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How childhood adversity affects components of decision making

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ABSTRACT

Extreme and chronic adverse experiences in childhood are linked to disruptions in a wide range of behavioral processes, including self-regulation, increased risk taking, and impulsivity. One proposed mechanism for these effects is alterations in how children learn and use information about rewards and risk in their environment. This type of decision making is a complex and multifaceted process consisting of distinct subcomponents, each of which may have varying effects on behavior. Here, we conducted a systematic review of the literature examining how reward and risk related decision making is influenced by childhood adversity. We aimed to identify whether childhood adversity is associated with alterations in how children learn about value information and how they subsequently use that information to inform decisions. Results suggest adverse experiences in childhood primarily impacts how individuals prioritize avoidance of risk and leads to devaluation of rewards.

1. Introduction

Chronic, extended, or extreme adverse experiences in childhood are associated with a wide range of behavioral disruptions, including decreased self-regulation, increased risk taking, and increased impulsivity (Birn et al., 2017; Loomis, 2021). Recent research suggests disruptions in how individuals process information about potential rewards and risks in their environments plays a role in the emergence of these behaviors (Gerin et al., 2017; Hanson, van den Bos, et al., 2017; Xu et al., 2023). A challenge in addressing this issue is that reward and risk related decision making are not unitary constructs. Rather, they represent complex, multifaceted motivational and cognitive processes encompassing both an individual's ability to first learn what predicts rewards or risks and to then make use of that learned information to guide subsequent behaviors (Berridge and Kringelbach, 2013; LeDoux and Daw, 2018; O'Doherty et al., 2017). Here, we review the literature on childhood adversity and decision making to clarify current knowledge about the mechanisms through which adverse experiences early in life influences the parameters of decision making throughout the life course.

1.1. Value-based decision making and childhood adversity

Value-based decision making refers to the process of recognizing there is some value to a particular cue and then using that information to inform decisions (Bradfield and Balleine, 2021; Daw et al., 2011). This type of decision making is critical for effectively navigating one's environment and facilitating basic survival needs, such as avoiding potential dangers and obtaining food, shelter, and safety. Value-based decision making also enables complex social behaviors (Bhanji and Delgado, 2014; Rudebeck et al., 2008), allowing individuals to learn when social cues signal a potential action or outcome. This kind of process is evoked when, for example, we make an inference that a facial movement such as a furrowed brow signals another person feels angry and then use this information to inform our behavior – perhaps by offering an apology or physically distancing ourselves from that person. Alterations in the processes underlying value-based decision making are reflected in increased risk-taking behaviors, alcohol and drug use (Beard et al., 2022; van Duijvenvoorde et al., 2022), depression (Pizzagalli, 2014), and posttraumatic stress disorder (Mehta et al., 2020). Based upon these associations, alterations in the development of value-based decision making may explain the emergence of myriad negative

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behavioral and health outcomes.

Value-based decision making represents a complex process that can be broken down into two predominant components: *learning* and *use* (each of which might be further parsed into further subcomponents). Our use of the term "learning" refers to an individual's ability to recognize signals in the environment and associate them with rewards or risks; the first step in the decision making process. In contrast, "use" refers to individuals' ability to then integrate and apply this newly acquired information to guide their behavior (Daw et al., 2006; Guassi Moreira et al., 2021; Porcelli and Delgado, 2017). Human behaviors are shaped by our motivation to seek rewards or avoid risks, two drives that may not always be aligned (Headley et al., 2019; Norman et al., 2014). Thus, a critical component of use involves how individuals assign values to competing motivational goals and prioritize their pursuit based on perceived salience. We focus this review on the broad distinction between learning and use because this distinction captures these themes of most current hypotheses regarding how childhood adversity affects decision making.

One current hypothesis is that childhood adversity disrupts how children learn to recognize cues of rewards and risks in their environment (Gerin et al., 2017; Harms et al., 2018; Morelli et al., 2021). By childhood adversity, we refer to a broad range of experiences that may challenge a child's sense of wellbeing in negative ways, including experiences of stress, lack of safety, or uncontrollability (Smith and Pollak, 2021; McEwen and McEwen, 2017). Adverse environments are often associated with high levels of unpredictability (Frankenhuis, 2016; Peters et al., 2017). In this type of environment, where events do not reliably predict rewards and risks, children may develop learning strategies more conducive to an unpredictable environment, resulting in poorer performance in more stable learning environments. A second prevailing hypothesis is that childhood adversity does not disrupt children's learning but rather changes how individuals are able to use or implement newly learned information to make decisions (Birn et al., 2017; Hanson, Nacewicz, et al., 2015; Kasparek et al., 2020). On this view, children exposed to more adverse experiences can adequately learn to recognize when an event is followed by a valued outcome, but their experiences have changed how they calibrate or factor in the motivational value of this information when making behavioral choices. For example, a child living in an environment with little support and high levels of harm/lack of safety may prioritize avoidance of potential threats – even if this avoidance comes at the cost of gaining rewards. In contrast, a child living in an environment characterized by high levels of support and safety may prioritize approach and exploration to maximize potential rewards. Unraveling whether observed differences in decision making processes related to childhood adversity are driven by changes in learning or use will provide insight into the mechanisms linking childhood adversity to later behavioral outcomes and inform more targeted interventions.

Despite growing interest in the associations between value-based decision making and developmental outcomes, the current literature has been inconclusive about the role of childhood adversity. Some accounts hold that childhood adversity affects factors that shape how children use reward information (Novick et al., 2018). However, other studies have concluded that childhood adversity exerts effects primarily on reward learning rather than motivational or subsequent implementation factors (Oltean et al., 2022). These inconsistencies in findings may result from measurement differences in both how value-based decision making is measured and how researchers conceptualize what constitutes childhood adversity (Smith and Pollak, 2022).

1.2. Inconsistencies arising from difference in how value-based decision making is measured

Difficulties in interpreting findings related to how childhood adversity affects different components of value-based decision making may arise from two sources of measurement related ambiguity: 1) tasks which do not adequately allow for disentangling of learning processes from use processes, limiting researchers' ability to draw conclusions about which component is most affected; and 2) minimal research examining how children behave in the context of direct threats to safety, as compared to rewards or reward losses, limiting researchers' ability to identify whether differences are due to general deficits in learning or a lack of prioritization of information about rewards.

1.2.1. Measurement of value-based decision making may not adequately distinguish between learning and use

One issue limiting interpretations of findings related to the effects of childhood adversity on decision making is that the tasks currently used to measure value-based decision making have not generally allowed researchers to disentangle which components of the process may be affected by adverse experiences. For example, conditioning tasks that measure physiological and behavioral responses elicited by a neutral cue allow for the assessment of learning, but not for use (Dayan and Berridge, 2014; Glimcher, 2011). Conditioning tasks only assess how children appraise and encode these cues, but not how individuals make decisions to approach or avoid them in the context of rewards and threats. In these types of studies an assumption is typically made that if an organism has learned an association, they will then make use of that knowledge – however that remains an empirical question. Instrumental tasks measure goal directed behaviors and decision making, allowing for the examination of how organisms make use of learned cues. But these tasks must rely upon reverse inferences about what an organism has learned based upon whether the organism executes a behavioral response to either approach an appetitive reinforcer or avoid an aversive reinforcer (Daw and O'Doherty, 2014; LeDoux and Daw, 2018). Adding to the complexity, performance on these tasks shifts depending on the types of stimuli used and the context in which they are administered (Hunter and Daw, 2021; Schreiner et al., 2021). Thus, an experimental task that relies on a singular outcome variable (such as response accuracy) makes it impossible to specify whether adverse experiences influence how children learn or how they use learned information.

1.2.2. Measurement of value-based decision making has focused on rewards and loss of rewards rather than direct threats to safety

A second issue is that extant research examining how childhood adversity affects value-based decision making has focused on rewards and losses of rewards with limited research examining how children behave in the context of direct threats to safety (Smith and Pollak, 2022; Weiss et al., 2019). Children living in environments characterized by high levels of adversity – also often characterized by a lack of safety – may view perceived threats to their safety as more salient than the monetary rewards or losses typically used in experimental tasks (Nusslock and Miller, 2016; Smith and Pollak, 2021b; VanTieghem and Tottenham, 2018). In fact, the handful of studies that have examined how childhood adversity influences decision making in contexts other than monetary reward (such as exposure to loud noises or shocks) do suggest that individuals with high adversity exposures prioritize information about direct threats (Bremner et al., 2005; Deslauriers et al., 2018; Marusak et al., 2021). Examining rewards in concert with risks that represent direct threats to safety could provide greater insight into how childhood adversity influences learning and use of value information, particularly how it changes how individuals weigh differing motivational demands.

1.3. Measurement of childhood adversity may not adequately capture experience

Inconsistencies in the conclusions drawn about how childhood adversity influences reward and risk related decision making may also be driven by ambiguity in how adversity is measured and conceptualized. To date, research examining childhood adversity has focused primarily on assessing whether children have been exposed to particular events that researchers have pre-determined to be adverse events, such as abuse, neglect, domestic violence, etc. (Evans et al., 2013; Felitti et al., 1998; Weems et al., 2020). However, it is not clear that examining these modern (by human evolutionary standards) events alone is sufficient to adequately characterize an individual child's adverse experiences (Danese and Widom, 2020; Smith and Pollak, 2020). Evidence from both humans and non-human animals indicates that adverse experiences are shaped by a wide range of factors beyond event exposures, including an organism's sense of predictability, control, and perceived safety when encountering specific events (McEwen and Akil, 2020; Sapolsky, 2015; Smith and Pollak, 2021a). For this reason, a broader and more contemporary conceptualization of how childhood adversity is measured could shed new light on the relationships between childhood adversity, reward and threat learning, and decision making.

1.4. The current paper

The goal of the current paper is to assess the current state of knowledge about how value-based decision making is affected by childhood adversity. We sought to determine whether there are consistent effects pointing to alterations in either 1) learning of value information or 2) the use of that information in the context of decision making. To do so we conducted a systematic literature review of studies assessing the relationship between childhood adversity occurring prior to 18 years of age and reward or risk related decision making. We reconciled divergent findings in the literature by characterizing whether the type of task used to measure value-based decision making allowed for disentangling different components of decision making, and if effects differed based on how childhood adversity was conceptualized.

