Infancy

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RESEARCH ARTICLE OPEN ACCESS

Holistic and Analytic Attention in Infancy: A Cross-Cultural Study in Sweden and Zimbabwe

Hsing-Fen Tu[1,2,3] | Linda van den Berg[1] | Kim Astor[1] | Samson Mhizha[4] | Gustaf Gredebäck[1]

[1]Department of Psychology, Uppsala University, Uppsala, Sweden | [2]Department of Women's and Children's Health, Uppsala University, Uppsala, Sweden | [3]Department of Applied Educational Science, Umeå University, Umeå, Sweden | [4]Faculty of Social and Behavioural Sciences, University of Zimbabwe, Harare, Zimbabwe

Correspondence: Gustaf Gredebäck (gustaf.gredeback@psyk.uu.se)

Received: 8 October 2024 | **Revised:** 3 December 2025 | **Accepted:** 9 December 2025

Handling Editor: Lisa Oakes

Keywords: attention | culture | eye tracking | individual differences | infant

ABSTRACT

This pre-registered eye-tracking study assesses whether there are differences in infants' attention allocation across diverse cultural contexts while taking several social-environmental factors into account. More specifically, we assess whether 9-month-old infants (n = 338; 166 girls, 172 boys) show holistic or analytic viewing when they are presented with naturalistic images, including 32 real-world images (8 outdoor and 8 indoor scenes from two cultural contexts). Infants came from families living in Uppsala, Sweden (Swedish n = 178, Arab n = 1, Bengali n = 1, Finnish n = 1) and Harare, Zimbabwe (Shona n = 136, Karanga n = 4, Malawian n = 1, Ndebele n = 1, Chewa n = 1, Hwesa n = 1, Zambian n = 1). Results demonstrate that attention allocation is different in these cultures in infancy, but that each culture has a unique pervasive, and dynamic attentional style that includes a mix of holistic and analytic components.

1 | Introduction

On a daily basis, we are confronted with a continuous stream of visual information. To effectively navigate and act in the world, we rely on an attentional system that helps prioritize what matters most in a given context (Amso and Scerif 2015; Berger and Posner 2023; Posner and Rothbart 2023). Individual differences in these attentional processes may reflect underlying attentional styles, which can be observed early in life and influence the strategies used to manage attention. In western context, built on literature investigating very young infants' looking behaviors, infants can be classified as rapid (i.e., short fixation durations assumed to be a sign of an efficient attentional style) or slow lookers (Colombo 2001; Hendry et al. 2019; Tu et al. 2022). Rapid lookers process information quickly, retain memories better, and attend to both featural and global aspects, while slow lookers focus more on global features (Colombo et al. 1991; Courage and Howe 2001), attending to both featural and global aspects, while slow lookers focus primarily on global aspects (Colombo et al. 1991). Later research found that rapid lookers follow a global-to-local processing sequence, whereas slow lookers require longer familiarization but eventually develop similar sensitivity to both (Colombo et al. 1995; Freeseman et al. 1993). More recent work has also identified distinct attentional phenotypes in infants aged 5–11 months using a cued-attention paradigm to measure spatial attention and orienting proficiency (Ross-Sheehy et al. 2020). Through latent profile analysis, three stable attentional styles were identified: high flexible infants, who exhibited efficient and adaptive orienting; low reactive infants, who were slower and less responsive; and high reactive infants, who showed rapid but often inaccurate orienting. However, it is still unclear what shapes the individual differences in attentional styles in infancy. These early looking behaviors not only reflect cognitive processes but also actively shape attention, learning, and visual development through social interaction and cascading effects (Oakes 2023). For instance, looking behaviors are often used as predictors to later self-regulation and executive function (Brandes-Aitken et al. 2019; Frick et al. 2018; Garon et al. 2008; Johansson et al. 2015; Sheese et al. 2008). However, a review of 16 longitudinal studies reported mixed results, with only 18% of tests showing significant effects (Tu et al. 2022). Furthermore, much of this foundational work has focused predominantly on Western samples, potentially overlooking the role of broader cultural and ecological contexts in shaping attentional development. Given that attentional mechanisms emerge within diverse social environments, considering fine-grained, cross-cultural observations becomes essential for a more comprehensive understanding.

1.1 | The Cultural Lens on Attentional Styles

For many years, psychological phenomena, such as attention, have primarily been studied within the confines of the WEIRD (Western, Educated, Industrialized, Rich, and Democratic; Henrich et al. 2010) populations, often assumed to represent universal human behaviors across the world. In a world where the vast majority of people live in culturally diverse, non-WEIRD societies, our view of psychology may be skewed (Bard et al. 2021; Henrich et al. 2010). This bias is particularly problematic in developmental psychology (Nielsen et al. 2017; Singh et al. 2023) and neuroscience (Caspar 2024), as it may limit effective early support and interventions that help children integrate into diverse contexts and reach their full learning potential. In response to this limitation, a growing body of cross-cultural research has sought to broaden our understanding, exploring how attentional behaviors are shaped by diverse social, cultural, and environmental factors (Čeněk et al. 2020; Chua et al. 2005; Goto et al. 2010, 2013; Lacko et al. 2020; Masuda 2017; Masuda et al. 2020; Masuda and Nisbett 2001; Masuda et al. 2014; Zhang and Seo 2015). Moreover, a recent review study in developmental research including approximately one million participants also highlighted the persistent under-reporting of sociodemographic data and a strong bias toward White infants from North America and Western Europe (Singh et al. 2023).

The previous distinction between WEIRD and non-WEIRD societies provides a useful lens for understanding global disparities in psychological research, yet, it does not fully capture the differences in which individuals engage with their environments. One important dimension within this broader cultural contrast is the sensitivity to relationships among people and context as a key cultural feature. Specifically, we focus on how individuals within a given cultural context attend to information from their surroundings, either through the holistic, context-sensitive lens of society-centered cultures, where individuals are more likely to view themselves as interconnected with others, or through the more focused, individual-centered perspective of independent cultures (Masuda 2017). Most of the evidence of cultural differences in attention comes from adult literature that shows that populations, for instance, East Asian or North Americans of Asian descent, focus more on contextual elements when asked to describe visual information, compared to North Americans of European descent and Europeans, who focus more on focal elements (Masuda 2017; Masuda and Nisbett 2001; Varnum et al. 2008). Using measurements such as fixations, looking time, and neural responses, previous research shows that European Americans are more likely than East Asians and Asians to focus on central objects (Kitayama and Murata 2013; Lao et al. 2013). A recent study found that cultural differences influence attention, with European Americans focusing more on traits, while Asian Americans and Japanese participants balanced attention between traits and situational factors (Shimizu and Uleman 2021). In sum, compelling evidence suggests that cultural differences shape attention allocation, affecting behaviors interpretation.

Similar results have been demonstrated in assessments of recognition memory (Masuda 2017; Masuda and Nisbett 2001), using semantic (in)congruence tasks (Goto et al. 2010, 2013; Masuda et al. 2014), and with eye-tracking techniques (Čeněk et al. 2020; Chua et al. 2005; Zhang and Seo 2015). The latter demonstrates that Chinese and Taiwanese populations spend more time examining backgrounds of scenes than North Americans and Czechs, (i.e., fewer fixations on focal areas, fixating the focal area later in time, and switching more between focal and background areas; Chua et al. 2005; Čeněk et al. 2020; Zhang and Seo 2015). Such findings have been suggested to mean that "WEIRD populations" attend to information in an analytical manner by examining focal parts of the scene whereas people from several "non-WEIRD populations" attend to information in a holistic manner by examining the entire scene (Masuda 2017; Masuda and Nisbett 2001). However, several recent studies suggest that even within non-WEIRD societies, there is meaningful variation in visual attention patterns. Studies include non-WEIRD and not Asian societies, when comparing rural villages in Pará in northern Brazil to capital São Paulo, it has been reported that children and adults from urban São Paulo showed higher context-sensitive attention than those from rural Amazon villages in Brazil (Mavridis et al. 2020). For instance, rural Cameroonian children demonstrated a stronger object focus than both urban Japanese and German children, challenging the idea of a single, uniform holistic style among non-WEIRD populations (Köster et al. 2018). Taken together, these results highlight the importance of moving beyond WEIRD versus non-WEIRD dichotomy and instead focus on context-specific variation within diverse cultural groups.

1.2 | Socialization Process and Attentional Styles

It has been theorized that socialization practices play a major role in the two attentional styles. People in interdependent cultures are more likely to be part of complex social worlds (many social relations) and consider themselves embedded into the context and thus learn that objects are also embedded in a similar manner. Grossmann and Varnum (2011) showed that Central and Eastern Europeans, who are assumed culturally more interdependent than Western Europeans and North Americans, demonstrated more holistic cognitive styles on tasks assessing categorization and visual attention. People in a more interdependent culture will teach collaboration, social relations, and context. People in independent cultures are part of social worlds with less social relations, which would encourage a focus on goals, rules, and explanations of single objects (Nisbett et al. 2001). Parents in these cultures teach autonomy and categorization of objects independently. For instance, research comparing U.S. and Japanese mother–infant interactions during shared book reading with infants aged 6–18 months shows that U.S. mothers emphasize focal objects, while Japanese mothers highlight social interactions, suggesting culturally distinct scaffolding of attention from an early age(Senzaki and Shimizu 2020). Moreover, within proximal caregiving practices (e.g., in Chinese or Japanese cultures, Maldonado-Duran and Goldberg 2019), the infant spends a lot of time near the parent (while maintaining bodily contact, e.g., held in the arms or carried in a sling or on the back) but facing outward and thus observing the social and physical environment, which enables them to focus on multiple elements of their environment instead of focusing on objects alone. Distal caregiving practices have often been described as contexts that emphasize interconnections with others, as indicated by adults who guide the infant's knowledge acquisition due to social hierarchies, parent-initiated interactions, and minimal signaling from the infant because the parent anticipates the child's needs (Jurkat et al. 2020; Kagitcibasi 2017; Knight and Nisbett 2007). Within distal caregiving, the infant spends most of the time facing the parent, thus enabling mutual gaze and guiding the infant to follow the parent's gaze (Bard et al. 2021; Keller 2007). Distal caregiving practices also emphasize scaffolding, autonomy, infant-initiated (triadic) interactions with parents and objects, infant pointing to objects, and signaling of desires, which help them learn about objects (Bard et al. 2021; Kagitcibasi 2017; Knight and Nisbett 2007). All of these factors may impact infants' attention and result in an early emerging cultural diversity in attentional styles.

