11

UNDERSTANDING THE CHILD'S ENVIRONMENT

Justine Hoch

11.1 Introduction

Harry Heft has spent 45 years (and counting) thinking about the environment. During his notable academic career, Heft wrote scores of articles and chapters and multiple books about ecological psychology, environmental psychology, and the reciprocal relations between the environment and perception-action systems. Throughout these works, Heft persuasively argues that the way psychologists conceptualize and describe the environment has consequences for behavioral analysis, especially in the context of human development. In this chapter, I expand Heft's argument and consider how new modes of child-centered descriptions of the environment are changing the way that researchers think about behavior and development.

11.2 Approaches to environmental description

From the inception of developmental psychology, researchers have studied how the environment shapes child development (for reviews, see Evans, 2006; Wohlwill & Heft, 1987). For example, researchers have examined relations between children's access to books and the development of literacy (Payne et al., 1994), children's access to toys and motor development (Saccani et al., 2013; Valadi & Gabbard, 2020), and children's access to outdoor green space and cognitive development (Dadvand et al., 2015). To study the effects of environmental variation on development, researchers must first choose how to describe the environment. But, as Heft (1988) argues, all methods of description have fundamental – often unexamined – consequences for the way researchers think about the environment and therefore its relation to behavior. Below, I briefly summarize Heft's argument for describing

the environment in terms of its functional features, rather than its forms, and the benefits of a function-based approach to description for behavioral analysis.

11.2.1 The traditional approach: Formal description

Most researchers use "form-based" language to describe children's environments (Heft, 1988). That is, researchers typically describe the environment in terms of the forms of the objects, surfaces, and other things in the surrounds that are available to children. A form-based description of a child's home might quantify the books on the child's shelves (Payne et al., 1994), the types of toys in the child's playroom (Saccani et al., 2013; Valadi & Gabbard, 2020), or even pixels of green space in satellite images of the child's neighborhood (Dadvand et al., 2015). Because form-based environmental descriptions rely on everyday terminology (e.g., "books," "toys," or "green"), such descriptions are convenient and easily understood.

A key characteristic of a form-based approach is that environmental features are described independently from – rather than in relation to – an individual. That is, books, toys, and green spaces can be described without referring to any particular child. This approach to description is especially common in studies comparing "enriched" and "impoverished" environments where the type of environment is defined by the things that are (or are not) available. Because form-based environmental features exist independently from the individual, they are typically conceptualized as external stimuli that are passively perceived and processed by the individual. In this way, form-based descriptions emphasize the distinction between the individual and the environment and often imply that behavior and development are the linear result of environmental stimulation (Heft, 1979; Wohlwill & Heft, 1977).

11.2.2 The Heft approach: Functional description

In contrast to a "form-based" approach, Heft (1988) argues for the utility of a "function-based" approach to environmental description. This approach is based on James Gibson's (1979) concept of "affordances." According to Gibson, affordances are possibilities for action that are jointly determined by the fit between the individual and the environment and are what make the environment functionally significant to an individual. Thus, rather than describing the environment in terms of its forms (e.g., objects, doorways, and stairs), a functional approach classifies environmental features in terms of the common activities they support. For example, an object smaller than an individual's hand affords *grasping* (Fagard, 2000), a doorway that is wider than an individual's body dimensions affords *passage* (Franchak et al., 2012), and a stair that is a certain height relative to an individual's leg length and balance control affords *climbing* (Warren, 1984).

A key characteristic of a functional approach is that it describes features of the environment in relation to a specific individual, rather than in isolation. For example, the ceiling affords climbing for a spider but not for a human, and a heavy bag of groceries affords lifting for a parent but not for an infant. Because functional environmental features are relations, not forms, they are conceptualized as dynamic properties that are objectively real and perceptible but are only realized when an individual acts in the environment. In this way, a function-based approach to description emphasizes the interdependence between the individual and the environment and implies that an individual's experience of the environment is both a product of and an influence on behavior and development (Heft & Wohlwill, 1987).