2. Method

2.1. Paper identification and review

To identify papers to include in the systematic review, we searched PubMed and PsychInfo for studies conducted in humans on childhood adversity and value-based decision making between January 1, 1960, and May 1, 2024. Childhood adversity was indexed using the following search phrases: "early life stress", "childhood adversity", "childhood trauma", "adverse childhood experiences", "childhood maltreatment", "emotional abuse", "emotional neglect", "physical abuse", "sexual abuse", "physical neglect", "SEC", "poverty", "harsh", "unpredictable environment", and "unpredictability". Value-based decision was indexed using "reward", "reinforcement learning", "instrumental learning", "conditioning", "threat learning", "safety learning", and "fear learning". We excluded the terms "drug", "opiate", and "cannabinoids", as the relationship between childhood adversity and addiction has been addressed elsewhere (Andersen and Teicher, 2009; Burke and Miczek, 2014; Delavari et al., 2016; Enoch, 2011) and is not the focus of this review. We applied the above search terms to the Title and Abstract sections. This search yielded a total of 688 papers, 293 papers on PubMed and 395 papers on PsychInfo. Of those, 268 duplicate records were removed, leaving 420 unique papers. Two coders then independently coded the relevancy of these papers based on abstracts, leaving 130 papers before the final screening.

Authors KES and LX reviewed the papers to identify any that were reviews or meta-analyses, did not use experimental tasks to assess value learning, did not assess adversity in childhood, or did not directly examine the relationship between childhood adversity and task performance, and excluded these papers. This process resulted in a total of 82 unique papers for inclusion. Fig. 1 presents the search and screening

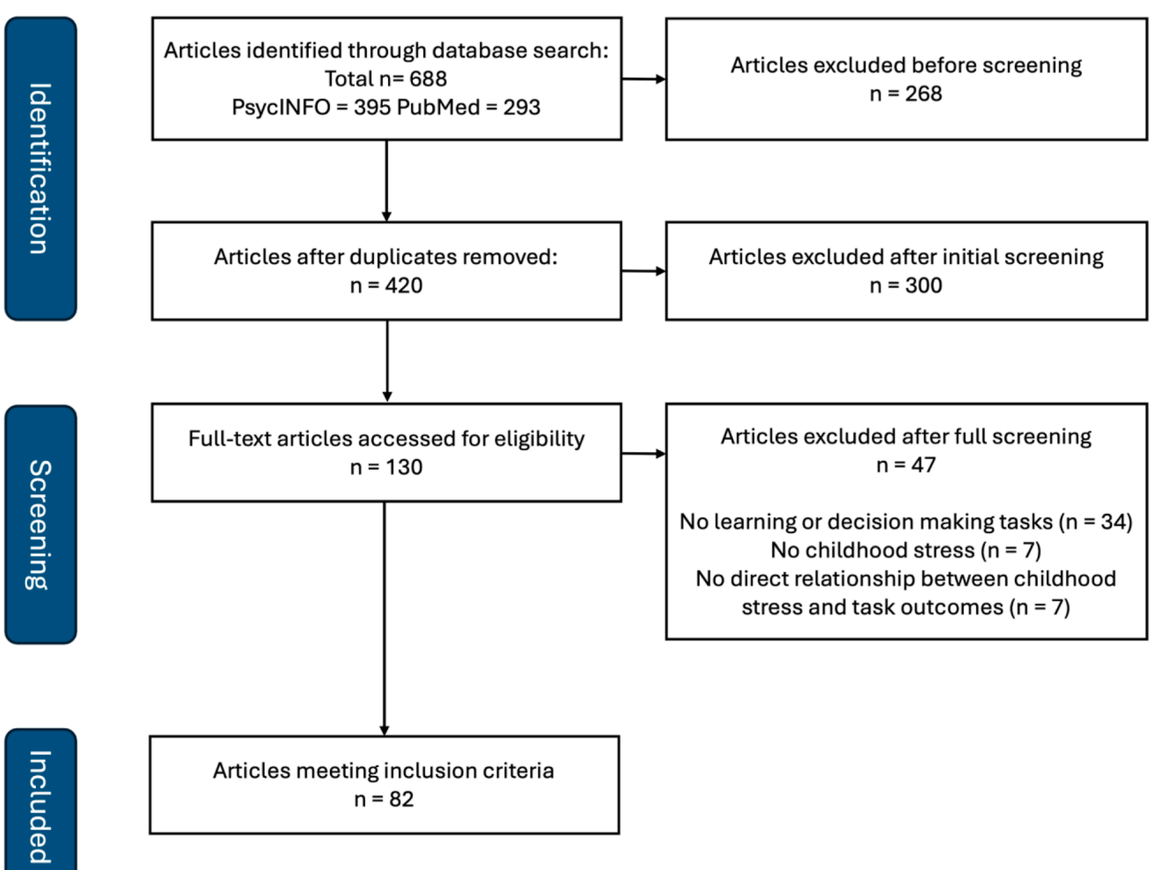

Fig. 1. The preferred reporting items for systematic reviews and meta-analyses (PRISMA) Flow diagram.

procedures based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. For each paper, we classified value learning as either reward learning, risk learning, or both. We included loss of rewards as reward learning, as this represents a very specific type of risk learning relying on valuation associations with rewards. For reward learning, these stimuli included money, points for prizes, toys, and images. Risk learning included air blasts, electric shocks, aversive white noise, valenced spoken sentences, and emotional expressions. Finally, we classified results into either neural/peripheral physiological responses or behavioral findings. Effects were coded based on each task type. Monetary Incentive Delay and number guessing tasks were coded for reward anticipation and reward feedback; probabilistic choice and instrumental conditioning tasks were coded for response accuracy and feedback sensitivity, and threat conditioning tasks were coded for acquisition and extinction phases (see Table 1).

2.2. Transparency and openness

We adhered to the PRISMA 2020 guidelines for systematic reviews (Page et al., 2021). All data and research materials are included in Tables 1 and 2 or is available on the Open Science Framework (OSFl https://osf.io/bz9mq/). This review was not preregistered.

2.3. Study characteristics

2.3.1. Measurement of value-based decision making

Studies used several different types of tasks to examine reward and risk related decision making (see Table 2). Most studies (62) examined indices of children's reward related decision making. Eighteen of these studies employed the Monetary Incentive Delay (MID) task which assesses individuals motivations to obtain or avoid rewards and losses; fifteen studies used number guessing tasks to investigate whether the anticipation and receipt of reward or punishment elicit altered activity in reward related brain regions; twelve studies used variations of probabilistic choice tasks where participants choose between multiple stimuli (e.g., shapes, words) that differ in reward value and/or probability of receiving associated reward; and seventeen studies used instrumental conditioning tasks that require participants to learn how to execute a response to receive a reward or avoid a loss. Eighteen studies examined risk related decision making. Seventeen of these studies used a fear/threat conditioning task in which neutral cues are paired with aversive (e.g. electric shock or loud noise) stimuli to examine learning of threat contingencies; and one study used a fear/threat instrumental conditioning task which require participants to learn to execute responses to different cues to avoid an aversive stimulus. There were only two studies identified examining both reward and risk learning. These studies employed variations of probabilistic choice tasks or instrumental conditioning tasks.

2.3.2. Measurement of childhood adversity

The selected studies examined a range of adverse experiences in childhood that employ different conceptualizations. Most (60) studies focused on specific subcategories of adverse events, such as maltreatment and low socioeconomic status; some (17 studies) assessed cumulative stress by lumping together multiple types of adverse events to create a composite score; and three studies focused on the unpredictability of the early environment. Additionally, two studies compared the effect of trauma, neglect, and food insecurity in two different samples.

The most common measures of childhood adversity were "maltreatment" (42 studies), defined as exposure to abuse (emotional, physical, or sexual) and/or neglect (emotional or physical; Table 1). Among these studies, a majority (28 studies) used the self-report Childhood Trauma Questionnaire. In addition to the Childhood Trauma Questionnaire, studies used various other questionnaires, like the Trauma Events Inventory (Kuehl et al., 2020; Norrholm et al., 2015) and the Conflict Tactics Scale (Dillon et al., 2009), and interviews including K-SADS (Mueller et al., 2012) and UCLA PTSD Reaction Index (Marusak et al., 2021), to assess traumatic experiences related to maltreatment. While most studies treated questionnaire scores as a continuous variable, six studies used cutoff points to divide participants into maltreatment/high adversity or control/low adversity groups (Deslauriers et al., 2018; Dillon et al., 2009; McLaughlin et al., 2016; Opel et al., 2019; Pechtel, Harris, et al., 2022; Richter et al., 2019). In addition, three studies leveraged reports from local Child Protective Services (Hanson, van den Bos, et al., 2017; Harms et al., 2018; Nishitani et al., 2021) to differentiate the maltreated and control groups, not reliant upon self- or other-report measurements.

"Socioeconomic circumstances (SEC)" was the second most common measure of adversity exposure across thirteen studies. These studies assessed SEC using a variety of metrics including parental occupation (Witryol et al., 1968), annual household income (Decker et al., 2024), income-to-needs ratio (Peckins et al., 2022; Ursache and Raver, 2015; White et al., 2022), parent-reported receipt of assistance (e.g., WIC, food stamps; Romens et al., 2015), neighborhood quality (Gonzalez et al., 2016, 2021), log-transformed family income (Palacios-Barrios et al., 2021), composite scores (Delgado et al., 2022; Harvey and Blake, 2022; Noble et al., 2007), and caste (Panda and Das, 1970). Other adverse experiences studied included harsh parenting (La Buissonnière-Ariza et al., 2019; Seitz et al., 2023), community violence (Westerman et al., 2024), peer victimization (Iffland et al., 2018), and parental psychopathology (Sharp et al., 2014), using respective questionnaires and diagnostic assessments.