Previous literature on cultural differences often characterizes Japan as a more interdependent culture, while Western countries, such as the United States, are considered more independent cultures (Nisbett 2003; Singelis et al. 1995). Based on this, many studies often included Japan and other Western societies as examples. Research suggests that maternal attentional guidance may be culturally specific, influencing children's attentional styles between 4 and 9 years old differently across contexts. For instance, German mothers tend to emphasize focal objects more than their Japanese and Ecuadorian counterparts (Jurkat et al. 2024). In another eye-tracking study, Senzaki and Shimizu (2022) examined how caregiver-child interactions influenced attention in three-to four-year-olds in the United States and Japan. They found that caregivers directed children's attention toward culturally relevant visual information, and after these interactions, Japanese children shifted their attention more toward contextual backgrounds. While face memory during familiarization appears consistent among very young infants across cultures (e.g., the U.S. and Malawi, Beckner et al. 2024), a more recent study reported that 15-month-old infants in Japan paid more attention to background as well as social cues (faces) than infants in the United States (Heise et al. 2025). A few studies have demonstrated that children around the age of five exhibit early signs of having holistic or analytic attentional styles. Children from Japanese culture focus more on contextual information than their European Canadian, non-Hispanic White, and North American peers (Senzaki et al. 2014), as they describe (Imada et al. 2013; Senzaki et al. 2016) or look at (Senzaki and Shimizu 2022) visual stimuli. However, other work has also demonstrated that young children (5 years old) in different cultures (urban Germany, urban Japan, and rural Cameroon) show similar styles (Köster et al. 2018) and it has been suggested that culturally specific attentional styles develop over time when comparing children in the United States and Japan between the ages of 4 and 9 years (Imada et al. 2013). The earliest findings suggest cultural differences in children as young as 12 (Köster et al. 2023, infants in Austria and Japan) and 24 months of age (Waxman et al. 2016, infants in the United States and China; note however that toddlers in both cultures showed similar distributions of attention, but a divergence started to occur at this age). Notably, Köster et al. (2023) found differences in visual attentional style at 12 months using neural measures, but no clear relationship between maternal attention guidance and infants' visual attentional style was established. There is currently no evidence for such differences earlier than 12 months of age. Given the available evidence, it is unclear whether culture affects attentional styles at an earlier age (during the first year of life). Although socialization is thought to be an important source of why some cultures are context-sensitive whereas others are object-sensitive (Nisbett et al. 2001), it is important to understand when the socialization processes start to affect children's attentional styles, not only in order to understand the developmental origins but also to uncover how these styles may affect other cognitive assessments. Previous research on joint attention shows that infants' attention development is strongly shaped by social interactions with the caregiver (Yu and Smith 2016), which in turn, may shape attentional styles. From other (i.e., gaze following) literature we have learned that parents influence infants' attention and that infants can follow their parents' gaze toward objects (Astor et al. 2020; Del Bianco et al. 2019; Hernik and Broesch 2019), which is also affected by cultural factors (Astor et al. 2022).

Although previous research has frequently contrasted children in Western and East Asian cultures, and some studies have explored attentional development in African cultures (e.g., Sierra Leone, Leppänen et al. 2022; e.g., rural Malawi, Pyykkö et al. 2020; Pyykkö, Forssman, et al. 2019), direct cross-cultural comparisons, particularly involving African and Western samples, remain scarce. In the context of the current study, which includes Swedish and Zimbabwean families, traditional Zimbabwean child-rearing practices emphasize close physical contact between parents, particularly mothers. This approach aligns with proximal parenting and strong communal values (Ganga and Chinyoka 2017). In contrast, Swedish parenting is characterized by its child-centered approach (İşci 2021), which prioritizes supporting children's natural development rather than imposing strict directives. Furthermore, a study comparing Zimbabwean parents in Harare and Wollongong found that parents in Harare reported significantly higher levels of social support (92%) than those in Wollongong (20%), indicating a more communal parenting style in Zimbabwe. Additionally, fewer Zimbabwean parents (8%) reported struggling to preserve cultural values compared with 40% of parents in Wollongong, further underscoring Zimbabwe's emphasis on collectivist parenting practices (Ngwaru 2024). Although it is not a clear binary, an individualistic society is generally defined as one that prioritizes personal autonomy, self-expression, and the pursuit of individual goals (Morling and Lamoreaux 2008; Takano and Osaka 2018). In contrast, a collectivist society emphasizes group cohesion, family obligations, and shared responsibilities over individual desires (Krys et al. 2022). Notably, until now, only very few studies have investigated these styles in "non-WEIRD" cultures outside of Asia (Masuda et al. 2020), although these cultures also show interdependent tendencies (such as Zimbabwe; Insights 2023). In the current study, Sweden and Zimbabwe reflect these cultural tendencies in parenting. Sweden emphasizes independence, consistent with Western individualistic values (Morling and Lamoreaux 2008). In contrast, Zimbabwe emphasizes interdependence, respect for elders, and cultural continuity, which are commonly associated with collectivist societies (Krys et al. 2022; Lacko et al. 2020). Furthermore, much of the existing work contains stimuli that do not resemble typical real-life scenarios, which may be crucial when assessing attentional styles as they occur in real life (Jurkat et al. 2020). Jurkat et al. (2020) showed that cultural differences in visual attention between children and adolescents from Germany and Cameroon depended on stimulus familiarity. When viewing highly familiar images, German participants showed a stronger object focus, supporting the social orientation hypothesis. These findings highlight the importance of using ecologically valid and culturally relevant stimuli in developmental research. Finally, perhaps most importantly for this paper, only a few of these studies assess the developmental origin of attentional styles, a critical step for distinguishing core, potentially universal cognitive mechanisms from those shaped by cultural, social, and environmental factors.

1.3 | From Group-Level Patterns to Individual-Level Variability

Having considered the broader, culturally shaped socialization processes that influence attentional styles, it is equally important to examine the individual-level variation within these cultural contexts. Moreover, while cross-cultural research often focuses on the group level analyses, cognitive development is shaped by the ecological and cultural environment, with factors like formal education, parenting practice, and cultural norms (Bohn et al. 2024; Gauvain and Perez 2015). To better understand how culture impacts cognitive processes, particularly attention, individual variation within cultures also is essential when examining how personal experiences interact with cultural influences. Examining individual variation within cultural contexts can provide patterns that group-level comparisons might miss. Bohn et al. (2024) also suggested that examining individual variation within groups settings can help clarify causal relationships by reducing confounding factors and providing a more accurate understanding of developmental processes. A previous review by Ji and Yap (2016) on cultural differences in cognitive styles, such as holistic versus analytic thinking, highlighted that these differences cannot always be reduced to individual traits alone. Factors such as social orientation and situational priming can influence cognitive styles (Ji and Yap 2016), suggesting that personal experiences and ecological environments have a significant impact on attentional styles. While we assume that socialization process may influence infant attentional styles, research on parent-infant interactions shows that even within the same ethnic or racial groups, there is substantial variation in the number of vocabulary words use (Hart and Risley 1995) and communication styles (e.g., assertive vs. obedient interaction styles) (Abels and Hutman 2015). Moreover, studies with African American, Dominican, and Mexican families have documented wide differences in how often mothers use language and gestures with their infants. Some mothers rarely use regulatory language, while others use it frequently, and children's vocabulary growth within these groups also varies considerably (Kuchirko and Tamis-LeMonda 2019). Furthermore, research on joint engagement and parent labeling shows how differences in caregiver communication may influence attentional styles. When parents label or discuss visible referents, analytic attention encourages infants to focus closely on object features; holistic attention leads infants to process entire scenes and relationships. It has been shown that parent labels provided during sustained joint engagement, in which infants share focus on objects with their parent, guide infants' attention to specific objects (Roemer et al. 2022). Barnhart et al. (2018) demonstrated that linguistic labels direct infants' visual attention toward either common or individuating features of objects, supporting holistic categorization or analytic individuation (Barnhart et al. 2018). Together, attentional styles may emerge not only from broad cultural norms but also from the specific ways caregivers interact with their infants. These studies underscore the importance of looking beyond simple group averages to fully understand the range of early communicative experiences.

1.4 | The Present Study

In this study, we examined differences in attentional viewing styles (analytic and holistic) in 9-month-old infants living in Harare, Zimbabwe, and Uppsala, Sweden. The study used a free-viewing eye-tracking paradigm with real-world images depicting everyday life in both cultural contexts. Differences in viewing styles are assessed using the following main measures: distribution of gaze (small distribution = more analytic/less holistic; Gredebäck et al. 2012), looking duration ratio (more attention to the central objects = more analytic/less holistic; Gredebäck et al. 2010), and the number of shifts between focal areas and background areas of the image (fewer shifts = more analytic/less holistic; Čeněk et al. 2020), in order to provide a broad description of infants' attentional styles in these two cultural contexts. We first assessed cultural differences across the entire sample, comparing the attentional styles of infants from Zimbabwe and Sweden. Based on the literature from older children and adults we hypothesize that infants from Zimbabwe will exhibit a more holistic attentional style, shown by a wider distribution of gaze across the images, a lower looking duration ratio on focal objects relative to the background, and a higher number of fixation-shifts between objects and background. Conversely, infants from Sweden are expected to show a more analytic style, with a narrower gaze distribution, higher looking duration ratio focused on central objects, and fewer fixation shifts. Moreover, several factors specific to the child's direct (social) environment within each culture, including the level of *postpartum depression* and *mental well-being* (i.e., maternal depression), *autonomy* and *relatedness* (i.e., independence/interdependence), formal *education* (i.e., socioeconomic status, SES), (financial) *poverty*, and the *value of children* (e.g., psychological, relational, and social benefits of having children), were assessed and their relation to infants' attentional styles was examined. Notably, peripartum depression has been found to affect approximately 10–20% of pregnant individuals globally (Mitchell et al. 2023; Woody et al. 2017), with even higher rates in certain high-risk groups and low-resource countries. Mothers suffering from postpartum depression have been found to have a negative effect on bonding and mother-infant interaction (O'Dea et al. 2023; Slomian et al. 2019), which may, in turn, affect the infant's early socialization. Together with findings that people in dependent and independent cultures have different looking styles (e.g., Masuda 2017), it may be imperative to examine how this dependence/independence influences attention, and whether this acts as a protective factor for infant attention development. Other factors that may affect these styles are (financial) poverty and formal education, which have been found to have detrimental effects on attention (e.g., delayed filtering and less sustained attention; Clearfield and Jedd 2013; D'Angiulli et al. 2008; Stevens et al. 2009), possibly caused by malnutrition (Clearfield and Jedd 2013), harsher and less responsive parenting as well as less cognitive stimulation and social support (Edin and Kissane 2010; Kagitcibasi 2017; Rosen et al. 2020; Wachs 2008; Wray and Ed 2015). In adult research, differences in social class have also been associated with attentional styles: individuals from lower social classes tend to show more holistic attention and interdependent self-views compared to those from higher classes within and across societies (Russians vs. North Americans, Grossmann and Varnum 2011; Northern vs. Southern Italians, Knight and Nisbett 2007). Next, the values parents hold regarding children may influence infant attention by shaping parenting styles and practices (Kagitcibasi 2017; Mayer et al. 2005), which in turn affect parent-child relationships (Trommsdorff et al. 2005), and child development (Gredebäck et al. 2024). Parental economic values, where children are seen as contributors to the family's economic well-being or economic resources through financial support or household labor, are linked to parenting styles characterized by greater emphasis on conformity and family interdependence (Adonteng-Kissi 2023; Mayer et al. 2005; Ndou 2023). Such parents tend to engage in more parent-guided interactions during parent-infant-object engagement, rather than promoting child autonomy and self-expression (Bard et al. 2021). Maternal depression, dependence/independence, SES, and values of children may thus affect the development of attentional styles. Given that these factors may differ between cultures, we believe they will be worthwhile to examine to get a broader understanding of attention across the world. We will assess these factors for each culture separately as in some instances these factors may not be continuous across the entire sample (e.g., poverty levels in Zimbabwe will always be higher than that of Swedish families living in Uppsala, Sweden) and thus perhaps qualitatively different and at the same time inseparable from culture in the statistical analysis. In sum, many factors, at both societal and individual levels, suggest that infants' allocation of attention will be affected by the social sensitivity in the culture and family in which they live. Cultural inclusivity may help us paint a clearer picture of typical development in infancy and beyond. To our knowledge, no studies have previously conducted eye-tracking studies on infant samples in Zimbabwe, thus providing us with the opportunity to examine their viewing behaviors. Furthermore, we hypothesized that, beyond cultural differences, variation in infants' direct social environment, such as maternal well-being, parenting values, and socioeconomic status, would also influence the development of their attentional styles.