11.2.3 Benefits of functional description for behavioral analyses

Heft argues that function-based descriptions of the environment have several benefits for behavioral analysis. First, describing environmental features in a functional manner – in terms of the activities that they afford to individuals – provides a richer, more meaningful account of the available environmental resources than the traditional form-based approach. For example, a form-based description of a playground might label the types of equipment available for play (e.g., slide, ladder, monkey bars) as if the physical features have the same meaning for all children. But these environmental features may not be equally meaningful for all children – playground equipment might offer very different opportunities for action to preschool and grade school students who differ in size, strength, and coordination (Adolph & Berger, 2006; Gibson, 1992). A three-year old might use the slide as a tent or canopy, a six-year old as a surface to slide down, and a nine-year old as a steep path for walking. In contrast, because functional descriptions are specified in relation to an individual (e.g., equipment that affords swinging for a particular child), they can capture the same functional meaning for individuals who share the same abilities to exploit the relevant affordances.

Second, functional descriptions may be preferable to form-based descriptions because they better reflect an individual's immediate experience of the environment. According to Gibson (1979), the affordances of environmental features are equally salient (if not more salient) than their forms. That is, individuals more readily perceive whether something is in within arms' reach or will fit into the palm of their hand than its shape or size. Moreover, because functional features of the environment may be especially salient to children who have limited experience categorizing and labeling forms (Heft, 1988), functional descriptions might capture children's perceptual experience more accurately than form-based descriptions.

Third, because functional descriptions are based on behavior, they allow common properties to be identified among different environmental forms, whereas form-based descriptions are mutually exclusive. For example, a small stone cannot also be a paper plane, but both objects afford throwing. Thus, functional descriptions may reveal environment-behavior relations that are overlooked by form-based descriptions.

Finally, functional environmental descriptions might be especially useful for describing children's environments because, unlike form-based descriptions, functional descriptions capture development. Form-based descriptions call attention to features of the environment that are stable and static (e.g., a ball is always a ball, and a staircase is always a staircase). But, because functional descriptions are defined relationally, they allow the meaningful features of the environment to change in relation to an individuals' developmental status. Despite their consistent forms, balls and staircases provide new opportunities for action as pre-mobile infants transition to crawling and walking. Thus, as infants gain new skills and new means of gathering information, new affordances emerge (Heft, 1989). In other words, as infants develop, the environment also develops (Adolph, 2019). In this way, functional descriptions prompt researchers to think about the significance of environmental features for specific individuals and to recognize that the environment has a developmental dimension.

11.3 New ways to describe children's environments

In recent years, developmental psychologists have embraced powerful, new recording methods to document the ecology of children's everyday experiences (de Barbaro & Fausey, 2022; Franchak, 2020). Like the functional approach to environmental description, these ecologically inspired methods aim to capture the meaningful features of children's physical and social environments as they change over development. For example, head-mounted cameras and head-mounted eye-trackers record the accessible environment from the child's first-person point of view. Wearable sensors track the movements of the eyes, head, and body record the exploratory actions that support environmental perception. And improvements in recording technologies and data sharing enable researchers to capture children's experiences at scale and in context. In the following sections, I provide illustrative examples that show how recent advances in environmental description are changing the way that researchers think about children's behavior and development.

11.3.1 The first-person point of view

Since 2010, developmental researchers have made considerable progress in documenting children's environments from the first-person point of view (Franchak & Adolph, 2010; Franchak et al., 2011; Sullivan et al., 2021). Typically, developmental researchers document children's environments using third-person camera views. As with form-based descriptions, third-person camera views capture the environment independently from an individual child. For example, a camera on a tripod or held in a researcher's hand might capture the toys on the floor, a parent's facial expression, and parts of the ceiling as a child plays at home. But, because they are recorded from the vantage point of an outside observer, third-person camera views tend to capture the same features of the environment regardless of a child's age, posture, or developmental status, and they tend to capture larger portions of the environment than can be viewed by a child at any given time (Smith et al., 2015). Consequently, third-person camera views may give the erroneous impression that the documented environmental features are simultaneously or equally accessible to all children.

In contrast to third-person camera views, "headcams" and head-mounted eye trackers enable researchers to document the environment as it is seen by children. Headcams are light-weight cameras that record children's field of view as they move and play (for review, see Smith et al., 2015). Head-mounted eye trackers also capture children's field of view, but they have a second camera that points in toward the eye and allows researchers to record children's point of gaze (for review, see Franchak, 2017). Like function-based descriptions, recordings from the first-person point of view are relational. That is, they record the parts of the environment that are visible to a specific child in a specific posture and at a specific developmental timepoint. Thus, instead of describing the potential environment – the stuff in the room that may or may not ever be in view, headcams and head-mounted eye trackers record the accessible environment – the stuff that is in view and accessible for learning (Smith et al., 2015).