A subset of seventeen studies adopted a cumulative approach to conceptualize childhood adversity, positing that multiple adverse events collectively impact child development more significantly than any single type of adversity (Evans et al., 2013). This approach generally defines childhood adversity in broader terms, extending beyond extreme forms of adversity, and often uses non-clinical samples. Composite scores of childhood adversity included factors like family environment, parenting quality, physical injury, household changes, and death of a significant person. For assessment, a range of interviews and questionnaires was used, such as the Early Life Stress Index interview (Morelli et al., 2021), the Early Life Stress Questionnaire (Wilkinson et al., 2021), the Youth Life Stress Interview (Birn et al., 2017; Harms et al., 2018), the Early Family Adversity index (Boecker et al., 2014; Boecker-Schlier et al., 2016; Holz et al., 2017), the Trauma History Questionnaire (Richter et al., 2019), the Kiddie Schedule for Affective Disorders and Schizophrenia for School age children (K-SADS; Mueller et al., 2012), the Life Changes Measure (Hanson et al., 2016), and the Adverse Childhood Experiences Questionnaire (Patterson et al., 2013). Notably, Agarwal et al. (2023), Gonzalez et al. (2021), Sacu et al. (2024) used a data-driven approach to lumping adversity measures; they conducted an exploratory factor analysis or a principal component analysis to extract latent commonalities in a batch of adversity measures, which provides new perspectives in categorizing childhood adversities.

In addition, two studies specifically focused on comparing different types of adversity instead of summing them up. They used the Childhood Trauma Questionnaire (Dennison et al., 2016) and Childhood Experiences of Care and Abuse (Kasparek et al., 2020) to assess trauma and neglect, respectively, and the United States Department of Agriculture (USDA) Food Security Scale to assess food insecurity (Dennison et al., 2016; Kasparek et al., 2020).

Different from the previous two approaches, three other studies conceptualized childhood adversity not based on a single type of predefined events or summing up a list of adverse events, but through assessing prominent features in adverse childhood environments, such as unpredictability. This characteristic of the early environment was assessed using caregiver's report of disruptive family events such as caregiver changes, residence changes, and job/income loss (Sturge-Apple et al., 2017), family instability (Davies et al., 2022), and children's self-report of their perceptions of the predictability of parenting behaviors and their daily routines (Xu et al., 2023).

Table 1
Study Summaries.

Study	Sample Size	Age (Mean ± SD; years)	Sex (% Female)	Type of Adversity	Type of Task	Result Coded	Learning or Use	Effect
Reward related								
Agarwal et al. (2023)	6830	9.96 ± 0.62 (low-risk) 9.97 ± 0.62 (medium-risk) 9.92 ± 0.62 (high-risk)	58.2 % (low-risk) 47.8 % (medium-risk) 37.5 % (high-risk)	Multiple	Monetary Incentive Delay	The high-risk group demonstrated reduced activation in various reward-processing regions during reward or loss anticipation. Additionally, they exhibited increased middle frontal cortex activity when receiving large rewards, but this effect was observed only in the test sample.	Use	Reward anticipation (-); Reward feedback (+)
Baranger et al. (2016)	665	19.64 ± 1.24	55.79 %	Maltreatment	Number Guessing	There was no significant difference observed between childhood adversity and reward-related ventral striatum reactivity.	Use	NS
Barker et al. (2015)	41	34.3 ± 8.5 (Borderline personality disorder) 34.5 ± 11.6 (Healthy control)	75 % (Borderline personality disorder) 76.19 % (Healthy control)	Maltreatment	Probabilistic Choice	Childhood trauma predicts the steepness of probability discounting, such that those with greater childhood trauma preferred safer rewards.	Both	Feedback sensitivity (+)
Birn et al. (2017)	54	20.5 (SD not identified)	51.85 %	Multiple	Monetary Incentive Delay	Childhood adversity was associated with reduced neural activation during reward and loss anticipation but increased responsiveness to the receipt of losses.	Use	Reward anticipation (-); Reward feedback (+)
Blair et al. (2022)	142	16.43 ± 1.20	35.92 %	Maltreatment	Instrumental Conditioning	Neglect, but not abuse, was associated with reduced differentiation between reward and punishment in the striatal and prefrontal areas.	Both	Feedback sensitivity (-)
Boecker et al. (2014)	162	24.4 (SD not identified)	58.00 %	Multiple	Monetary Incentive Delay	Childhood adversity was associated with reduced (verbal) reward anticipation but increased responsivity to the receipt of verbal rewards in neural activities.	Use	Reward anticipation (-); Reward feedback (+)
Boecker-Schlier et al. (2016)	168	24.71 ± .46 (Metmet genotype) 24.59 ± .50 (Valmet genotype) 24.59 ± .50 (Valval genotype)	57.9 % (Metmet genotype) 56.8 % (Valmet genotype) 62.9 % (Valval genotype)	Multiple	Monetary Incentive Delay	Childhood adversity was associated with reduced reward anticipation; It was also associated with increased neural responsiveness to the receipt of rewards in individuals with the COMT Met polymorphism genotype.	Use	Reward anticipation (-); Reward feedback (+)
Burani et al. (2023)	149	11.02 ± 1.16	40.94 %	Maltreatment	Number Guessing	Corporal punishment was associated with a larger error-related negativity and a more blunted reward positivity, beyond the impact of harsh parenting and lifetime stressors.	Use	Reward anticipation (-); Reward feedback (+)
Corral-Frías et al. (2015)	820	19.63 ± 1.24	56.58 %	Maltreatment	Number Guessing	There was no significant correlation observed between childhood adversity and reward-related ventral striatum activity.	Use	NS
Crum et al. (2023)	174	16.05 ± 1.49	41.70 %	Maltreatment	Instrumental Conditioning	There was no significant difference observed between the healthy control	Both	NS

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Table 1 (*continued*)

Study	Sample Size	Age (Mean ± SD; years)	Sex (% Female)	Type of Adversity	Type of Task	Result Coded	Learning or Use	Effect
						and the trauma group in task performance.		
Davies et al. (2022)	221	6.60 ± .44	56.00 %	Unpredictability	Probabilistic Choice	Higher levels of parental relationship instability during preschool predicted better performance in detecting reward probabilities in an implicit learning task two years later. Specifically, these children were able to more rapidly identify the locations of hidden rewards during the early stages of the games, rather than in the later stages.	Both	Response accuracy (+); Feedback sensitivity (+)
Decker et al. (2024)	114	13.46 ± 0.68	49.12 %	SEC	Number Guessing	Lower-SEC adolescents exhibited less deceleration after rare rewards compared to their higher-SEC counterparts. Additionally, their striatal activations did not track reward rate fluctuations as closely as those of higher-SEC adolescents.	Use	Reward anticipation (-); Reward feedback (-)
DelDonno et al. (2019)	50	25.09 ± 3.32 (Major depressive disorder group) 29.15 ± 9.00 (Health control group)	70 % (Major depressive disorder group) 85 % (Health control group)	Maltreatment	Monetary Incentive Delay	Childhood maltreatment was positively associated with increased striatal neural activations during reward anticipation.	Use	Reward anticipation (+); Reward feedback (NS)
Delgado et al. (2022)	227	6.27 ± 0.58	49.00 %	SEC	Probabilistic Choice	Children from middle/high-SEC backgrounds learned to choose more frequently from the deck with higher future rewards compared to the low-SEC group. Among those with higher explicit knowledge of the game, middle/high-SEC children outperformed their same-SEC peers with no understanding on the last blocks of the task, whereas this pattern was not observed in the low-SEC group.	Both	Response accuracy (-); Feedback sensitivity (-)
Dennison et al. (2016)	59	16.95 ± 1.44	61.00 %	Maltreatment	Monetary Incentive Delay	The relationship between childhood maltreatment and reaction time in behavioral response is trending towards significance.	Use	NS
Dennison et al. (2019)	94	13.57 ± 13.57	48.90 %	Multiple	Monetary Incentive Delay	Food insecurity but not trauma or neglect was associated with lower reward points earned.	Use	Response accuracy (-); Reward anticipation (NA); Reward feedback (NA)
Dillon et al. (2009)	44	24.58 ± .88 (Maltreated group) 37.08 ± 13.77 (Control group)	69 % (Maltreated group) 45 % (Control group)	Maltreatment	Monetary Incentive Delay	Maltreated participants rated reward-predicting cues less positively, and showed decreased anticipatory reward activity in the left pallidus relative to control participants.	Use	Reward anticipation (-); Reward feedback (NS)
Gonzalez et al. (2016)	83	24.41 ± 1.11	49.40 %	SEC	Monetary Incentive Delay	Childhood poverty was associated with increased striatal activation in reward and loss anticipation.	Use	Reward anticipation (+); Reward feedback (NS)
Gonzalez et al. (2021)	82	33 (SD not identified)	53.66 %	Multiple	Monetary Incentive Delay	Neighborhood harshness was associated with increased striatal and	Use	Reward anticipation (+);

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Table 1 (*continued*)