2 | Methods

2.1 | Participants and Procedures

Our total sample consisted of 338 infants of which 191 infants were Swedish (95 girls and 96 boys) and 147 infants were Zimbabwean (71 girls and 76 boys). Infants with known neurological disorders were not included in the study or when their mothers did not accompany them, as the questionnaires pertained to the mother's life and well-being. The aim was to collect data from 200 infants in Uppsala and 200 infants in Harare. The target sample size of 200 infants per site was determined using G*Power 3.1.9.2 (www.gpower.hhu.de) to achieve a statistical power exceeding 0.99. However, due to delays in starting up the study in Harare, the final sample there consisted of 151 infants, of which 4 dropped out. In the Swedish sample, mothers identified as Swedish (n = 178), Arab (n = 1), Bengali (n = 1), Finnish (n = 1), or unknown (n = 8), and all living in the environment considered as part of the Swedish culture. In the Zimbabwean sample, mothers identified as Shona (n = 136), Karanga (n = 4), Malawian (n = 1), Ndebele (n = 1), Chewa (n = 1), Hwesa (n = 1), or Zambian (n = 1), but were all considered as part of the Zimbabwean culture and the majority of infants lived in a high-density urban area. One additional infant from Zimbabwe was tested, but the data was excluded upon the caregiver's request. Infants were recruited at 9 (+/− 1 month) months of age. The average age of infants in Sweden was 8.45 months (SD = 0.53) and 9.18 months (SD = 1.1) in the Zimbabwean sample. We focused on 9-month-old infants because distinct attentional phenotypes have been shown to emerge during the second half of the first year (Ross-Sheehy et al. 2020). Additionally, 9 months was selected to maintain consistency with the larger multi-site project examining infants across Uganda, Zimbabwe, Sweden, and Bhutan (Gredebäck et al. 2025). The average age of Swedish mothers was 33 years (SD = 4.2) and 28 years (SD = 6.7) in the Zimbabwean sample. In both countries, mothers provided written informed consent. Swedish infants received a gift card worth € 10 and Zimbabwean infants received a toy. This study received approval from the local ethics board in Sweden Dnr 2021-05530-01 and Zimbabwe MRCZ/A/2919. Additionally, approval was granted by the Ministry of Health and Childcare in Zimbabwe 02022022 and the City of Harare 30052022. Caregivers provided written informed consent prior to participation, and all procedures were conducted in accordance with the Declaration of Helsinki.

Infants were recruited using two different approaches. Swedish infants were recruited via a registry letter that is sent to all infants in the Uppsala region in Sweden at the age of 4 months. If parents were interested in joining studies at the Uppsala Child and BabyLab in Uppsala, Sweden, they would contact the lab. In the recruitment stages of this study in Sweden, parents were then called and asked to participate in the current study. Subsequently, these Swedish parents were asked to come to the lab for testing. Zimbabwean infants were recruited at Greendale Family Health Service in Harare, Zimbabwe and Tafara Family Health Service in Harare, Zimbabwe on the day of testing. At the clinics in Harare, mothers waited outside the clinic for their child's inoculation and weighing. While they were waiting, they were given information about the study. Mothers who decided to participate in this study were first given additional information about the study and its duration and asked to give written consent. They were asked to participate in the study before continuing with their child's vaccinations. In both countries, the eye-tracking session was conducted in a quiet, dimly lit room with minimal visual and auditory distractions to ensure infants could focus on the stimuli. In Sweden, the testing room was a closed space with restricted access, limited to the experimenter and authorized lab personnel only. In Zimbabwe, the testing room was an isolated space with windows but the environment was carefully controlled during the experiment to ensure that no one intervened or disrupted the procedure. To further minimize external influence, visual barriers were placed around the testing area to ensure that infants could not see the experimenter or other individuals during the session. Mothers in both countries were seated in front of the eye tracker with their child on their lap at a distance of 70 cm from the screen. Mothers wore darkened sunglasses to avoid the eye tracker picking up their eyes. The instructions for the eye-tracking task in Sweden and Zimbabwe were similar. Parents were informed about the procedures and instructed to follow the eye-tracking session (during which the child would watch a film) and subsequently participate in the interview with questions. For the eye-tracking task, mothers were explained that the system detects reflections from the eyes to determine where the infant is looking. The session started with the eye-tracking section (10 min) consisting of multiple tasks, some of which (e.g., gaze-following) was part of a larger multi-site study examining infants from Uganda, Zimbabwe, Sweden, and Bhutan (Gredebäck et al. 2025). The eye-tracking stream started with a five-point calibration (Gredebäck et al. 2010) and alternated between free-viewing stimuli of natural scenes (Figure 1), gaze following stimuli (similar to Gredebäck et al. 2008), and stimuli assessing the pupillary light response (similar to Nyström et al. 2018) and tasks assessing oculomotor reaction times (similar to Gredebäck et al. 2006). Infants proceeded to the task only if at least 4 of the 5 calibration points were successfully registered. Following the eye-tracking session, the study continued with an interview (40–50 min) in which a variety of questionnaires were administered orally (to accommodate all literacy levels) to mothers. The questionnaires targeted the infants' physical, social, and emotional context: value of children, residential history, poverty, mothers' autonomy/relatedness, life satisfaction, trust in society/community, home environment, postpartum depression, mental wellbeing, and family composition. An overview of these questionnaires can be found in Section 2.3.

2.2 | Eye-Tracking Apparatus and Stimuli

In both Zimbabwe and Sweden, the eye tracking task was conducted under identical setup. A Tobii Pro Nano (60 Hz) eye tracker was used in each country, paired with a 14-inch portable screen. Both systems operated on Windows 10, with stimuli presented on screens set to a resolution of 1920 × 1080 pixels. The recording monitor had an average latency of 10 ms. The eye-tracking task in the current study consisted of 32 real-world images (Figure 1) to ensure an ecologically valid assessment of attention that is non-artificial stimuli. Sixteen of the images were photographed by author vdB in Zimbabwe of which eight were indoor scenes (eight outdoor scenes) and the other 16 images were photographed by the same author in Sweden of which eight were indoor scenes (eight outdoor scenes), to ensure that infants were familiar with their own ecology in half of the images. To balance cultural relevance with comparability, all infants viewed the full set of 32 images in two blocks in a pseudorandomised order, which included scenes from both Zimbabwe and Sweden. Half of the images depicted their own ecology to ensure familiarity, while the other half represented a different cultural context. To enable a meaningful comparison of attentional styles, the content of images from both countries was made as similar as possible in terms of composition, subject matter, and setting. All images were captured around the same time period and were carefully matched, allowing for a clearer analysis of cultural differences. Outdoor scenes contained street view, open space (like a lake), playgrounds, backyards, gardens, and garages. Indoor scenes included images related to items or spaces in a common household, such as living rooms, dining tables, etc. This approach builds on an emerging body of research showing that, by the second half of the first year, infants from North American and European contexts show increasingly adult-like gaze patterns when viewing natural scenes, shifting from salience-driven to more goal-directed attention (Helo et al. 2016; Pomaranski et al. 2021; van Renswoude et al. 2020). Notably, infants are more likely to fixate on semantically meaningful regions of scenes, with this effect strengthening with age, highlighting a developmental increase in the influence of scene meaning on visual attention (Oakes et al. 2024). Our use of real-world imagery and cross-cultural stimuli allows us to extend this developmental framework to underrepresented populations, enabling a broader examination of the environmental and cultural factors that shape early attentional styles. Moreover, as prior research has shown, infants reliably orient to faces even when they are not visually salient (Kwon et al. 2016), and their eye movements differ markedly in the presence of people (Kelly et al. 2019). Furthermore, recent cross-cultural evidence shows that infants exhibit a robust and distinct attentional bias toward faces across diverse populations, with delayed disengagement occurring in over half of face-viewing trials but being nearly absent for non-face patterns, highlighting a fundamental dissociation in face versus pattern processing (Pyykkö, Ashorn, et al. 2019). To avoid the confound and ensure a more balanced assessment of infants' attention to non-social features within naturalistic environments, we intentionally excluded human figures from our natural scenes. Each image was presented centrally for 8 seconds in a randomized order that was identical for each infant (see Materials at https://osf.io/52ntm/resources for the original stimulus files).

2.3 | Questionnaire-Based Interview and Assessments

The choice for the questionnaires and subsequent variables in this study was based on previous studies that indicated that

