theoretical account of how care-related experiences might be internalized into IWMs.

Returning to the inconsistencies in attachment theory and research that we noted, the Learning Theory of Attachment could help interpret why supportive parenting only partly explains individual differences in attachment development (Verhage et al., 2016). The theory acknowledges the importance of supportive parenting behaviors for attachment development. However, it also points at the additional importance of CS-UCS$_{support/no_support}$ contingency to explain the development of secure versus insecure attachments and shifts between secure and insecure attachment in development. It could well be that parents are, overall, sufficiently sensitive and responsive, but that the CS-UCS$_{support/no_support}$ changes due to circumstances. For example, due to stress at work, a conflict between parents, sleeping problems, or other circumstances parents might temporarily be less sensitive. This would affect contingency and the extent to which children's support seeking behavior is continuously or more intermittently reinforced. New research techniques such as experience sampling methods (e.g., Larson and Csikszentmihalyi, 2014) might facilitate the analysis of microlevel contingencies and tipping points in shifts from secure to insecure attachments. In traditional attachment research, daily variations in contingencies induce systematic noise in the data and suppress correlations between parenting and attachment.

Moreover, the theory provides testable predictions about how experiences with parental support are internalized. More specifically, the theory predicts that repeated experiences result in the establishment of neural networks that affect the processing of attachment information at both automatic and strategic levels of processing. This occurs in a process of increasing consolidation. It affects the automatic attentional, interpretation, and recall-related processing of attachment information, the strategic appraisals of the parent’s availability, and the automatic organization of care-related experiences according to the secure base script. This could be the level of processing previously conceptualized as the IWM. The idea that IWM development reflects increased synaptic connectivity could be studied at the level of Long-Term Potentiation (LTP). This refers to research that shows how learning occurs through a process of repeated stimulation of hippocampal neurons. This results in a rapid and long-lasting increase in synaptic connectivity that can persist for many days (Nicoll, 2017). The basic Hebbian rule is that simultaneous excitation of the input and recipient components of a synaptic connection makes the link stronger. This has, for example, been documented to happen in imprinting of newborn birds to their protective conspecific (McCabe, 2019). Although we are not aware of any LTP research on human attachment, this could be a fruitful avenue to further examine the development of IWMs. In support of this idea, Lewis and Durrant (2011) have argued that LTP plays a role in cognitive schema development. Optogenetic tools might open a window for the in vivo study of attachment learning at the level of LTP (Moulin et al., 2019).

The second inconsistency in attachment research is the finding that attachment appeared to be less stable over time than assumed in traditional attachment theory. This observation is in line with learning research’s evidence that changes in the learning context have both short-term and long-term effects on the instability of developing expectations, schemas/scripts, and behaviors. The Learning Theory of Attachment suggests that attachment-related expectations have a state-like and a trait-like component. Experiences during single learning events result in secure or insecure attachment states that accumulate over learning trials to affect information processing, appraisals, and interpersonal script/schema development. Although the latter function more on a trait-like level, changes in the context can change the learning experiences and affect trait-like attachment development. Once trait-like secure or insecure attachment has been established at different levels of processing, this can never be unlearned. Nevertheless, new learning occurs. If trait-like attachment development shifts from secure to insecure or vice versa, novel trait-like attachment-related information processing biases, appraisals, and scripts/schemas will be acquired that deactivate older knowledge. However, as soon as the older knowledge is reactivated by contextual cues at the expense of the more recent knowledge, this will translate into changes in attachment security at the trait-like level. The Learning Theory of Attachment suggests that attachment development is actually much more open to change than originally assumed, and it proposes ways in which the changes can be described and explained at the microlevel of daily experienced contingencies. To study these dynamics of attachment (in)stability new research techniques are needed that allow the trial-by-trial study of attachment learning and that allow the manipulation of CS-UCS contingency so it is possible to establish how many learning trials it takes to establish trait-like attachment (in)security or to switch from secure to insecure attachment and vice versa (for an example, see Bosmans et al., 2019b).

In addition, the Learning Theory of Attachment also raises new questions about the conditions that determine CS-UCS contingency in attachment development. Traditional attachment theory has a strong focus on maternal behavior to explain attachment development. This focus has led to the criticism that attachment theory has a strong inclination to blame the parent for children's insecure (attachment) development. A parent-blaming attitude interferes with clinicians' ability to establish an adequate working alliance with parents when treating children's emotional and behavioral problems. Because learning theory provides clear predictions of the neurobiological and endocrinological processes that determine CS-UCS contingency, it might well be that children's experience of sensitive and responsive care is affected by individual differences at the level of these biological processes. If for some children sensitive care does not elicit a strong oxytocin or dopamine response, this might impair conditioning and decrease the probability that children develop a secure attachment. Also, if children have a strong cortisol response, unsupportive parenting during distress may have a more negative effect on attachment development. We discussed genetic and epigenetic studies that provide some preliminary support for this idea. Similar epigenetic research could be conducted for oxytocin and dopamine related genes as they can also be epigenetically affected and influence animal relation formation (e.g., Gundersen, 2013). New research can test the extent to which child-related variation at the level of neurobiological mechanisms of conditioning processes affects trial-by-trial attachment learning. Such research would contribute to our understanding of child factors in attachment development and help clinicians to apply attachment theory in their work without making the impression that the parents are blamed for their children's relational issues.

As a concluding remark, we are well aware that we are not only proposing an integration of learning theory and attachment theory. We also bring together two very different clinical traditions that have a history of mutual skepticism that is almost as old as our entire research field: psycho-analysis versus behaviorism. We think that one of the merits of the current attempt to formulate a Learning Theory of Attachment is that it can inform both traditions with otherwise overlooked but highly relevant pieces of the same puzzle. A premier example is the integration of attachment theory and social learning in the parent coaching program Video-feedback Intervention to promote Positive Parenting and Sensitive Discipline (VIPP-SD; Juffer et al., 2017). This integrative approach aligns with an increasing effort in the research community to integrate relevant knowledge crossing boundaries of disciplines and theoretical frameworks. In doing so, we hope to have contributed to the achievement of one of the dreams John Bowlby confessed in a letter he wrote during an interchange with Aaron T. Beck, the founding father of Cognitive Behavior Therapy:

"Naturally, I find the way that the ideas of all of us converging most heartening. Perhaps we shall yet live to see a unified theory of personality development and psychopathology." (John Bowlby, 8th October 1981).

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Appendix A. Supplementary data

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