Study	Sample Size	Age (Mean ± SD; years)	Sex (% Female)	Type of Adversity	Type of Task	Result Coded	Learning or Use	Effect
						prefrontal response to reward anticipation.		Reward feedback (NS)
Gordon et al. (2020)	122	20.62 ± 2.46	82.79 %	Maltreatment	Instrumental Conditioning	Childhood adversity, particularly physical neglect, was associated with more habitual responding.	Both	Response accuracy (-); Feedback sensitivity (-)
Guyer et al. (2006)	59	11.44 ± 1.67	55.26 % (Maltreated) 57.14 % (Controls)	Maltreatment	Probabilistic Choice	Maltreated children with depressive disorders preferred safe over risky choices, and their reaction time did not differ as a function of the likelihood of winning.	Both	Feedback sensitivity (+)
Hanson et al. (2016)	72	26.3 ± 1.1	0.00 %	Multiple	Number Guessing	Early childhood adversity was associated with reduced activation specifically for rewards.	Use	Reward anticipation (NA); Reward feedback (-)
Hanson, Hariri, et al. (2015)	106	13.67 (sd not identified)	48.11 %	Maltreatment	Number Guessing	Greater levels of emotional neglect were associated with blunted development of reward-related ventral striatum activity between the first and second assessments.	Use	Reward anticipation (NA); Reward feedback (-)
Hanson et al. (2017)	81	15.02 ± 1.28	50.62 %	Maltreatment	Probabilistic Choice	Physical abuse was associated with impaired associative learning.	Both	Response accuracy (-)
Hanson et al. (2017)	926	Mean and SD not identified.	Not identified	Maltreatment	Number Guessing	Childhood maltreatment interacted with recent life stress to predict increased reward-related functional connectivity between the left ventral striatum and the medial prefrontal cortex.	Use	Feedback sensitivity (+)
Harms et al. (2018)	53	14.95 ± .91 (Healthy control) 14.78 ± .85 (Early stress)	45.5 % (Healthy control) 41.4 % (Early stress)	Multiple	Instrumental Conditioning with reversal	Adolescents with childhood adversity learned to pair stimuli with outcomes more slowly and showed impaired cognitive flexibility.	Both	Response accuracy (-); Feedback sensitivity (-)
Harvey and Blake, (2022)	194	5.28 ± 0.48 (4–5-year-old group) 6.94 ± 0.63 (6–7-year-old group) 9.32 ± 0.88 (8–10-year-old group)	58 % (4–5-year-old group) 47 % (6–7-year-old group) 52 % (8–10-year-old group)	SEC	Probabilistic Choice	Lower-SEC children made more risky choices for high-value choices compared to higher-SEC children. This effect was specific to gains but not losses.	Both	Feedback sensitivity (+)
Hendrikse et al. (2022)	114	40 ± 12 (Childhood abuse-exposed group) 46 ± 15 (Childhood abuse-unexposed group)	70.59 % (Childhood abuse-exposed group) 63.49 % (Childhood abuse-unexposed group)	Maltreatment	Monetary Incentive Delay	Abuse was related to increased ventral striatal activation during reward anticipation; but there were no effects for abuse or neglect on orbitofrontal cortex activation during reward outcome.	Use	Reward anticipation (+); Reward feedback (NS)
Holz et al. (2017)	171	25 (SD not identified)	Not identified	Multiple	Monetary Incentive Delay	Childhood adversity was associated with a decreased ventral striatum response during reward anticipation.	Use	Reward anticipation (-); Reward feedback (NS)
Kasparek et al. (2020)	132	12.73 ± 2.6	48.50 %	Multiple	Monetary Incentive Delay	Trauma exposure, but not food insecurity or neglect, was associated with the total rewards gained.		Response accuracy (-)
Kasparek et al. (2023)	228	11.58 ± .48	48 %	Multiple	Monetary Incentive Delay	Threat, but not deprivation, was associated with blunted behavioral reward sensitivity (i.e., slower reaction time) with a trending significance after including deprivation as a covariate. There was no direct relationship found for	Use	Reward anticipation (-); Reward feedback (NA)

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Table 1 (*continued*)

Study	Sample Size	Age (Mean ± SD; years)	Sex (% Female)	Type of Adversity	Type of Task	Result Coded	Learning or Use	Effect
						deprivation and reward sensitivity.		
Kiyar et al. (2021)	98	21.61 ± 2.53 (Abuse group) 21.23 ± 3.50 (Neglect group) 21.05 ± 3.04 (Comparison group)	100.00 %	Maltreatment	Instrumental Conditioning	Abuse, but not neglect, was associated with faster response to rewarded stimuli.	Both	Feedback sensitivity (+)
Letkiewicz et al. (2022)	60	14.8 ± 2.3 (Control group) 15.7 ± 1.5 (Trauma group)	100.00 %	Maltreatment	Instrumental Conditioning	Greater sexual abuse severity predicted less use of model-based compared to model-free reinforcement learning and less left frontoparietal network encoding of model-based reinforcement learning updates.	Both	Response accuracy (-)
Lloyd et al. (2022)	145	38.91 ± 11.09	not identified	Maltreatment	Instrumental Conditioning	Participants who reported more adverse childhood events explored less, and they tended to underweight recent feedback.	Both	Response accuracy (-); Feedback sensitivity (-)
Morelli et al. (2021)	46	7.31 ± 0.72	54.35 %	Multiple	Monetary Incentive Delay	Children with higher childhood adversity showed blunted reward anticipation in the left temporal lobe and exaggerated reactivity to the receipt of reward/loss feedback in frontal and posterior regions.	Use	Reward anticipation (-); Reward feedback (+)
Mueller et al. (2012)	46	11.32 ± 1.89 (Adopted children) 11.93 ± 2.36 (Control)	58.82 % (Adopted children) 55.17 % (Control)	Multiple	Monetary Incentive Delay	While children with higher childhood adversity had comparable performance in prosaccades trials, they did not show the incentive-related improvement on inhibitory control as observed in their typically developing peers.	Both	Response accuracy (-); Feedback sensitivity (-)
Nikolova et al. (2012)	170	19.55	61.18 %	Maltreatment	Number Guessing	Childhood maltreatment was not found to be associated with altered ventral striatum activity in reward processing.	Use	NS
Noble et al. (2007)	150	6 (SD not identified)	46.67 %	SEC	Instrumental Conditioning with reversal	SEC was not related to behavioral performance in reward processing.	Both	NS
Opel et al. (2019)	161	37.36 ± 11.81	55.90 %	Maltreatment	Number Guessing	Childhood maltreatment interacted with the polygenetic risk score to negatively predict reward sensitivity in the right insula.	Use	Reward anticipation (NA); Reward feedback (-)
Palacios-Barrios et al. (2021)	78	15.2 ± 0.67	44.90 %	SEC	Instrumental Conditioning	Lower SEC was associated with decreased value assignment to reward, as shown by lower activity in the subgenual anterior cingulate (sACC), in response to approach stimuli.	Both	Feedback sensitivity (-)
Panda and Das (1970)	116	Mean and SD not identified, age range 8–10	0.00 %	SEC	Instrumental Conditioning with reversal	High caste (status in traditional Hindu social system) was associated with faster learning in a verbal reinforcement learning task, whereas being rich was associated with better performance in a relatively non-verbal task.	Both	Response accuracy (-)
Patterson et al. (2013)	73 (Study 1) 212 (Study 2)	19.82 ± 1.37 (Study 1) 20.21 ± 2.29 (Study 2)	80.82 % (Study 1) 76.41 % (Study 2)	Multiple	Instrumental Conditioning with reversal	Childhood adversity was associated with reduced goal-directed behaviors and increasing reliance on	Both	Response accuracy (-); Feedback sensitivity (-)

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Table 1 (*continued*)

Study	Sample Size	Age (Mean ± SD; years)	Sex (% Female)	Type of Adversity	Type of Task	Result Coded	Learning or Use	Effect
						habits, as well as lower expectation for rewards.		
Pechtel and Pizzagalli, (2013)	49	31.60 ± 10.98 (Childhood sexual abuse + Major depressive disorder) 24.81 ± 3.94 (Major depressive disorder) 30.44 ± 10.78 (Healthy control)	100.00 %	Maltreatment	Probabilistic Choice	Sexual abuse was associated with impaired instrumental learning for previously rewarded but not punished cues.	Both	Feedback sensitivity (+)
Pechtel, Harris, et al. (2022)	48	17.04 ± 1.79	100.00 %	Maltreatment	Number Guessing	No differences in fronto-striatal response to reward emerged for the for the childhood sexual abuse + depression group compared to the depression group.	Use	NS
Pechtel, Belleau, et al. (2022)	62	26.48 ± 5.68	100.00 %	Maltreatment	Instrumental Conditioning	Reward responsiveness was not related to childhood sexual abuse experience. Although exploratory analyses showed that blunted cortisol response and non-modulation of reward responses emerged for those who experienced sexual abuse at a younger age.	Both	Feedback sensitivity (-)
Peckins et al. (2022)	study 1: n = 464; study 2: n = 27	14.63 ± 2.14 (Study 1) 10.22 ± 0.91 (Study 2)	43.32 % (Study 1) 51.85 % (Study 2)	SEC	Number Guessing	There was no relationship observed between income-to-needs ratio and ventral striatum activation in response to reward.	Use	NS
Richter et al. (2019)	97	23.78 ± 2.50	67.01 %	Multiple	Instrumental Conditioning	Cumulative stress was associated with reduced activity in ventral striatum (VS) and ventral tegmental area (VTA) during reward receipt, as well as impaired functional connectivity between VS, VTA, and anteroventral prefrontal cortex (avPFC) during reward rejection.	Both	Feedback sensitivity (-)
Romens et al. (2015)	123	16 (SD not identified)	100.00 %	SEC	Number Guessing	Childhood poverty was associated with increased prefrontal activation in reward anticipation.	Use	Reward anticipation (+); Reward feedback (NA)
Sacu et al. (2024)	156	32.4 ± 0.4	55.77 %	Multiple	Instrumental Conditioning	Lower maternal stimulation was linked to lower expected value representation in the right putamen, right nucleus accumbens (NAcc), and anterior cingulate cortex.	Both	Response accuracy (-); Feedback sensitivity (-)
Schellhaas et al. (2022)	64	32.45 ± 11.05	92.19 %	Maltreatment	Instrumental Conditioning	There was no relationship observed between adverse childhood events and contextual learning.	Both	NS
Seitz et al. (2023)	118	31.1 ± 11	78 %	Parenting	Monetary Incentive Delay	Higher levels of maternal antipathy was associated with decreased reward-related brain activation specifically during the anticipation of social rewards, not monetary rewards.	Use	Reward anticipation (-); Reward feedback (NS)
Sharp et al. (2014)	52	13.42 ± 1.78 (Currently depressed daughters) 13.00 ± 1.92	100.00 %	Maternal Psychopathology	Number Guessing	Maternal depression was associated with reduced striatal activation in daughters when they received reward outcomes.	Use	Reward anticipation (NA); Reward feedback (-)

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Table 1 (*continued*)