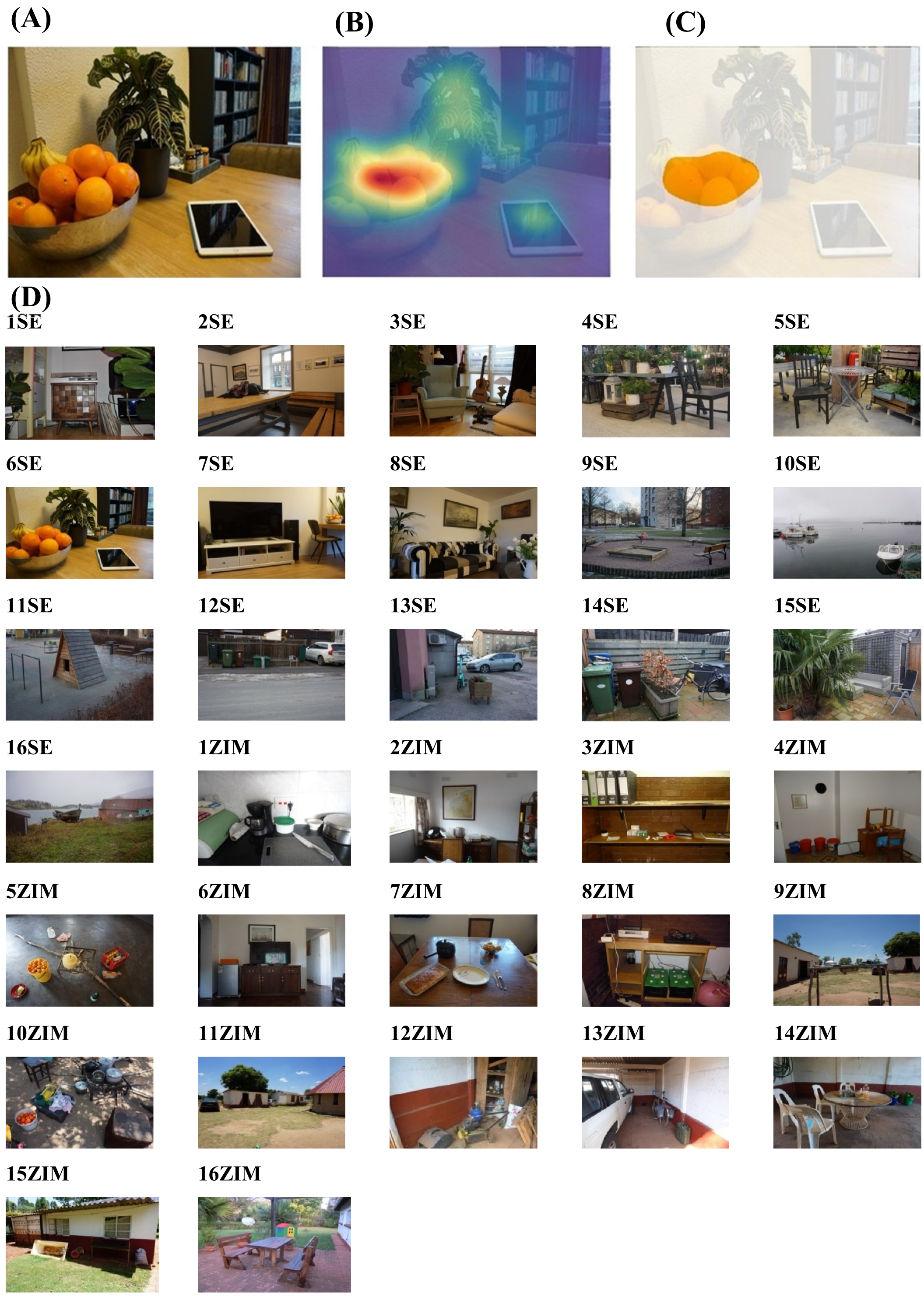

FIGURE 1 | Visual stimuli and data processing steps used in the eye-tracking section. (A) Example of a Swedish indoor scene presented as a stimulus. (B) Corresponding heatmap showing the distribution of participants' gaze. (C) Resulting areas of interest (AOIs) derived from the gaze data. (D) All 32 real-world images included in the eye-tracking task; two images (1SE and 15SE) were excluded from analysis due to insufficient data.

certain variables were of empirical importance in cultural research. Therefore, we found it necessary to include them in order to control for as many cultural factors as possible while answering the highly theoretical core question. The interview with Zimbabwean and Swedish mothers included five questionnaires and a set of orally administered descriptive questions about the infant and the mother's life and environment. To ensure consistency and minimize the impact of differences in education or literacy levels, all questionnaires and descriptive questions were administered orally to participants in both cultural groups. The purpose of these assessments was to capture fine-grained individual and familial factors that may vary within and across cultural contexts and potentially relate to infants' attentional styles. The overview of questionnaires used is listed in Table 1. Note that mothers were informed beforehand that they would be asked a series of questions drawn from five

TABLE 1 | Questionnaires used in the overarching study to which this report belongs.

Questionnaire	Description	*N* items	Reference	Current study	Cronbach's alpha
Parent descriptives	Education, ethnic background, language, income, household	15	—	Yes	—
Infant descriptives	Date of birth, birth order, sex, health	4	—	Yes	—
The Edinburgh postnatal depression scale	Postpartum depression assessment of the last 7 days	10	Cox et al. (1987)	Yes	0.793
The WHO (five) well-being index	Mental well-being assessment of the last X days	5	Topp et al. (2015)	Yes	0.783
The simple poverty scorecard poverty- assessment tool zambia	Poverty assessment targeting living conditions	10	Schreiner (2017)	Yes	0.358[a]
Autonomy-relatedness scale	Autonomous self	9	Kagitcibasi (2017)	Yes	0.788
	Related self	9		Yes	0.672[a]
	Autonomous-related self	9		No	—
The value of children scale	Wanting children (social)	10	Kim and Park (2005)	Yes	0.915
	Wanting children (relational)	7	Kim and Park (2005)	Yes	0.909
	Wanting children (psychological)	10	Kim and Park (2005)	Yes	0.687[a]
	Not wanting children	27		No	
Residential history	Residential history from rural to urban areas	10	—	No	
Life satisfaction	General satisfaction and day-to-day satisfaction	7	—	No	
Trust in society/community	A participant's position and feelings toward their community	4	—	No	
Home environment	Participant's social life and feeling of safety	14	—	No	
Family composition	Family composition and religion	9	—	No	

Note: Included are whether sub-items were used in this report, the number of items, and a description.
[a]Removal of items did not change internal consistency. Low Alphas were still included in this study given the pre-registration of the analyses.

different questionnaires. They responded verbally and were encouraged to ask for clarification whenever something was unclear. While some questions occasionally needed to be repeated or rephrased for clarity, there were no significant indications of confusion or misunderstanding.

2.3.1 | Postpartum Depressive Symptoms

The Edinburgh Postnatal Depression Scale (Cox et al. 1987) was administered to examine postpartum depressive symptoms. This scale consisted of 10 items in which mothers were asked questions about how they felt during the past week. Each item was rated on a 4-point scale ranging from 0 to 3, depending on the severity or frequency of the symptom described. The total score was calculated by summing the scores for all 10 items, resulting in a possible range from 0 to 30. A depression score was the outcome, of which a score of 12 or higher indicated that the mother's depressive symptoms reached the level of clinical significance. This questionnaire has a reliability of $\alpha = 0.83$ (Smith-Nielsen et al. 2018).

2.3.2 | Mental Wellbeing

The WHO (Five) Well-being Index (Topp et al. 2015) was administered to examine mothers' general mental well-being. This scale consisted of five items; each rated on a 6-point Likert scale ranging from 0 ("At no time") to 5 ("All of the time"). The raw scores for each item are summed, resulting in a total score ranging from 0 to 25. This total score is then multiplied by 4 to yield a final well-being index score ranging from 0 to 100, with higher scores indicating better subjective well-being. In this study, lower scores were interpreted as reflecting greater risk for poor mental well-being. Reliability for this questionnaire has ranged between $\alpha = 0.83$–0.93 (Sischka et al. 2020).

2.3.3 | Autonomy and Relatedness

The Autonomy-relatedness scale (Kagitcibasi 2017) was used to assess the orientations toward independence and interdependence through self-reported attitudes and beliefs. In this study, two out of three subscales were used for analysis: autonomous self and related self. The autonomous self-subscale measures the extent to which individuals (mothers) perceive themselves as independent and self-directed within close relationships (e.g., "I feel independent of the people who are close to me"). In contrast, the related self-subscale assesses the degree of emotional connectedness and interdependence individuals experience in close relationships (e.g., "I need the support of persons to whom I feel very close"). Each subscale consists of 9 multiple items rated on a Likert scale (e.g., from 1 = "Strongly disagree" to 5 = "Strongly agree"). Scores for each subscale were averaged to generate separate autonomy and relatedness scores for each participant. Higher scores on each subscale indicate stronger endorsement of the respective dimension.

2.3.4 | Descriptive Questions and Education

Some elements of the descriptive questions were used for analyses in combination with the variables derived from the questionnaires. It was investigated in which country the infant and mother reside, their yearly income, and both the mother's and father's education level. Participants were asked to provide the highest attended *level of education*. Education responses were transformed into a value ranging from 1–6, with 1 being the lowest level of education and 6 being the highest level. Given that Zimbabwe and Sweden have different education systems, efforts were made to ensure that the values ascribed to each education level were comparable between the two cultures. Categorizations were based on the ages of children in primary and secondary school. The value 1 represented primary school, 2 represented schooling until the age of 16, 3 represented schooling until the age of 19, 4 represented unfinished university attendance, 5 represented a completed university degree, and 6 represented PhD as the highest level of education.

2.3.5 | Poverty and Income

The Simple Poverty Scorecard Poverty- Assessment tool Zambia (Schreiner 2017) was used to measure poverty in the Zimbabwean sample only. This scale consisted of 10 items that targeted living conditions. Although this questionnaire was initially designed to capture poverty in Zambia, two authors vdB and SM with deep knowledge of the local conditions in Zimbabwe deemed this questionnaire appropriate for Zimbabwean participants due to similarities in living conditions. The outcome was a percentage score in which a score closer to zero indicated that people were more likely to be living in poverty. Reliability outcomes for this questionnaire are unknown as this has not been examined (Schreiner 2017). However, it has been suggested that this scale might underestimate poverty in poor areas and overestimate poverty in wealthy areas (Skoufias et al. 2020). In the Swedish sample, self-reported income was used instead of a formal poverty assessment. This was included to enable later modeling of socioeconomic predictors within each cultural context.

2.3.6 | The Value of Children

The Value of Children Scale (adapted by Kim and Park 2005) was also administered to measure values or reasons that parents hold for having children. These values can serve as a proxy for understanding parenting attitudes, which may influence infant attention through differences in parenting styles and practices. In this study, a newer version of the original scale was used that consisted of 27 items (Kim and Park 2005) instead of the 20 items (Kağitçibaşi 1982). Each item was rated on a Likert scale (typically ranging from 1 = "Strongly disagree" to 5 = "Strongly agree"). The three categories of values of having children (from the positive scale) as specified by (Kim and Park 2005) were used for further analysis: Social benefits, Relational benefits, and Psychological benefits. Social benefits represented economic and utilitarian values, such as children who contribute to the household financially and physically. Relational benefits represented items that targeted relationships between parents, their children, partners, friends, and family, and how these relationships grow stronger or bring you new relationships. Psychological benefits represented positive feelings parents may have toward their children, such as the love between parent and child, the joy of having a child around, life satisfaction, but also companionship. These three subscales have been found to be highly reliable: Social benefits ($\alpha = 0.85$), Relational benefits ($\alpha = 0.78$), and Psychological benefits ($\alpha = 0.83$; Kim and Park 2005).