Study	Sample Size	Age (Mean ± SD; years)	Sex (% Female)	Type of Adversity	Type of Task	Result Coded	Learning or Use	Effect
		(Never depressed daughters) 13.71 ± 1.85 (Control group)						
Sturge-Apple et al. (2017)	194 (Study 1) 201 (Study 2)	4.6 ± 0.44 (Study 1 initial assessment) 2.16 ± 1.69 (Study 2 initial assessment)	56 % (Study 1) 44 % (Study 2)	Unpredictability	Probabilistic Choice	Family instability at age 2 was correlated with reduced delay control at age 4, such that they were more likely to favor immediate rewards over greater total rewards. This correlation was significant in study 2 but not study 1.	Both	Feedback sensitivity (+)
Suor et al. (2023)	96	12.29 ± 2.20	69 %	Maltreatment	Number Guessing	Greater childhood maltreatment was significantly associated with reduced Reward Potential in children with depressive mothers (high-risk) but not in the low-risk group.	Use	Reward anticipation (NA); Reward feedback (-)
Ursache and Raver, (2015)	382	10.57 ± 0.60	53 %	SEC	Probabilistic Choice	There was no significant relationship observed between childhood poverty and altered loss sensitivity (preference for infrequent loss) in the task.	Both	Feedback sensitivity (-)
Westerman et al. (2024)	444	14.74 ± 2.06	43.90 %	SEC	Probabilistic Choice	Exposure to community violence was associated with greater reward-related ventral striatum activation, and the association remained after accounting for family-level markers of disadvantage.	Both	Feedback sensitivity (+)
White et al. (2022)	172	13.94 ± 0.52	65.70 %	SEC	Instrumental Conditioning	Lower income-to-poverty ratio was associated with worse behavioral performance on the passive avoidance task. Neurobiologically, lower income-to-poverty ratio was associated with a greater response in attention brain regions to reward and loss cues and to reward and loss feedback, as well as reduced differentiation between reward and loss feedback in the ventromedial prefrontal and parietal cortex.	Both	Response accuracy (-); Feedback sensitivity (-)
Wilkinson et al. (2021)	129	37.3 ± 1.30 (No childhood stress group) 38.0 ± 1.24 (High childhood stress group)	55.40 % (No childhood stress group) 62.50 % (High childhood stress group)	Multiple	Probabilistic Choice with reversal	Childhood adversity was associated with reduced sensitivity to positive feedback and decreased learning rate in behavioral performance.	Both	Response accuracy (-); Feedback sensitivity (-)
Witryol et al. (1968)	80	6.75 ± 0.27 (Grade 1) 8.83 ± 0.40 (Grade 3) 10.42 ± 0.42 (Grade 5)	50.00 %	SEC	Probabilistic Choice	Childhood poverty was associated with a reduced sensitivity to the reward contingencies in cue-outcome associations.	Both	Feedback sensitivity (-)
Xu et al. (2023)	78 (Study 1) 84 (Study 2)	11.2 ± 0.96 (Study 1) 11.2 ± 1.08 (Study 2)	48.72 % (Study 1) 47.62 % (Study 2)	Unpredictability	Instrumental Conditioning	Childhood unpredictability was associated with reduced flexibility in information seeking and reward-driven decision making.	Both	Response accuracy (-); Feedback sensitivity (-)
R. Yang et al. (2021)	45	14.9 ± 1.90	51.11 %	Maltreatment	Monetary Incentive Delay	Abuse alone was associated with increased reward sensitivity in threat/ emotion regulation circuits;	Use	Reward anticipation (+); Reward feedback (+)

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Table 1 (*continued*)

Study	Sample Size	Age (Mean ± SD; years)	Sex (% Female)	Type of Adversity	Type of Task	Result Coded	Learning or Use	Effect
						Neglect and abuse interacted to predict exaggerated responses to reward feedback.		
Yang et al. (2024)	192	21.08 ± 1.91	59.40 %	Maltreatment	Number Guessing	There was no relationship observed between adverse emotional abuse and reward responsiveness in the brain.	Both	NS
Risk related								
Ahrenholtz et al. (2021)	76	range 21–50; Mean and SD not identified	100 %	Maltreatment	Threat Conditioning	Physical and sexual abuse contributed substantially to both biotype 1 and biotype 3, yet these biotypes exhibited distinct neural responses in the salience, frontoparietal, default mode, and visual networks during the acquisition and extinction phases.	Both	NA. No specific direction of effect in neural profiles.
Bremner et al. (2005)	19	38 ± 10 (PTSD) 36 ± 11 (no PTSD)	100.00 %	Maltreatment	Threat Conditioning	PTSD was associated with increased amygdala activity during fear acquisition and decreased anterior cingulate function during extinction.	Both	Acquisition (+); Extinction (-)
DeCross et al. (2022)	147	12.63 ± 2.68	47.1 % (Trauma) 51.9 % (Control)	Maltreatment	Threat Conditioning	Childhood trauma is associated with poor threat-safety discrimination in right amygdala and altered functional coupling between salience and default mode network regions during aversive learning.	Both	Acquisition (-); Extinction (NA)
Deslauriers et al. (2018)	714	22.30 ± 2.89 (Met/Met genotype) 22.30 ± 2.89 (Met/Val genotype) 22.04 ± 2.61 (Val/Val genotype)	0.00 %	Maltreatment	Threat Conditioning	PTSD interacted with genotype (homozygous Met carrier) and PTSD diagnosis to predict greater fear-potentiated response to safety cues during extinction.	Use	Acquisition (NS); Extinction (+)
France et al. (2022)	29	9.55 ± 0.29	48.28 %	Maltreatment	Threat Conditioning	Fear Potentiated Startle (FPS) during extinction was not correlated with trauma exposure.	Both	Acquisition (NS); Extinction (NS)
Huskey et al. (2022)	42	20.4 ± 4.9	86.00 %	Maltreatment	Threat Conditioning	Childhood trauma indirectly predicted lower fear inhibition which indicates less inhibitory learning during extinction, but did not predict the physiological measures (i.e., HRV and fear inhibition).	Use	Acquisition (NA); Extinction (-)
Iffland et al. (2018)	94	24.63 ± 3.41	64.90 %	Peer Victimization	Threat Conditioning	Peer victimization was associated with an increased physiological sensitivity to neutral stimuli during conditioning and prolonged negative evaluation for negative stimuli post conditioning.	Both	Acquisition (-); Extinction (-)
Kampa et al. (2024)	103	23 ± 3.1	55.34 %	Maltreatment	Threat Conditioning	Childhood adversity was associated with increased right anterior insula response to the unconditioned stimulus, which indicates increased salience processing.	Both	Acquisition (+); Extinction (NA)
Kuehl et al. (2020)	118	39.6 ± 10.7 (MDD/ACE) 33.8 ± 11.4 (MDD/No ACE)	50 % (MDD/ ACE) 41.67 % (MDD/No	Maltreatment	Threat Conditioning	Childhood maltreatment was associated with reduced discrimination	Learning	Acquisition (-); Extinction (NS)

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Table 1 (*continued*)

Study	Sample Size	Age (Mean ± SD; years)	Sex (% Female)	Type of Adversity	Type of Task	Result Coded	Learning or Use	Effect
		33.7 ± 9.8 (No MDD/ACE) 34.9 ± 10.1 (No MDD/No ACE)	ACE) 4615 % (No MDD/ACE) 45.45 % (No MDD/No ACE)			between safety and risk cues during conditioning.		
La Buissonnière-Ariza et al. (2019)	84	14.01 ± 0.70 (harsh parenting) 14.03 ± 0.64 (control)	40.00 % (harsh parenting) 52.27 % (control)	Parenting	Threat Conditioning	Harsh parenting was associated with increased threat sensitivity in the medial temporal lobe and reduced functional connectivity between amygdala and insula.	Both	Acquisition (+); Extinction (NA)
Marusak et al. (2021)	44	8.8 ± 1.45	50.00 %	Multiple	Threat Conditioning	Childhood trauma was associated with higher fear-related brain activation to safety cues during extinction, indicating blunted safety learning	Use	Acquisition (NA); Extinction (-)
McLaughlin et al. (2016)	94	13.64 ± 3.27 (Maltreated) 13.52 ± 3.47 (Controls)	48.6 % (Maltreated) 47.3 % (Controls)	Maltreatment	Threat Conditioning	Childhood maltreatment was associated with blunted physiological reactivity to threat cues and reduced discrimination between threat and safety cues during conditioning.	Both	Acquisition (-); Extinction (NS)
Norrholm et al. (2015)	269	40.02	66.00 %	Maltreatment	Threat Conditioning	Childhood maltreatment was not related to fear-potentiated startle during extinction.	Both	Acquisition (NS); Extinction (NS)
Patterson et al. (2019)	189 (Study 1) 112 (Study 2)	20.31 1.81 (Study 1) 20.54 1.59 (Study 2)	78.30 % (Study 1) 80.36 % (Study 2)	Maltreatment	Instrumental Conditioning	Childhood maltreatment was associated with enhanced avoidance habits (but not avoidance behavior).	Use	Acquisition (NS); Extinction (-)
Penzkofer et al. (2024)	60	30 ± 7.90	38.33 %	Maltreatment	Threat Conditioning	Adverse childhood experiences were associated with decreased activation in the precuneus and the intracalcarine cortex for signals of pain versus safety, indicating reduced processing of pain signals.	Learning	Acquisition (-); Extinction (NA)
Stenson et al. (2021)	137	10.2 ± 1.4	54.01 %	Parent Psychopathology	Threat Conditioning	Children of mothers with high childhood sexual abuse experience showed blunted threat and safety learning; Children of mothers with high trauma and PTSD showed blunted safety learning.	Both	Acquisition (-); Extinction (-)
Thome et al. (2018)	90	31.87	100 %	Maltreatment	Threat Conditioning	PTSD expected higher risk of an aversive event, and showed impaired discrimination between safety and risk cues during the generalization phase.	Both	Acquisition (-); Generalization (-)
Zoladz et al. (2022)	291	19.37 ± 1.93	46.39 %	Maltreatment	Threat Conditioning	Females reporting high childhood maltreatment had enhanced fear learning (greater fear-potentiated startle responses to the CS+) during late acquisition and greater fear generalization (greater fear-potentiated startle responses to the CS−) in the extinction phase.	Both	Acquisition (+); Generalization (+)
Both								
Smith and Pollak, (2022)	72	8.43 ± 0.50	40 %	Multiple	Instrumental Conditioning	Childhood adversity was associated with impaired ability to use the learned information to guide approach/avoidance choices but not the ability to	Both	Response accuracy (NS); Feedback sensitivity (-)

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Table 1 (*continued*)

Study	Sample Size	Age (Mean ± SD; years)	Sex (% Female)	Type of Adversity	Type of Task	Result Coded	Learning or Use	Effect
						learn those information for those who perceived themselves as socially isolated.		
Weiss et al. (2019)	51	51.7 ± 1.20	35.30 %	Maltreatment	Instrumental Conditioning with reversal	Childhood maltreatment was associated with greater difficulties in positive to negative reversals than vice versa.	Both	Response accuracy (-); Feedback sensitivity (-)

Note. For effects, + indicates a significant positive relation between childhood adversity and the reported outcome; - indicates a significant negative relation, and NS indicates a non-significant relation. Abbreviations: SEC – socioeconomic circumstances; PTSD – post-traumatic stress disorder; HRV – heart rate variability.