2.4 | Analyses

2.4.1 | Preprocessing and AOI Selection Procedure of Eye-Tracking Data

We applied an Identification by Velocity Threshold (I-VT) fixation filter using the default settings in Tobii software, which included a three-sample median filter, a velocity threshold of 30° per second, a velocity window of 20 ms, a maximum gap of 75 ms, and a maximum angle between fixations of 0.5°. The maximum gap setting allowed for brief interruptions in gaze data (e.g., due to blinks) of up to 75 ms to be interpolated, maintaining the continuity of fixations. Additionally, adjacent fixations within 75 ms and 0.5° were merged to reduce oversegmentation and ensure more accurate fixation classification. Fixations shorter than 60 ms were discarded. In order to determine whether infants were looking at focal objects or background objects, the images underwent a data-driven Areas of Interest (AOI) selection procedure. Unlike pre-defined AOIs determined by adults, this approach identifies areas of interest based on the actual gaze behaviors of infants, allowing for a more infant-centered perspective on visual attention. This method also helps reduce misclassification of gaze, as data-driven AOIs better align with fixation clusters and are less prone to false positives and false negatives compared with fixed, predefined AOIs, particularly when tracking precision is limited (Vehlen et al. 2022). All data were pooled without information identifying which culture each individual came from and heatmaps of fixations (Figure 1B) were plotted against the images to find densely fixated areas. Scatter plots and heatmaps were then generated to analyze infants' gaze patterns, with heatmaps created using the stat_density_2d function in ggplot2 (RStudio) to visualize fixation density per image. Heatmaps were overlaid on images to identify high-density fixation areas, which were used as AOIs for further analysis. Scatter plots served as a comparison tool to detect fixation density. Density thresholds were adjusted within stat_density_2d (ranging from 1.25e-05 to 2.50e-06) to define AOIs large enough to encompass objects without covering the entire image. The final threshold (2e-06 and 2e-05) allowed each image to have 1– 4 AOIs that covered entire objects. Fixations outside these criteria were plotted as transparent to isolate high-density areas. These areas were marked as focal AOIs after manually adjusting the heatmap thresholds to find the correct threshold. The adjustment of the thresholds was necessary to ensure that the AOIs were broad/specific enough but not too broad/specific. Subsequently, the X- and Y coordinates (using the pnt.in.poly function in the SDMTools package) of these heatmap-based AOIs were used to match the individual infant's fixations (Tobii I-VT fixation filter) to the AOI locations in a binary fashion that represents a hit (1, within/on the boundary) or miss (0, outside the boundary). Each data point was compared to the AOI and received either a 0 (not inside the AOI) or a 1 (inside the AOI). Each AOI captured on average 16.15% (SD = 6.82%) of infant's data (1–4 AOIs per image). Table 2 demonstrates the percentage of data that each image elicited. As per the pre-registration, two images (out of 36) received less than 2% of the total gaze data and did not yield sufficient fixations to define Areas of Interest (AOIs). These images were therefore excluded from further analysis as they lacked enough data for meaningful interpretation. The final set of images consisted of 16 Zimbabwean images (eight indoor) and 14 Swedish images (seven indoor). The supplementary material (Table S1, Zimbabwean infants; Table S2, Swedish infants) shows the percentage of data each infant contributed and the amount of data each image captured (Figure S1). On average, infants contributed eye-tracking data for 79.91% (Zimbabwe) and 91.92% (Sweden) of the stimulus duration. For some infants eye-tracking data was captured for less than half of the stimulus duration, but this is to be expected in infancy research where infants frequently look away, get bored or tired. Moreover, large amounts of data loss do not mean the remaining data cannot be analyzed (Hessels and Hooge 2019). The amount of data loss in this study is also comparable to previous studies that have used eye-tracking methods (Gredebäck et al. 2010).

2.4.2 | Non-AOI-Based Global Attention Measures

In order to examine an infant's overall engagement with the included stimuli, two global variables were created: total looking duration and the number of fixations. During the creation of these variables, the previously discussed AOIs were not taken into account. Looking duration was defined as the duration of all fixations, regardless of whether the fixation fell within the AOIs and was calculated by averaging the total fixation durations on all stimuli (de Jong et al. 2016). The number of fixations were defined as the number of times an infant looked to any point on the stimuli and was calculated by averaging the total number of fixations on the stimuli, regardless of AOIs (Čeněk et al. 2020). These measures served primarily as control analyses to confirm that both cultural groups attended to the stimuli similarly, based on the assumption that no significant interaction effects between culture and stimulus type would be found on these basic attention metrics. To verify this assumption, the effect of cultural group (Zimbabwe vs. Sweden) and stimuli ecology (Zimbabwean vs. Swedish) on these global attention measures was tested using two-way ANOVAs, as reported in Section 3.1.

2.4.3 | AOI-Based Analytic versus Holistic Attention

The analytic/holistic analysis focused on three variables: distribution of gaze, looking duration ratio of the AOIs, and number of shifts. Distribution of gaze was defined as the relative

TABLE 2 | Overview of the percentage of data that the AOIs in each image collected.

Images from Sweden	Percentage of data	Images from Zimbabwe	Percentage of data
7SE	24.22	10ZIM	31.05
9SE	23.71	5ZIM	26.55
12SE	20.03	4ZIM	26.03
11SE	19.50	8ZIM	23.64
5SE	18.57	13ZIM	20.13
13SE	17.08	9ZIM	20.03
2SE	15.70	14ZIM	19.53
8SE	14.50	16ZIM	17.57
6SE	10.90	1ZIM	17.03
15SE	10.89	7ZIM	16.97
10SE	12.21	15ZIM	16.57
16SE	9.79	11ZIM	15.28
4SE	8.91	2ZIM	14.33
3SE	8.75	12ZIM	12.57
14SE	**1.47**	**6ZIM**	**12.53**
1SE	**0**	**3ZIM**	**10.78**

Note: Images in bold were excluded from analysis due to a lack of data.

distribution of infants' fixations across the stimuli and created by calculating the average fixation location for each stimulus (separate for x and y) and subtracting the location from each fixation (x or y) from the average fixation location for x or y. This method quantified the spatial dispersion of fixations, specifically, how widely the infant's gaze was spread across the image. After squaring these differences, the root of the sum of the squared x and y was calculated and averaged (Gredebäck et al. 2012). A higher value of the distribution indicated a more holistic attentional style. Looking duration ratio of the AOIs was defined as the looking duration to the focal AOIs relative to the background. The measure was calculated as the time infants spent looking at the AOIs divided by the time infants spent looking at the entire scene (Gredebäck et al. 2010). A low value of the ratio indicated a more holistic attentional style. Number of shifts were defined as the transitions between focal stimuli and the background and calculated as the number of times infants switched between fixating the focal AOIs and the background (Čeněk et al. 2020). A high number of shifts indicated a more holistic attentional style. Data were analyzed in RStudio (R. Team 2020; R. C. Team 2016).

2.4.4 | Pre-Registered Statistical Analyses

In this pre-registered study (https://osf.io/52ntm/overview) we planned to first analyze differences in holistic/analytic attention between Zimbabwean infants and Swedish infants, at the group level. We conducted three ANOVAs to examine cultural differences in attentional viewing styles, with each analysis focusing on one dependent variable: looking duration, number of gaze shifts, and distribution of gaze. In all models, we controlled for the familiarity of the cultural context depicted in the images. Following this, we conducted multiple regression analyses within each cultural group to explore how individual-level factors, including poverty, maternal and paternal education, postpartum depression, general mental well-being, autonomy, relatedness, and values regarding children, were associated with variations in attention. These steps were then repeated in a separate set of analyses using general attention as the outcome to assess whether similar patterns emerged. From here on out we will refer to the country in which the infants reside as culture, which is either Zimbabwe or Sweden. We will also refer to the countries from which the images were taken (i.e., the cultural environment they are familiar with) as stimuli ecology. Culture and the stimuli ecology were used as independent variables to predict attentional styles. In addition to the culture variable that indicated the infants' country, stimuli ecology was added to examine whether familiarity with the scenes would affect their viewing. At the time of preregistration, the visual stimuli and analysis code were not yet finalized and therefore were not uploaded with the initial OSF record. To ensure transparency and reproducibility, we later added an associated OSF component containing the analysis code and clarification analyses (https://osf.io/vfm7q), and visual stimuli (https://doi.org/10.17605/OSF.IO/DEK4Y). These additions did not alter the preregistered hypotheses, study design, or analysis plan, but served to complete the preregistered materials.

2.4.5 | Deviations From the Pre-Registered Statistical Analyses

Due to high correlations (ranged from $r = 0.71$ to $r = 0.90$; see Table 3 for all correlations between variables) between culture, poverty, and education, it was decided to deviate from the preregistration. Instead of including culture as a predictor, multiple regressions were fitted to the data for each culture separately to examine the contribution of each independent variable. Defining a measurement of poverty proved difficult in this study. To our knowledge, there were no assessments that equally targeted poverty in both Sweden and Zimbabwe. Poverty

TABLE 3 | Correlations between variables used in this study.

	CU	PP	GM	PO	AU	RE	EM	EF	DG	LR	NS	LD
CU												
PP	0.08											
GM	0.17	**−0.61**										
PO	**0.81**	0.00	**0.34**									
AU	−0.04	−0.08	0.14	0.04								
RE	**0.36**	0.09	−0.03	**0.30**	**−0.48**							
EM	**0.90**	0.06	0.17	**0.79**	0.06	**0.31**						
EF	**0.71**	0.04	0.13	**0.63**	0.01	0.16	**0.74**					
DG	**0.29**	0.00	0.06	0.17	−0.06	−0.13	**0.27**	0.21				
LR	0.17	−0.01	0.05	**0.20**	0.09	−0.02	**0.21**	0.19	0.03			
NS	**0.22**	−0.01	0.09	0.16	0.00	0.07	**0.23**	0.13	**0.43**	**0.56**		
LD	0.13	−0.01	0.08	0.04	−0.05	0.06	0.14	**0.23**	**0.58**	**0.31**	**0.67**	
NF	0.22	0.00	0.04	0.12	−0.00	0.14	**0.21**	0.07	**0.61**	**0.19**	**0.81**	**0.69**

Note: Pearson's correlation coefficients are presented. Significance levels are indicated in bold for $p < 0.05$. Correlations were computed using pairwise complete observations. The variable "CU" represents country, coded as Sweden = 1 and Zimbabwe = 0.
Abbreviations: AU = autonomy; CU = culture; DG = distribution of gaze; EF = education father; EM = education mother; GM = general mental health; LD = total looking duration; LR = looking ratio; NF = total fixations; NS = number of shifts; PO = poverty; PP = post-partum depression; RE = relatedness.

in Sweden is difficult to detect using poverty assessments as the entire Swedish sample would be classified as "not living in poverty" as the items are not relevant to Sweden. For example, when asked to describe the material of the floor in your home, Swedish parents will most likely choose "concrete", whereas Zimbabwean parents may also answer "mud". However, the alternative (asking income levels) also proved to be inappropriate in Zimbabwe, as parents may not be willing to share this information or cannot share this information due to fluctuating income or an active involvement in informal economic activities. For this reason, poverty in Zimbabwe was assessed using the poverty assessment, while this variable was replaced by income in the regression analyses on the Swedish data. However, we acknowledge that the Swedish income may not be informative given likely floor-effects.

2.4.6 | Exploratory Analysis

In order to examine whether the values of having children may affect infants' attention, multiple regressions were fitted to the aforementioned dependent variables using culture and the three categories of values as independent variables: Social benefits, Relational benefits, Psychological benefits. These analyses were conducted on both non-AOI-based global attention (e.g., total looking duration, number of fixations) and AOI-based measures (e.g., looking ratio and number of shifts). These analyses were not pre-registered but results are included in the supplementary material (Table S3, Zimbabwean infants; Table S4, Swedish infants) for transparency. They were conducted to explore potential sociocultural factors that may shape early attentional patterns, given prior work suggesting links between parental values and child development outcomes.

3 | Results

Descriptive statistics for the demographic information and the results of key variables included as predictors are presented in Table 4. The following sections will present the results of the Analytic versus Holistic Attention, Global Attention, and Exploratory Analyses.

3.1 | Non-AOI-Based Global Attention

In order to examine attentional styles, it was important to examine global attention as a control. Two ANOVAs included culture (Zimbabwe & Sweden) and stimuli ecology (Zimbabwean & Swedish) as the independent variables, and two global attention measures as dependent variables: looking duration, which reflects the total time (in seconds) participants spent looking at the stimuli, and number of fixations, which indicates the average count of discrete fixations per image. These analyses (see Figure 2A,B) demonstrated that infants in the two cultures significantly differed in the look durations F (1,671) = 10.47, $p < 0.001$, and the number of fixations F (1,671) = 28.58, $p < 0.001$. Infants in Zimbabwe, on average, made 10.29 (SD = 3.01) fixations for 3.92 s (SD = 1.46), and infants in Sweden made 11.56 (SD = 3.14) fixations for 4.30 s (SD = 1.41). There was an effect of stimuli ecology on the number of fixations F (1,671) = 7.55, $p = 0.006$ but not the look durations, F (1,671) = 0.51, $p = 0.47$. On average, infants looked at Zimbabwean images with 10.68 (SD = 3.08) fixations and at Swedish images with 11.33 (SD = 3.19) fixations. There was no interaction between culture and stimuli ecology for the number of fixations, F (1,671) = 2.77, $p = 0.097$, or look durations, F (1,671) = 2.21, $p = 0.47$. In sum, Zimbabwean infants looked shorter at the images and with fewer fixations compared to their Swedish peers. At the same time, infants from both cultures looked more often at scenes in which a Swedish ecology was depicted.