3. Results

3.1. Evidence for changes in learning versus use

Overall, the evidence indicates that childhood adversity primarily affects the use of value information in decision making, particularly through reduced motivation to pursue rewards and heightened sensitivity to risks. However, there is also some evidence suggestive of an impact on learning processes. Below we summarize findings related to reward-based and risk-based decision making tasks. We explore whether these results differ for reward as compared to risk, type of task used, and how childhood adversity is conceptualized, with the ultimate goal of better understanding whether childhood adversity more so affects learning or use of value information. There was substantial variability in tasks, outcome measures, and indices of childhood adversity across the identified studies, limiting formal comparisons of statistical effects. Thus, we determined that a qualitative synthesis, rather than a formal meta-analysis, was appropriate for this integration.

3.1.1. Reward related decision making

3.1.1.1. Monetary incentive delay and number guessing tasks. Evidence supporting a role of childhood adversity in reward related decision making was most robust in tasks that incorporate minimal learning components suggestive of alterations in use. In particular, childhood adversity was associated with differences in behaviors and neural reactivity in the Monetary Incentive Delay and number guessing tasks. The Monetary Incentive Delay task involves participants first seeing a cue that is either associated with monetary reward or loss, then being asked to press a button promptly in response to a target to gain the reward or prevent losses. In this task, faster reaction times are indicative of increased motivation to approach rewards or avoid losses (Helfinstein et al., 2013; Knutson et al., 2000). With a few exceptions (Boecker-Schlier et al., 2016; Dennison et al., 2016; Dillon et al., 2009), studies using the Monetary Incentive Delay task found childhood adversity is associated with lower reward gains (Birn et al., 2017; Del-Donno et al., 2019; Dennison et al., 2019; Kasparek et al., 2020) and slower reaction times (Boecker et al., 2014), suggestive of reduced motivation to approach rewards. One study using a modified Monetary Incentive Delay task found that increased childhood adversity was associated with impaired performance when children had to inhibit a response, rather than perform one (Mueller et al., 2012), suggesting that impulsivity could be a factor that hinders the use of learned information. Further, studies examining neural activation during reward anticipation in the Monetary Incentive Delay Task found dampened activity in regions associated with reward pursuit including the ventral striatum, caudate, putamen, and nucleus accumbens (Agarwal et al., 2023; Birn et al., 2017; Boecker et al., 2014; Boecker-Schlier et al., 2016; Dillon et al., 2009; Holz et al., 2017; Kasparek et al., 2023; Morelli et al., 2021; Seitz et al., 2023). One study found childhood adversity was associated with evidence of increased activation in the ventral striatum, but only for social, not monetary rewards (Seitz et al., 2023).

Number guessing tasks also involve minimal learning and are thought to index motivational value associated with use. In number guessing tasks, participants are presented with a card and asked to guess whether it will be above or below five. Cards do not contain information signaling the potential reward value; thus, no cue-outcome associations are learned. Neural activity in response to this task indexes motivational value placed on the potential reward. Similar to findings using the Monetary Incentive Delay task, studies using the number guessing task primarily found reduced activation during reward processing in the ventral striatum and other reward related regions (Burani et al., 2023; Decker et al., 2024; Hanson et al., 2016; Hanson, Hariri, et al., 2015; Opel et al., 2019; Sharp et al., 2014; Suor et al., 2023). Together, these observed behavioral and neural differences suggest altered use of reward related information, indicating reduced motivation to approach or receive rewards.

3.1.1.2. Probabilistic choice and instrumental conditioning tasks. Effects of childhood adversity on reward related decision making were less consistent in studies employing probabilistic choice and instrumental conditioning tasks. Unlike the Monetary Incentive Delay tasks and number guessing tasks, these tasks require participants to learn and update associations between cues and valued outcomes through feedback. Behavioral choices made during these tasks are often characterized by overall response accuracy (e.g., Hanson, van den Bos, et al., 2017; Harms et al., 2018). However, differences in response accuracy could be driven by either reduced learning or reduced motivation to make choices aimed at obtaining rewards (or avoiding losses), making it difficult to disentangle learning from use. Some studies also examined indices of feedback sensitivity (e.g., Barker et al., 2015; Guyer et al., 2006; Wilkinson et al., 2021), investigating whether individuals alter choice behaviors in response to feedback that differs along multiple dimensions, such as valence (e.g., rewards and punishments/losses), reward probability (e.g., safe and risky options), or temporal scale (e.g., long-term or recent feedback). Altered feedback sensitivity, including increased vigilance to losses, a preference for safe but less rewarding options, and underweighting of recent feedback, has been observed following childhood adversity. While influenced by multiple factors, these changes may more strongly indicate alterations in use, as they suggest shifts in motivation to seek rewards or avoid losses.

Studies examining response accuracy found that childhood adversity was associated with decreased performance in 15 studies, especially during reversal learning (e.g., Harms et al., 2018; Patterson et al., 2013). One study using computational modeling approaches suggested the reduced accuracy may be due to alterations in learning strategies rather than use (Letkiewicz et al., 2022). This study examined whether childhood adversity was associated with differences in use of model-based learning strategies, in which individuals flexibly update cognitive maps for future planning and is more cognitively taxing, and model-free

Table 2
Task Descriptions.

	Task Purpose	Description	Neural Outcomes	Behavioral Outcomes	Examples
Reward					
Monetary Incentive Delay (MID) task	This task allows researchers to separate the measurement of the anticipation of and the response to reward/loss.	Participants press a button following a reward or punishment cue to earn money or prevent monetary loss.	Reward-related brain activity, including striatal and prefrontal areas and the functional connectivity	reaction time (behavioral sensitivity to reward/loss), total rewards earned, valence ratings of the reward cues	Dennison et al. (2019), Dillon et al. (2009)
Probabilistic Choice task	This task allows researchers to understand individual differences in choosing between options with various reward histories or reward probabilities.	Participants select between multiple options which differ in their probability of leading to rewards and/or losses. The task stimuli can be various, such as shapes, words, etc.	Reward-related brain activity, including striatal and prefrontal areas and the functional connectivity	Reaction time, accuracy, choice preference (e.g., safe/risky options; temporal discounting), computational modeling parameter (e.g., model-free learning rate, choice variability, and response bias)	Gordon et al. (2020); Mueller et al. (2012); Guyer et al. (2006)
Instrumental Conditioning task	This task allows researchers to examine how individuals learn to respond to various cues. It is very similar to the probabilistic choice task	Participants learn the pairing of stimuli with a probabilistic reward or loss feedback through trial and error. The task stimuli can be various, including shapes, colors, and images, and the response includes button presses and eye gaze. For tasks that involve reversal learning, an additional phase will be presented where the reward contingency is updated, which tests participants' flexibility to learn the new rules.	Reward-related brain activity, including striatal and prefrontal areas and the functional connectivity	Reaction time, accuracy, computational modeling (e.g., learned expected value and prediction error)	Guyer et al. (2006); Hanson et al. (2017)
Number guessing task	This task elicits reward-related VS activity.	During each trial of the number guessing task, subjects guess whether the value of a visually presented card is lower or higher than 5. After the choice is made, the numerical value of the card will be presented and followed by appropriate feedback.	Reward-related ventral striatum activity	NA	Romens et al. (2015); Hanson et al. (2016)
Risk					
Fear conditioning task	This task allows researchers to examine individual differences in the learning of threat and safety cues.	This task usually consists of two phases: the conditioning (or acquisition) phase and the extinction phase. In the conditioning phase, a previously neutral stimulus, such as a shape, image, or a neutral facial expression (conditioned stimulus) is paired with an aversive event (unconditioned stimulus) such as an electric shock, an air blast to the eyes, or a loud noise through repeated pairing. In the extinction phase, the conditioned stimulus will be presented in the absence of the unconditioned stimulus.	Fear-related brain activity	Fear-potentiated startle response, reaction time, ratings of the CS+ and CS- stimuli	Marusak et al. (2021); Thome et al. (2018)

learning, which relies on simpler, automatic trial-and-error processes. The study found that experiences of sexual abuse, but not physical or overall trauma exposure, were associated with decreased model-based learning compared to model-free learning. However, results from most studies were not specific enough to conclude that this reduced accuracy is due to impaired learning. Indeed, some evidence was suggestive of poorer response accuracy performance when gaining rewards but not when avoiding losses (Pechtel, Harris, et al., 2022). This type of specific impairment points to a devaluation of rewards and an over-valuation of potential loss, indicative of alterations in use.

Studies investigating feedback sensitivity also support this interpretation. These studies find evidence of reduced reward sensitivity but similar or increased risk/loss avoidance. For example, Wilkinson et al. (2021) observed a reduced tendency to stick with previously rewarded choices among adversity-exposed individuals, but no differences in the tendency to shift away from responses previously associated with loss. Gordon et al. (2020) found that undergraduate students who experienced physical abuse in childhood were more likely to repeat previously learned avoidance responses (i.e., pressing a button to a warning cue) even when the cues no longer resulted in monetary losses. Further, children with histories of maltreatment and trauma prefer safer, albeit less rewarding, options (Barker et al., 2015; Guyer et al., 2006; Humphreys et al., 2015), and adolescents who experienced childhood unpredictability prefer familiar options over exploration of unfamiliar even when they yield fewer rewards (Xu et al., 2023). Together these findings indicate a preference for safe options that prioritize loss avoidance, even at a potential cost to the individual in terms of reward.