In order to assess individual differences within this data, multiple regression analyses were fitted onto the Zimbabwean and Swedish data separately. The number of fixations and looking duration were the dependent variables and depression, general mental health, autonomy, relatedness, mother's education, and poverty/income were included as independent variables. However, in both samples, the full regression models were not significant (see Tables S5 and S6).

3.2 | Analytic Versus Holistic Attention

Three ANOVAs included culture (Zimbabwe & Sweden) and stimuli ecology (Zimbabwean & Swedish) as the independent variables and the distribution of gaze, looking duration ratio of the focal AOIs, and number of shifts as the dependent variable. These analyses (see Figure 2C–E) demonstrated that infants in the two cultures significantly differed in the distribution of gaze, F (1,671) = 13.62, $p < 0.001$, $\eta_p^2 = 0.08$, looking ratio on focal AOIs, F (1,671) = 27.32, $p < 0.001$, $\eta_p^2 = 0.14$, and the number of shifts, F (1,671) = 9.34, $p < 0.001$, $\eta_p^2 = 0.05$. The analysis of the distribution of gaze indicated that Swedish infants showed an average distribution of 296.59 visual degrees (SD = 39.17°) whereas Zimbabwean infants showed an average distribution of 270.64 visual degrees (SD = 45.35). The analysis of the average looking ratio on focal AOIs resulted in 0.19 s (SD = 0.05) for Swedish infants and 0.17 s (SD = 0.05) for infants in Zimbabwe. Finally, Swedish infants made an average of 2.66 (SD = 0.97) shifts whereas infants in Zimbabwe made an average of 2.24 (SD = 0.84) shifts. There was an effect of stimuli ecology (Zimbabwean or Swedish) on the looking duration ratio of the focal AOIs, F (1,671) = 63, $p < 0.001$, $\eta_p^2 = 0.27$, and the number of shifts, F (1,671) = 43.89, $p < 0.001$, $\eta_p^2 = 0.21$, but not on the distribution of gaze, F (1,671) = 1.96, $p = 0.16$, $\eta_p^2 = 0.011$. There were no interaction effects between culture and stimuli ecology on the distribution of gaze, F (1,671) = 330.95, $p = 0.71$, $\eta_p^2 = 0.67$, the looking ratio on the focal AOIs, F (1, 671) = 2.08, $p = 0.15$, $\eta_p^2 = 0.01$, or the number of shifts, F (1,671) = 0.23, $p = 0.63$, $\eta_p^2 = 0.001$.

In sum, while scanning images, Swedish infants' fixations traversed larger distances, they looked at the focal AOIs for longer periods of time relative to the background, and they made more shifts between the background and the focal AOIs compared to Zimbabwean infants.

TABLE 4 | Descriptive statistics of demographic information and variables included as predictors.

	Data from Sweden (n = 191)			Data from Zimbabwe (n = 147)			
Variable	Number of available samples	Missing, n	Value (mean (SD) or % of Swedish sample)	Number of available samples	Missing, n	Value (mean (SD) or % of Zimbabwean sample)	p value
Boys	96	0	50.3%	76	0	51.7%	0.87[a]
Girls	95	0	49.7%	71	0	48.3%	0.87[a]
Age	191	0	100%	147	0	100%	
Age in month			8.45 (0.53)			9.18 (1.1)	< 0.001
Number of children in the household	189	2	99.0%	145	2	98.6%	
Overall mean number			1.55 (0.81)			2.46 (1.48)	< 0.001
1	114		59.7%	48		32.7%	
2	53		27.7%	33		22.4%	
3	17		8.9%	36		24.5%	
4	4		2.1%	15		10.2%	
5	0		0%	8		5.4%	
6	1		0.5%	2		1.4%	
7	0		0%	2		1.4%	
8	0		0%	0		0%	
9	0		0%	1		0.7%	
Household size	190	1	99.5%	145	2	98.6%	
Overall mean value			3.52 (0.88)			4.59 (1.64)	< 0.001
2	6		3.1%	1		0.7%	
3	110		57.6%	48		32.7%	
4	52		27.2%	31		21.1%	
5	15		7.9%	29		19.7%	
6	6		3.1%	14		9.5%	
7	0		0%	16		10.9%	
8	1		0.5%	2		1.4%	
9	0		0%	3		2.0%	
10	0		0%	0		0%	
11	0		0%	1		0.7%	
Mother's education (1 lowest to 6 highest)	189	2	99.0%	143	4	97.3%	
1 (primary school)	0		0%	11		7.5%	
2 (schooling until age of 16)	0		0%	120		81.6%	
3 (schooling until age of 19)	21		11.0%	9		6.1%	
4 (unfinished university attendance)	15		7.9%	0		0%	
5 (a completed university degree)	148		77.5%	3		2.0%	
6 (PhD as the highest level)	6		3.1%	0		0%	

(Continues)

Variable	Data from Sweden (n = 191) Number of available samples	Missing, n	Value (mean (SD) or % of Swedish sample)	Data from Zimbabwe (n = 147) Number of available samples	Missing, n	Value (mean (SD) or % of Zimbabwean sample)	p value
Father's education (1 lowest to 6 highest)	184	7	96.3%	42	105	28.6%	
1 (primary school)	0		0%	3		2.0%	
2 (schooling until age of 16)	0		0%	32		21.8%	
3 (schooling until age of 19)	49		25.7%	5		3.4%	
4 (unfinished university attendance)	17		8.9%	2		1.4%	
5 (a completed university degree)	109		57.1%	0		0%	
6 (PhD as the highest level)	9		4.7%	0		0%	
Postpartum depressive symptoms (EPDS; 0–30, 12 or higher indicate depressive symptoms)	191	0	100%	147	0	100%	
Mother with depressive symptoms	17		8.9%	17		11.6%	
Mean EPDS scire (SD)			13.9 (1.8)			15.3 (1.9)	0.036
Mother without depressive symptoms	174		91.1%	130		88.4%	
Mean EPDS scire (SD)			4.6 (3.0)			3.4 (3.6)	< 0.001
Maternal general well-being (WHO-5; 0–100)	191	0	100%	147	0	100%	
Mean value (SD)			60.6 (14.7)			53.9 (24.7)	0.004
Autonomy (1–5)	190	1	99.5%	143	4	97.3%	
Mean value (SD)			2.9 (0.6)			3.0 (0.7)	0.447
Relatedness (1–5)	190	1	99.5%	143	4	97.3%	
Mean value (SD)			3.9 (0.5)			3.6 (0.4)	< 0.001
Psychological value of children (1–5)	190	1	99.5%	142	5	96.6%	
Mean value (SD)			3.1 (0.4)			3.9 (0.4)	< 0.001
Social value of children (1–5)	190	1	99.5%	142	5	96.6%	
Mean value (SD)			1.4 (0.4)			3.0 (0.5)	< 0.001
Relational value of children	190	1	99.5%	142	5	96.6%	
Mean value (SD)			2.6 (0.5)			3.7 (0.4)	< 0.001
Poverty scale, N (%)	NA	NA	NA	147	0	100%	
Poverty scale (0–100, the higher, the higher level of poverty. Only applied in Zimbabwean sample)	NA	NA	NA			70.7 (16.0)	

(Continues)

Variable	Data from Sweden (n = 191)			Data from Zimbabwe (n = 147)			p value
	Number of available samples	Missing, n	Value (mean (SD) or % of Swedish sample)	Number of available samples	Missing, n	Value (mean (SD) or % of Zimbabwean sample)	
Income, N (%)	182	9	95.3%	NA	NA	NA	
Income (only applied in Swedish sample, currency SEK)[b]			75,791.5 (57,620.2)	NA	NA	NA	

Note: The *p*-value indicates the statistical difference between the values (mean ± SD or percentage) of the Swedish and Zimbabwean samples.
Abbreviations: EPDS, Edinburgh postnatal depression scale; NA, not applicable; SD, standard deviation.
[a]Two-sample proportion comparison test.
[b]One SEK is ca. 0.09 Euro.

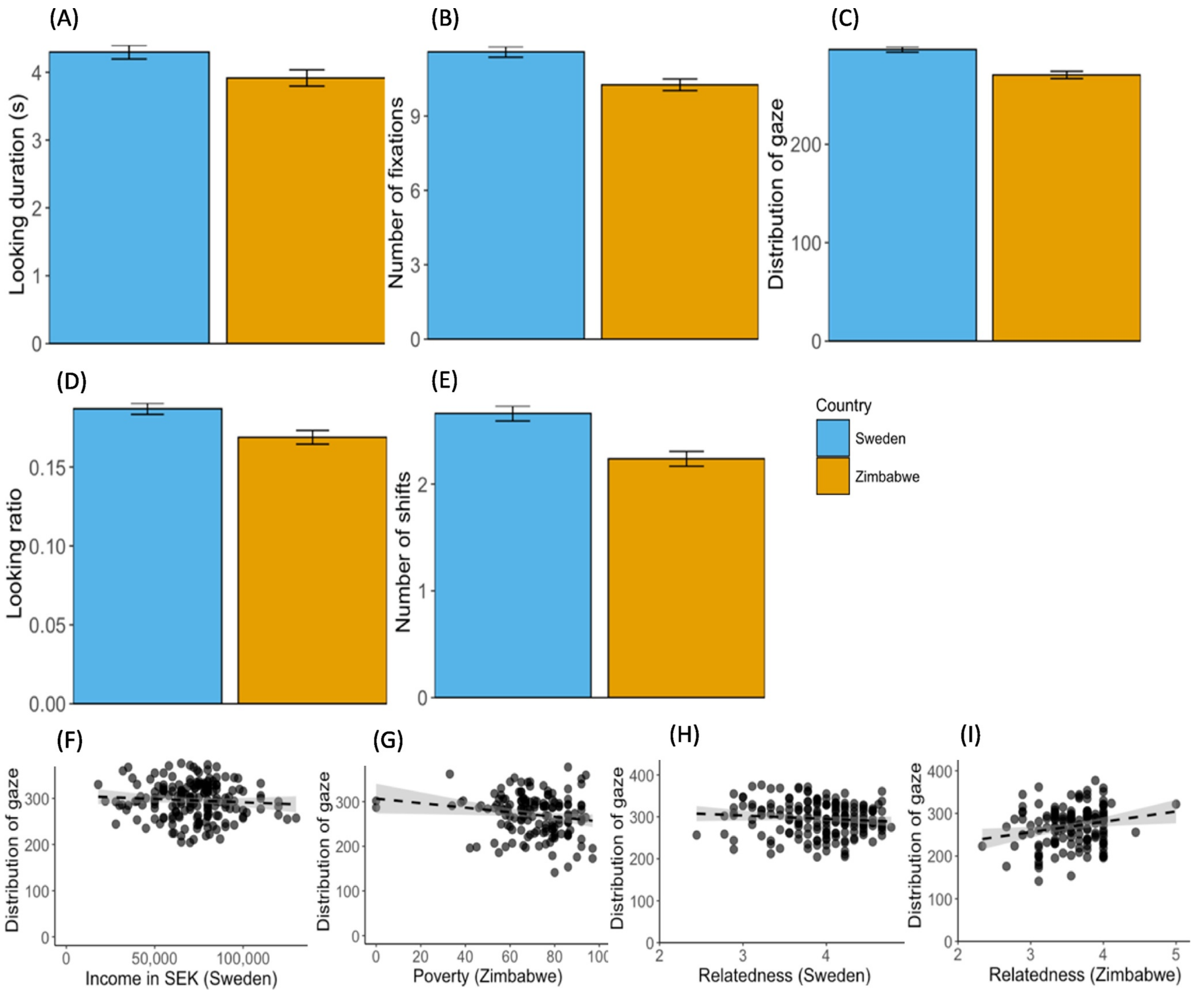

FIGURE 2 | (A)–(E) present group-level comparisons of looking behavior metrics between infants from Zimbabwe (orange) and Sweden (blue). Bars represent the means ± 1 standard error across all included images. (A) and (B) display global measures of attention (looking duration and number of fixations), and (C)–(E) show AOI-based measures (distribution of gaze, AOI looking ratio, and number of shifts). (F) and (G) show the relationship between gaze distribution and poverty or income in the Zimbabwean and Swedish samples, respectively. (H) and (I) illustrate the association between gaze distribution and relatedness in the two samples. The dotted line indicates the regression trend, and the shaded area represents the 95% confidence interval. All metrics were computed per trial and averaged at the participant level for comparison.

In order to assess individual differences within this data, multiple regression analyses were fitted on the Zimbabwean and Swedish data separately. The distribution of gaze, looking duration ratio of AOIs, and number of shifts were the dependent variables and post-partum depression, general mental health, autonomy, relatedness, mother's education, and poverty/income were included as independent variables. In the Zimbabwean sample, the full regression model significantly explained the variance in the distribution of gaze ($R^2 = 0.09$, $R^2_{\text{adj}} = 0.05$, F (6, 135) = 2.24, $p = 0.043$), representing a small to moderate effect size (Cohen's $f^2 = 0.10$). Poverty was a significant predictor of the distribution of gaze ($\beta = -0.71$, 95% CI [−1.31, −0.11], $p = 0.021$). This indicated that more poverty was associated with a longer distance of viewing (i.e., a more holistic style). A maternal relatedness was also a significant predictor of the distribution of gaze ($\beta = 28.89$, 95% CI [4.18, 53.60], $p = 0.022$), which indicated that a high degree of relatedness (i.e., someone has more interdependent than independent tendencies) was associated with a more widespread viewing of an image (i.e., holistic style). Tables 5 and 6 and Figure 2F–I show regression statistics. In sum, these results demonstrated that with more relatedness, and more poverty, infants showed more holistic viewing styles. In the interdependent culture of Zimbabwe, infants that were more interdependent and lived in more poverty showed more holistic viewing. The remaining models in the Zimbabwean sample and all models in the Swedish sample were not significant (See Table 5 and Section 4 in Tables S5 and S6).

3.3 | Results of Exploratory Analyses

In order to explore the data further, the influence of mothers' values (positive for having children) on infants' attention was

TABLE 5 | An overview of all regression models summarizing infant attention patterns in Swedish and Zimbabwean samples.

	Dependent variable	F value	R^2	Adjusted R^2	p value	Content location
Zimbabwe	Distribution of gaze	2.24	0.09	0.05	**0.043**	Main text
	Looking duration ratio	1.67	0.07	0.03	0.132	Tables S3 and S5
	Number of shifts	0.60	0.03	−0.02	0.734	Tables S3 and S5
	Number of fixations	1.23	0.05	0.01	0.294	Tables S3 and S5
	Look duration	1.06	0.05	0.003	0.389	Tables S3 and S5
Sweden	Distribution of gaze	0.99	0.03	−0.0005	0.436	Tables S4 and S6
	Looking duration ratio	0.68	0.03	−0.01	0.68	Tables S4 and S6
	Number of shifts	0.57	0.02	−0.01	0.756	Tables S4 and S6
	Number of fixations	0,58	0.02	−0.01	0.746	Tables S4 and S6
	Look duration	0.70	0.02	−0.010	0.647	Tables S4 and S6

Note: Values in bold represent significant values.

TABLE 6 | Predictor estimates of the distribution of gaze in the Zimbabwean and Swedish samples.

Dependent variable	Predictor	Estimate	SE	t	p value
Zimbabwean sample					
Distribution of gaze	Intercept	210.95	65.27	3.23	**0.002**
	Post-partum depression	−1.00	1.12	−0.89	0.372
	General mental health	−0.005	0.25	−0.02	0.984
	Autonomy	3.63	7.49	0.48	0.629
	Relatedness	28.89	12.49	2.31	**0.022**
	Mother's education	0.40	6.69	0.06	0.952
	Poverty	−0.71	0.30	−2.34	**0.021**
Swedish sample					
Distribution of gaze	Intercept	3.21	4.68	6.87	**< 0.001**
	Post-partum depression	3.88	9.41	0.41	0.681
	General mental health	1.82	2.58	0.71	0.481
	Autonomy	−1.73	5.65	−0.31	0.760
	Relatedness	−1.01	6.72	−1.50	0.134
	Mother's education	2.91	4.42	0.68	0.511
	Income	−8.97	5.19	−1.72	0.088

Note: Values in bold represent significant values.

examined. Multiple regression analyses were fitted onto the data. Looking duration, the number of fixations, distribution of gaze, looking ratio to the AOIs, and number of shifts were the dependent variables and culture, social benefits, relational benefits, and psychological benefits were included as independent variables. Multicollinearity checks revealed that culture had a high variance inflation factor (VIF) value (Table S7). Despite this, to further explore the influence of culture separately, analyses were conducted without culture as a predictor, and separate regression models were run for the Zimbabwean and Swedish data. In both samples, the regression models did not significantly explain the variance in any of the dependent variables (Tables S3 and S4). In sum, the values of having children did not affect infants' performance on the attention measures. Neither general attention nor the analytic versus. holistic attention measures were found to be affected by these values.

4 | Discussion

This study is the first to examine whether 9-month-old infants in Zimbabwe and Sweden have holistic or analytic attentional styles, using a large sample and ecologically relevant stimuli that reflect the real world around the infant and their families. In addition, we investigated whether these viewing styles are influenced by individual difference factors related to these cultural dimensions (autonomy, relatedness, SES, post-partum depression, and the value of children). Our results demonstrated that Swedish infants traversed larger areas when scanning images, looked at focal elements longer compared to the background, and made more shifts between the focal elements and background than Zimbabwean infants. Both the Swedish and Zimbabwean infants showed mixed viewing styles that were distinct to each culture. Swedish infants showed more analytic tendencies, including greater focus on focal objects, while also engaging in broader scanning and frequent gaze shifts, which are typically associated with holistic attention. Conversely, Zimbabwean infants showed less focus on focal objects, but individual differences revealed that those growing up in environments marked by greater poverty and stronger caregiver relatedness displayed more distributed, holistic viewing patterns. This pattern may reflect adaptive attentional strategies shaped by the socioecological context. In environments with strong social interdependence or limited resources, attending more broadly to both objects and backgrounds may help infants monitor social interactions, detect environmental contingencies, and learn efficiently from multiple sources simultaneously. Holistic attention in such contexts emphasizes relational and contextual information over isolated focal elements. Furthermore, both groups engaged with the stimuli, but Zimbabwean infants showed fewer fixations and shorter total looking durations overall, indicating basic differences in global attention. However, these group-level differences were not associated with individual-level predictors and did not account for the culturally distinct within-scene viewing patterns observed in AOI-based analyses. Our results challenge the simplistic binary of WEIRD versus non-WEIRD cultural categorizations. Accordingly, our study highlights the importance of moving toward both cultural and context-sensitive approaches that account for both cultural values and socioecological conditions when interpreting early development of attentional styles across settings.

Within developmental psychology, the idea was widely held that the development of infant attention is rather universal across cultures (e.g., Amso and Scerif 2015; Berger and Posner 2023; Mundy and Newell 2007), with the acknowledgment of individual differences (Berger and Posner 2023; Colombo 2001). However, the present study (at the group level and individual level) demonstrates that infants in Swedish and Zimbabwean cultures show distinct patterns of attention and challenge the assumptions that attentional (and developmental) processes are uniform across cultures. Furthermore, in line with Bohn et al.'s argument that individual-level analyses are essential to discern how specific cultural and ecological factors influence cognitive development, our findings also question the simplified cultural categorizations. Although Swedish and Zimbabwean infants exhibited different attentional styles, both groups demonstrated mixed viewing styles. This suggests that even when comparing culturally distinct groups, considerable individual variations exist in how infants engage with their environment. These variations are shaped by both cultural values and specific socioecological conditions such as maternal well-being, SES, and the value of children. It is important that we take these results as an opportunity to change our approach to learning about infant (attention) development and our underlying assumptions. Aside from examining the effect of culture, it is also important to investigate which specific cultural factors shape developmental patterns. As Amir and McAuliffe (2020) highlight, developmental psychology has historically focused on children from WEIRD populations, but integrating broad, cross-cultural comparisons with in-depth ethnographic approaches offers a more comprehensive view of human behavioral diversity from early in life (Amir and McAuliffe 2020). Consequently, these results have far-reaching implications for infant development as a shift to cultural inclusivity will allow detailed knowledge of development in infancy and beyond (Bard et al. 2021).

The results of the current study paint a complicated picture of infant attention in Sweden and Zimbabwe. Zimbabwean and Swedish infants show a mix of styles that cannot be categorized as either completely holistic or analytic. Based on studies with older children (Imada et al. 2013; Köster et al. 2018; Senzaki et al. 2016; Senzaki and Shimizu 2022) and adults (Čeněk et al. 2020; Chua et al. 2005; Goto et al. 2010; Lacko et al. 2020; Masuda 2017; Masuda et al. 2020; Masuda and Nisbett 2001; Masuda et al. 2014; Zhang and Seo 2015), we expected to find that infants in Zimbabwe would demonstrate a holistic style. This assumption was based on previous studies that have claimed that interdependent cultures demonstrate holistic attentional styles whereas independent cultures show analytic styles (e.g., Masuda 2017; Masuda et al. 2020). The current results demonstrate that there are cultural differences in how young infants view visual scenes, but that these differences do not fall in the dichotomy that previous work has suggested.

These results raise two important points. First, there are factors that affect attentional styles that prior studies have not focused on. From our individual difference results, poverty could be an important contributor, that has not been examined before.

Changes in attention due to poverty have been suggested to stem from malnutrition (Stevens et al. 2009), stress induced by poverty (Stevens et al. 2009), and altered brain structures (mostly prefrontal cortex, Hodel 2018). These results also demonstrate that variations in social-cultural values (relatedness/interdependence) within the Zimbabwean context affect infants' attention. It is possible that the manner in which infants are interacted with differs across families in Zimbabwe (e.g., the number of triadic interactions and parent-initiated interactions discussed earlier, Bard et al. 2021; Keller 2007). Notably, the observed association between poverty, relatedness, and viewing patterns was specific to the Zimbabwean sample, as poverty was not measured in the Swedish group. Future research should include additional populations facing poverty, such as marginalized communities within Europe, to provide more robust evidence on the role of poverty in shaping attentional development.