Studies examining neural responses in the context of probabilistic choice and instrumental conditioning tasks are suggestive of alterations in circuits involved in both learning and use of value information. Harms et al. (2018) found greater activation in left anterior cingulate cortex, midbrain/thalamus area, and the cerebellum in response to punished errors, suggesting increased negative affect following punishments. They also found lower activation in bilateral middle frontal gyri for errors and lower activation in the right anterior cingulate cortex for rewards during the reversal learning, suggesting a potential rigidity in rule updating and a diminished effort in seeking rewards. These results indicated heightened emotional distress and diminished reward-seeking behavior. Studies by Blair et al. (2022), Palacios-Barrios et al. (2021), Richter et al. (2019), and Sacu et al. (2024) reported findings of blunted neural responses to rewards and punishments/losses in reward-related areas, such as striatum, medial prefrontal cortex, subgenual anterior cingulate cortex, ventral tegmental area, and hippocampus, in individuals with adverse childhood experiences. Additionally, women with histories of childhood sexual abuse and depression demonstrated impaired neurophysiological differentiation between correct and incorrect responses (Pechtel and Pizzagalli, 2013), and children from lower SEC backgrounds showed reduced discrimination between reward and loss feedback in the ventromedial prefrontal cortex (White et al., 2022). These findings lack the specificity that exclusively point to either learning or use, underscoring the need for refined analyses to fully understand these effects.

One study used a variation on a probabilistic learning task that allowed for some separation of learning and use (Pechtel and Pizzagalli, 2013). In this study, participants who had major depression and experienced sexual abuse underwent a learning phase and a test phase. During the learning phase, participants were presented with pairs of cues, followed by either positive or negative feedback. In this phase, participants who had experienced sexual abuse and those who had not demonstrated comparable response accuracy, albeit participants who had experienced sexual abuse were slower in learning the pairings. In the test phase, participants then saw familiar (from the learning phase) or novel (not presenting during learning) pairings. The childhood sexual abuse group demonstrated lower accuracy and responded slower for rewards in both familiar and novel contexts, but demonstrated no differences in responses to negative feedback, further suggestive of reduced motivational approach value for rewards.

3.1.2. Risk related decision making

3.1.2.1. Threat conditioning tasks. Risk related decision making was primarily examined in the context of threat conditioning tasks. Threat conditioning tasks consist of two distinct phases. During the acquisition phase of the task, a negative or unpleasant stimulus (e.g., aversive loud noise or electric shocks) is paired with a neutral cue. Participants' physiological responses and/or reaction times to the neutral cue are then measured to determine if they have learned the association. A variation on this task involves instrumental learning, where participants are asked to learn to make a response that allows them to avoid the negative stimulus - learning is assessed based on whether they exhibit the expected response. In the extinction phase, the neutral cue is presented multiple times without the negative stimulus, allowing participants to learn that the cue now indicates safety rather than danger. Generally, during extinction, participants start to demonstrate reductions in the level of physiological or behavioral responses to the cue, indicative of safety learning.

The effects of childhood adversity were most consistent during the extinction phase of threat conditioning tasks. During the extinction phase, studies consistently identified a pattern of poorer differentiation between risk and safety cues in individuals with higher levels of adversity exposure. For instance, adults exposed to childhood adversity exhibited increased fear-potentiated startle responses, diminished corrugator muscle reactivity, and reduced heart rate response to neutral cues no longer paired with aversive stimuli (safety cue) compared to control participants (Deslauriers et al., 2018; Huskey et al., 2022; Iffland et al., 2018; Zoladz et al., 2022). Additionally, individuals who experienced peer victimization perceived risk cues as more negative and arousing one month post-conditioning (Iffland et al., 2018) suggesting they maintain those learned relationships for longer. Children with a history of trauma avoided both risk and safety cues, whereas those without such a history avoided only the risk cues during extinction (Marusak et al., 2021). Furthermore, childhood adversity was associated with increased habitual avoidance of a previously aversive cue that predicted loud noise in an instrumental learning task (Patterson et al., 2019). These findings in the extinction/devaluation phase in both types of threat related tasks suggest that exposure to childhood adversity leads to a longer retention of risk associations, reflecting a prioritization of information about potential risks and modifications in how this information is used.

Conversely, there was variability in findings related to the effects of childhood adversity on the acquisition of fear conditioning. Some studies noted dampened neural and/or physiological reactivity to aversive stimuli during acquisition (DeCross et al., 2022; McLaughlin et al., 2016; Penzkofer et al., 2024; Thome et al., 2018), while others reported no significant differences (Kuehl et al., 2020; Marusak et al., 2021; Norrholm et al., 2015) or even heightened responses (Bremner et al., 2005; Kampa et al., 2024; Stenson et al., 2021; Zoladz et al., 2022). This inconsistency in activation during the acquisition phase highlights the heterogeneity in the ways childhood adversity impacts fear learning. Nevertheless, the convergence of findings on poorer discrimination between safety and risk cues in the extinction phase provides relatively pronounced evidence of an implicit bias in how individuals process and utilize the information learned about risks, likely as a cascading effect of childhood adversity.

3.1.3. Decision making in the context of both reward and risk

There were only 2 studies identified that examined both reward and risk related decision making, allowing for the examination of learning and use in the context of competing motivations; both provided evidence for altered use. One study used an instrumental conditioning task where participants learned to respond to cues (pictures of a chair versus a car) that are associated with either rewards (pictures of money) or punishments (pictures of a bomb). Here, adversity exposed individuals were less accurate in responses to stimuli with positive outcomes but demonstrated no differences in responses to negative outcomes. Moreover, in the reversal phase where the cue previously associated with positive outcomes was switched to negative outcomes and vice versa, adversity exposed individuals performed better in positive to negative reversal condition than in negative to positive reversal condition (Weiss et al., 2019). This performance suggests an increased sensitivity to negative stimuli that corroborates the heightened risk prioritization in the risk related decision making literature.

The second study further supports that this increased sensitivity to negative stimuli is a manifestation of alterations in use rather than learning. This study separated reward and risk learning from use of that information to make decisions (Smith and Pollak, 2022). This task consists of two parts. First, a conditioned learning paradigm paired neutral stimuli with either rewards (monetary reward points and images that elicit positive feelings) or risks (aversive noise and images that elicit negative feelings). Learning was assessed using reaction times to the neutral shapes and valence ratings. In the second part, children saw the same neutral shapes and were then asked to make use of what they had learned in the previous task to make decisions about whether to approach or avoid different outcomes. In this experiment, individuals who had experienced childhood adversity showed comparable learning to their typically developing peers but difficulties using that learned information to decide whether to approach or avoid positive and negative outcomes. This finding could also explain the alterations in safety learning observed in previous studies – if children in adverse environments prioritize the avoidance of threats, they may behave in ways that assume threat even after its cessation.

3.2. Differences in decision making dependent on measurement of adversity

There was limited and disparate evidence regarding how different types of adversity exposures impact learning and use. Four major adversity types were identified in these studies: maltreatment, socioeconomic circumstances (SEC), cumulative stress, and unpredictability. Three of these adversity types (maltreatment, SEC, and cumulative stress) are focused on identifying children's exposures to events. The fourth, unpredictability, is oriented towards capturing a dimension of how children perceive their experience. The predominance of event focused measures, which have been criticized as inadequate measures of children's experiences of stress (Cohodes et al., 2023; Kahhalé et al., 2023; Smith and Pollak, 2021a), may contribute to the disparate findings across studies.

Studies focusing on one subcategory of adversity exposure types were variable in their findings; notably, research on maltreatment presents particularly inconsistent findings for the use hypothesis, with some studies reporting increased sensitivity to rewards, others noting decreased sensitivity, and still others observing no significant relationships. For instance, abuse, a subtype of maltreatment, was found to correlate with blunted reward responsiveness in the Monetary Incentive Delay or number guessing tasks in Burani et al. (2023), Kasparek et al. (2023), and Suor et al. (2023), but increased reward anticipation or sensitivity in Hendrikse et al. (2022) and Yang et al. (2021), suggesting that a single type of event is not sufficient to characterize the effects of adversity. Additionally, some evidence suggests distinct subtypes of maltreatment have differential effects on value-based learning. Abuse, but not neglect, was associated with faster responses to rewarded stimuli (Kiyar et al., 2021) and increased reward sensitivity in threat and emotion regulation brain circuits during reward anticipation (Hendrikse et al., 2022; R. Yang et al., 2021); neglect, but not abuse, was associated with reduced differentiation between reward and punishment in reward-related brain activities (Blair et al., 2022). Yet other data found minimal evidence for distinct effects. One study clustered participants based on their neural activation in a threat conditioning task and then examined the relation of these neurobiological markers to maltreatment exposure subtypes (Ahrenholtz et al., 2021). Findings were suggestive of greater similarities than differences in neural activation across abuse subtypes (sexual, physical, emotional), although there was some evidence of differences for emotional abuse. These findings suggest marked heterogeneity in associations between subtypes of maltreatment and value-based decision making processes, pointing to minimal evidence for specific effects of different types of exposures.

There was some evidence suggesting SEC, characterized by either proximal indicators such as family income or distal ones such as neighborhood harshness, has distinct effects on aspects of use. In contrast to findings suggesting childhood adversity is linked to devaluation of rewards and overvaluation of risk, lower SEC was associated with increased valuation of rewards, particularly immediate rewards. Children from lower SEC backgrounds were more willing to take risks for high-value rewards (Harvey and Blake, 2022), preferred immediate returns (Delgado et al., 2022), had difficulties processing the trade-off between frequency and magnitude of losses (Ursache and Raver, 2015), and have increased brain activation at the reward anticipation stage (Gonzalez et al., 2016, 2021; Westerman et al., 2024). Specifically, even with more accurate understanding of the game, low-SEC children did not outperform their same-SEC peers, a pattern that was not seen in their middle/high-SEC counterparts (Delgado et al., 2022), pointing to a deficit regarding how to use the explicit knowledge to inform behaviors. However, results for learning are disparate, as some studies found reduced learning performance (Panda and Das, 1970; Witryol et al., 1968), while others found null effects (Noble et al., 2007).