Secondly, the current results highlight that the division between analytic and holistic attention may be overly simplistic, at least in infancy. Although we expected to find the dichotomy that has been demonstrated at different ages of childhood (Imada et al. 2013; Köster et al. 2018; Senzaki et al. 2016; Senzaki and Shimizu 2022) and adulthood (e.g., Masuda 2017; Masuda et al. 2020), the Zimbabwean and Swedish infants' data show a mix of viewing behaviors. These patterns of attention are difficult to explain within the existing theoretical framework because the leading theory claims that interdependent cultures show holistic styles and independent cultures show analytic styles (Masuda 2017; Masuda et al. 2020). Given that infants in our study showed a mix of styles, their attentional styles are most likely best categorized differently, as complex and multidimensional.

A complementary suggestion might be that there is a true dichotomy of attentional styles for older children and adults but that these have not yet developed into stable and pervasive styles at this age. Future research should employ multidimensional assessments of attentional styles across different developmental stages to better understand how these patterns emerge and stabilize. It might be also important to capture the dynamic interaction between children's evolving cognitive capacities and the attentional styles modeled by caregivers, as parental attention likely plays a crucial role in shaping infants' attentional development. Moreover, longitudinal studies following infants over time are especially valuable for identifying when stable cultural differences in holistic versus analytic attention emerge and how these relate to broader developmental processes.

Some aspects of this study may affect how we interpret these findings. It is important to note that this study included variables that may serve as proxies for differences between countries, which may have complicated our search of individual differences. Constructs like income, education, and household composition may carry different meanings and implications in different settings. As such, the predictive value of these variables should be understood as context-specific rather than universally comparable. Future work would benefit from the development of more culturally grounded and equivalent measures to enhance cross-cultural interpretation. Furthermore, while we assumed that distal and proximal parenting practices may influence infants' attentional styles, parenting styles were not directly measured. Instead, parental values served as a proxy for broader caregiving attitudes that may shape infant attention. This indirect approach is a limitation, and future studies should include direct assessments of parenting styles to better understand their impact on attentional development.

Nevertheless, these outcomes may still provide important information regarding factors that affect attentional differences. Future work would benefit from variables that can distinguish within-country differences. Zimbabwe is made up of three different types of districts: rural, low-density urban, and high-density urban, with different exposures to poverty, education, and technologies associated with urban life (Bremner et al. 2016). In this study, the majority of infants lived in a high-density urban area and only a handful of infants lived in a low-density urban area. As a result, our sample may not fully capture the diversity of Zimbabwean infants, potentially underrepresenting those with greater access to books, digital media, and other educational resources. This difference in exposure may influence the contextual focus during testing, as prior research suggests that infants with less access to these resources may develop different attentional and learning patterns (Bremner et al. 2016). Though eye-tracking studies have so far generally failed to address this crucial factor, it is important to emphasize that the current infants are very young and that pervasive long-term digital media exposure might occur at a later point in development. Moreover, though not the scope of the current study, maternal digital exposure in different cultures or socioeconomic levels may also play a role in these differences. Frequent maternal digital use has been associated with reduced maternal responsiveness and lower quality mother-infant interactions (Golds et al. 2025; Mason et al. 2024). These disruptions can potentially shape early attentional styles, affecting how infants engage with their environment and learn from social cues. To increase generalizability, future studies should include infants from rural and low-density urban areas across diverse countries. Regional differences in access to resources, technologies (Camera 2020), and parenting practices (Kalil and Ryan 2020) exist also within highly industrialized nations, and these variations can shape early socialization and attentional styles.

An important consideration when interpreting the results is the variability in gaze data quality between the two cultural groups. While most Swedish infants contributed consistently high proportions of usable gaze data (often above 90%), Zimbabwean infants exhibited greater variability, with some showing lower tracking ratios. To address this, we used relative measures such as looking ratio to AOIs and gaze distribution, which are less sensitive to differences in total looking time and help maintain comparability across participants. Nevertheless, differences in data quality could influence the precision of estimates for some gaze metrics, potentially underestimating or overestimating cultural differences in attentional patterns. Lower tracking ratios might also reduce the likelihood of detecting more subtle within-scene scanning behaviors, particularly for Zimbabwean infants. Therefore, while the overall patterns remain interpretable, caution is warranted in attributing fine-grained group differences solely to cultural or individual factors. We interpret the more frequent shifts between focal objects and background elements observed in Swedish infants as indicating a tendency toward analytic attentional styles, while the viewing patterns of Zimbabwean infants suggest a more holistic style. However, some infants in our sample may have been exposed to more than one cultural context in daily life. Although the majority of families identified as Swedish or Zimbabwean, a small number of caregivers reported other cultural backgrounds (e.g., Arab, Bengali, Finnish, Malawian, Ndebele), which could influence early caregiver-infant interactions and, consequently, attentional styles. Although the experimental setup in both cultures was identical, there may be other factors beyond our control, such as potential multicultural exposure, subtle differences in data quality, or recording protocols, that could have influenced the results, and we acknowledge these as limitations. Future research is needed to refine measurement methods and better capture the nuanced complexity of infant attentional behaviors across cultures.

Another notable limitation of this study is the challenge of directly comparing demographic variables, such as poverty and parental education, across diverse cultural contexts. These factors can carry different meanings and implications in various societies, which may influence their relevance to developmental outcomes in distinct ways. For instance, rich societies, such as the United States, United Kingdon, Japan, are not immune to poverty (Acri et al. 2017; Desmond and Western 2018; Sutton et al. 2014), it manifests in various forms and dimensions, including relational aspects that may not be immediately visible. While absolute poverty may be less prominent, relative poverty continues to affect individuals' perceptions of well-being (Sutton et al. 2014). The experience of poverty, as well as the role of parental education, can vary significantly across cultures, potentially influencing infants' attentional patterns in unique ways. Future research should explore alternative methods for measuring and interpreting these variables to better account for cultural differences.

Next, Swedish infants were tested in a soundproof room at a university lab, whereas Zimbabwean infants were tested in a separate room at the two clinics in which there was less control of the sound levels in the building. Noise levels could have interfered with Zimbabwean infants' behaviors, but there is no reason to believe that this may have been the case. Although we have no objective measures of the impact of external sounds, infants in both cultures looked at the stimuli and paid attention. The infants only differed on what information they attended to and in which manner they scanned the scenes, making this explanation of the current results less likely. In terms of the stimuli themselves, we used natural scenes that were designed to reflect typical environments in each setting and were intended to be relatively neutral in emotional tone and visual complexity. Even so, future research could benefit from systematically exploring how different stimulus characteristics, such as familiarity, emotional salience, or visual clutter, influence attentional patterns across cultures.

A further limitation concerns the validity of the questionnaire measures relating to poverty and well-being. In the Zimbabwean sample, the questionnaire was administered orally due to varying levels of literacy, which may have influenced how certain concepts were understood or interpreted. Moreover, the experience and perception of poverty or mental health problems can differ markedly across cultural contexts. These contextual differences raise important questions about how well standard questionnaire constructs capture lived realities in diverse settings (Cardona et al. 2023). Future research would benefit from incorporating culturally adapted instruments or complementary mixed-methods approaches to strengthen the interpretability and validity of such measures.

In addition to the limitations discussed earlier, it is important to note that while eye-tracking effectively captures overt attention through gaze direction, it does not measure covert attention, which is the mental focus without corresponding eye movements. This limitation is particularly relevant when studying infants' holistic versus analytic attentional styles in complex naturalistic scenes, where they may attend to objects or backgrounds without directly fixating on them. To address this, future studies could combine eye-tracking with neural methods such as EEG or *f*NIRS, which can detect covert attentional processes. For instance, Kulke et al. (2016) demonstrated that EEG reveals neural signatures of covert attention that are not accessible through eye-tracking alone (Kulke et al. 2016), providing a more comprehensive understanding of how infants allocate attention across scenes. Complementing these lab-based measures, wearable eye-tracking in naturalistic home settings, for instance, provides the opportunity to capture infants' attention within their everyday social routines and enhance ecological validity (Bradshaw et al. 2023). However, such naturalistic recordings can present practical and technical challenges, including variable lighting, head movements, and the need to ensure infant comfort. Future studies can address these challenges, further enabling more reliable investigation of attention in natural settings.

In conclusion, this study demonstrates that infants' attention, at least 9-month-old infants in Sweden and Zimbabwe, cannot be categorized in a binary fashion. Instead, infants demonstrated culturally specific complex patterns of attention that encompass aspects of both analytic and holistic styles. To deepen our understanding of how these patterns develop and change over time, further longitudinal research is essential. Such studies would provide critical insights into the developmental trajectories of attentional styles across diverse cultural contexts, helping to clarify the role of experience and maturation in shaping infant attention.

Author Contributions

Hsing-Fen Tu: data curation, formal analysis, validation, writing – review and editing. **Linda van den Berg:** conceptualization, data curation, formal analysis, investigation, methodology, project administration, visualization, writing – original draft, writing – review and editing. **Kim Astor:** conceptualization, data curation, methodology, project administration, writing – review and editing. **Samson Mhizha:** conceptualization, project administration, resources, writing – review and editing. **Gustaf Gredeback:** conceptualization, funding acquisition, resources, writing – review and editing.

Acknowledgments

We are deeply grateful to all the families who participated in this study.

Funding

The study was supported by two Knut and Alice Wallenberg Foundation grants to G.G.: KAW 2012.0120 and KAW 2017.0284.

Ethics Statement

This study received approval from the local ethics board in Sweden 2021-05530-01, and Zimbabwe MRCZ/A2919. Additionally, approval was granted by the Ministry of Health and Childcare in Zimbabwe 2022-02-17 and the City of Harare 2022-05-30.

Consent

Written informed consent was obtained from legal guardians prior to participation.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

R-code for analysis is available on OSF (https://osf.io/52ntm). Data is available on request.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.
Figure S1: Percentage of data captured for each image, independent of AOIs. Blue dots represent the Swedish sample, and yellow dots represent the Zimbabwean sample. The x-axis shows the images: 1–8 correspond to indoor pictures, and 9–16 correspond to outdoor pictures. Image labels "SE" indicate Swedish pictures, while "ZIM" indicates pictures taken in Zimbabwe. **Table S1:** Individual percentage of data produced by Zimbabwean infants. **Table S2:** Individual percentage of data produced by Swedish infants. **Table S3:** Regression results for multiple outcomes examine the influence of mothers' values on infants' attention in the Zimbabwean Sample (n = 147, 71 girls, 76 boys). **Table S4:** Regression results for multiple outcomes examine the influence of mothers' values on infants' attention in the Swedish Sample (n = 191, 95 girls, 96 boys). **Table S5:** Regression results for multiple outcomes using shared predictors in the Zimbabwean sample (n = 147, 71 girls, 76 boys). **Table S6:** Regression results for multiple outcomes using shared predictors in the Swedish sample (n = 191, 95 girls, 96 boys). **Table S7:** Variance inflation factors (VIF) for predictors included in the linear model assessing infant attention and cultural differences.