Specific studies that directly compared the effects of distinct adverse events have yielded contradictory results. Using the Monetary Incentive Delay task, Dennison et al. (2019) observed that food insecurity, defined as material deprivation, correlated with fewer reward gains and decreased response accuracy in the task. However, this study found no significant link between neglect or trauma exposure and behavioral performance. Conversely, Kasparek et al. (2020) reported no relation between food insecurity or neglect and performance in the Monetary Incentive Delay task but identified a negative association between trauma exposure and the reward gains.

Research focusing on cumulative stress generally supports the hypothesis of use over learning. At the neural level, cumulative stress has been linked with diminished neural activation in reward-related brain regions during reward anticipation in the Monetary Incentive Delay task (Birn et al., 2017; Boecker et al., 2014; Boecker-Schlier et al., 2016; Holz et al., 2017; Morelli et al., 2021). These altered neural activations could indicate a reduction in reward motivation, as suggested by Hanson et al. (2016) who observed a correlation between lower ventral striatum activity in response to rewarding cues and a tendency to switch options after winning in a probabilistic choice task.

Last, research examining childhood unpredictability was scarce, yet emerging patterns suggested alterations both in use and learning. Children exposed to greater unpredictability showed a preference for immediate tangible rewards rather than waiting for maximum rewards or exploring options with more uncertain outcomes (Sturge-Apple et al., 2017; Xu et al., 2023), indicative of a prioritization of avoidance of uncertainty/risk suggestive of changes in motivations or use. However, higher family instability was also associated with a faster detection of changing reward probabilities in a choice task, indicative of alterations in learning advantageous in environments where the cue-outcome associations are transient (Davies et al., 2022). These results imply that the effects of childhood adversity might not be specific to certain types of adversity, but rather common factors underlying various adversity exposures could influence the development of brain and behavior.

4. Discussion

This review examined two possible mechanisms linking childhood adversity to alterations in value-based decision making: 1) alterations in the ability to recognize and learn contingent relationships; and 2) alterations in how individuals use information to inform decisions. Evidence was most consistent with changes in the second component – that is, exposure to childhood adversity influences how individuals subsequently use information about rewards and risks in making behavioral choices.

The reviewed studies suggest that changes in use related to childhood adversity are driven by shifts towards prioritization of information about potential risks (and thus avoidance of those risks) and devaluation of information about reward. In reward related tasks, children with high adversity exposure demonstrate dampened motivation to approach rewards, are more sensitive to negative as compared to positive feedback, are more sensitive to reversals going from positive to negative than negative to positive, and demonstrate altered activity in reward related neural regions during the anticipation and receipt of reward. In risk related tasks, there was no evidence for disruptions in children's ability to learn relationships between cues and threats, but rather childhood adversity was consistently associated with maintaining these relationships longer once safe, indicative of prioritization of information about potential threats. The one study that used a task designed to separate out learning and use (Smith and Pollak, 2022) supported an alteration in use reflective of prioritization of risk information, with children with high levels of adversity demonstrating increased avoidance of both rewards and risks.

Prioritizing information about risks is likely adaptive when in an adverse environment. Adverse environments are often characterized by high levels of threat and decreased safety (Brosschot et al., 2017; McEwen and Akil, 2020). Continuing to treat a cue that has been associated with potential harm allows an individual in an adverse environment to prioritize avoidance of threats and harm. Indeed, prior research suggests that in other emotional contexts (e.g. facial expressions and emotional scenes) individuals exposed to childhood adversity demonstrate increased sensitivity to cues of threat (Briggs-Gowan et al., 2015; Shackman and Pollak, 2005; Silvers et al., 2016). Taken together with the findings highlighted in the current review, this evidence indicates that childhood adversity influences how children value and use threatening information, and that these effects contribute to observed differences in decision making.

4.1. Issues related to the measurement of value-based decision making

A significant challenge in understanding how childhood adversity impacts value-based decision making is the diversity of tasks that scientists have used. Tasks that measure aspects of use without incorporating learning components, such as the Monetary Incentive Delay and number guessing tasks, yield the most consistent results supporting the use hypothesis. In contrast, probabilistic choice and instrumental learning tasks often conflate learning and use because they were designed with the implicit assumption that one component facilitates the other. As a result, evidence for the learning versus use hypothesis in these tasks is difficult to interpret. However, some evidence suggests individuals with higher levels of childhood adversity behave in these tasks in ways consistent with increased valuation of losses and threats and reduced valuation of rewards (e.g. change behaviors more in response to losses/threats than rewards and prefer safer less rewarding options; Barker et al., 2015; Gordon et al., 2020; Guyer et al., 2006; Wilkinson et al., 2021). Research using multiple behavioral outcomes, rather than relying on a single measure (e.g. response accuracy) can provide further insight into how childhood adversity influences learning and use components of decision making.

In addition, all tasks indexing value-based decision making are limited in that they are susceptible to a multitude of motivational factors, beyond those associated with task rewards and risks. Individual differences in motivational states may shift behaviors dramatically. For example, rodents who have been put in a state of salt deprivation will demonstrate appetitive engagement with a cue previously associated with the release of water with high concentrations of salt (Robinson and Berridge, 2013). Rodents who are not in a state of salt deprivation avoid this cue. These differences make it difficult to separate out learning from other motivational factors that may influence decision making in the context of a single task and point to a need for more research examining how childhood adversity influences decision making across different tasks and contexts.

4.2. Issues related to the measurement of childhood adversity

Another factor limiting the ability to draw conclusive results about whether childhood adversity affects learning or use (or both) is a lack of conceptual clarity regarding measurement of childhood adversity. To date, the focus has been on exposures of maltreatment and poverty. However, these represent coarse measures of experience (see Richter-Levin and Sandi, 2021; Smith and Pollak, 2021a for review) and encompass a range of different events and types of exposures. Some studies have attempted to disentangle different dimensions of children's adversity exposures by examining how different types of exposures influence value-based decision making. While these studies sometimes find differences, the results are not consistent and sometimes even conflicting (see Dennison et al., 2019; Kasparek et al., 2020). It is possible that measures of adversity that focus on factors beyond potentially adverse event exposures may demonstrate differential effects and provide further insight into how childhood adversity influences value-based decision making.

For example, perceptions of predictability and safety both have been linked to perceptions of stress (Brosschot et al., 2018; Smith and Pollak, 2021a). However, these may have different effects on how an individual learns about and uses value information. A child who perceives their environment to lack predictability – parents are not consistent, they move frequently, they lack a regular routine – may be more likely to demonstrate difficulties in learning when an event is associated with a valued outcome, possibly due to a belief that rules and cue-outcome relationships are not always reliable and can change from time to time. In contrast, children who perceive themselves to lack safety – they do not view their parents as safe and do not perceive themselves to have supportive relationships – may be more likely to demonstrate differential use of information as compared to altered learning. It is likely not as simple as one type of experience affecting one facet of value-based decision making – these types of different experiences may interact or have different effects dependent on context. There may also be experiences that affect both learning and use, rather than one or the other. To better understand if this is the case, research assessing aspects of experience beyond sole events is necessary.

4.3. Future directions

There are several potential routes for future research that could clarify some of the current findings. Using multiple tasks that are designed to specifically disentangle different components of value-based decision making (e.g. learning of contingent relationships; use of those relationships to make decisions) has the potential to greatly inform our understanding of how childhood adversity shapes these processes. Combining this type of approach with computational models designed to characterize different parameters of learning and use from children's behaviors has the potential to identify specific mechanisms underlying changes in cognition, and thus can be used to inform more effective programs and interventions for children in adverse environments. Testing learning and decision-making systematically across both social and non-social contexts could further enhance our understanding of how stress-related mechanisms generalize across different environments, particularly given that social interactions often play a critical role in shaping these processes.

Research assessing reward and risk, particularly risk involving direct threats to children's sense of safety, simultaneously will additionally allow for a better understanding of complex motivational interactions that may be at play. Findings suggest children in adverse environments may prioritize information about direct threats to safety, but adequately testing this question requires examining it in concert with reward. Incorporating measures of participants' value judgments of the positive (or rewarding) and negative (or threatening) stimuli has the potential to inform whether behavioral differences are due to the learning of contingent relationships or differences in how an individual values certain stimuli (Knutson et al., 2009; Scheffel et al., 2022).

Last, incorporating measures that better capture children's experiences of stress could aid in elucidating variability in existing findings. Growing research suggests that factors linked to predictability (Fields et al., 2021; Xu et al., 2023) and safety (Kahhalé et al., 2023; Smith and Pollak, 2022) play a critical role in shaping variability in response to stress. Research incorporating indices of environmental and caregiver predictability, perceptions of social relationships, and perceptions of stress, along with the events children are exposed to, has the potential to better identify how different features of adverse experiences shape learning and use.

4.4. Conclusion

Overall, existing evidence suggests that childhood adversity shifts children towards prioritizing avoidance of potential risks and de-value information about potential rewards when making decisions. While existing evidence points to alterations in use of value information rather than learning, more research is necessary to understand the mechanisms through which this occurs. Learning and use still represent broad categories within value-based decision making that can be further divided into multiple other component processes. Using more targeted tasks that better capture the complexities of children's experiences (exposure to multiple rewards and/or threats simultaneously) can help inform this understanding. Together this can aid in better understanding how childhood adversity influences children's long term behavioral outcomes, particularly related to risk taking and psychopathology, and identify potential targets of intervention aimed at supporting children most at risk for negative stress related outcomes.

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Data availability

Any data and code associated with the manuscript is available on the Open Science Framework (OSF; https://osf.io/bz9mq/).

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