Recordings from the first-person point of view reveal surprising discoveries about the contents of infants' visual environments. For example, although ecological psychologists have long argued that looking is an embodied process (Gibson, 1979), data from headcams and head-mounted eye trackers demonstrate the extent to which infants' visual worlds are constrained by their size, body position, and abilities. Headcam data, for instance, show that two-month-olds see faces more frequently than do 15-month-olds (Jayaraman et al., 2015). These differences are likely explained by infants' developing motor skills (two-month-olds cannot yet sit and spend a lot of time on their backs, whereas 15-month-olds can sit up and walk) and the fact that caregivers hold younger infants more often than older infants (Franchak, 2019). Accordingly, very young infants' visual worlds are filled with faces because their views are limited by their posture, and adults frequently put their faces into young infants' field of view. As infants gain postural and locomotor skills, their views are less constrained (Adolph & West, 2022), and infants see more hands and objects as they spend more time engaging with their surrounds (Fausey et al., 2016). Thus, first-person recordings reveal that developmental constraints structure infants' visual environments and carve the world into ordered training datasets that may support learning and generalization (Smith et al., 2018).

In addition to documenting change over developmental time, recordings from the first-person point of view reveal that real-time changes in the accessible environment shape infants' opportunities for learning. Head-mounted eye tracking, for example, shows that while crawling, infants mostly see the ground in front of their hands. To see the objects or people in the room, infants must stop to sit or stand up. In contrast, while walking, infants can see the whole room even while moving (Franchak et al., 2018; Kretch et al., 2014). These real-time changes in infants' visual ecology have consequences for environmental exploration: although infants rarely fixate and then go to a new destination (only 32% of crawlers' and 16% of walkers' locomotor bouts), crawlers are more likely to do so when starting

from sitting or upright postures compared to prone postures (Hoch et al., 2020). Infants' locomotor posture also shapes what they choose to explore: compared to walking infants, crawling infants are more likely to fixate and travel to objects on the floor, but less likely to fixate and travel to objects that are higher off the ground (Hoch et al., 2020).

Recordings from a first-person point of view also reveal surprising discoveries about where infants don't look. Infants guide locomotion over precarious ground mostly using visual information from the periphery of their field of view. They step over things in their path and even walk over narrow bridges while pointing their gaze at their goal, not at the ground under their feet (Franchak et al., 2011; Kretch & Adolph, 2017).

Perhaps the most surprising discovery is that infants and children rarely look at others' faces. Despite decades of research focused on what infants learn from face-to-face interactions with their caregivers (Kaye & Fogel, 1980; Tronick & Cohn, 1989), headcam recordings from children at home show that faces are only in view for five minutes per hour by the time infants reach 11 months of age (Jayaraman et al., 2015). Likewise, head-mounted eye-tracking data show that freely mobile 12-month-old infants spend less than 5% of the time looking at their caregivers' faces during free play (Franchak et al., 2018). These real-world visual statistics are challenging long-held assumptions about developmental mechanisms. For example, head-mounted eye tracking data show that inattention to faces – long held to be a signature characteristic of atypical social interactions – is not unique to autistic children (Yurkovic-Harding et al., 2022). Both autistic and neurotypical two- to four-year-olds ignore their parent's face. While playing with their parents in a room filled with toys, children in both groups look at their parent's face only 1% of the time. Thus, although lack of eye contact is a robust diagnostic marker of autism, data recorded from the first-person point of view suggest that it is no more a behavioral mechanism for autistic or neurotypical social interaction than itchy spots are a mechanism for chicken pox (Adolph & West, 2022).

Child-centered recordings also provide new insights into problems researchers once considered intractable. For example, centuries of researchers and philosophers puzzled over the problem of reference in language learning – that is, how infants learn that a particular word maps onto a particular object or feature in the visual scene (Quine, 1964; Yu & Smith, 2012). From a third person point of view, the problem indeed appears extremely difficult – children's environments are littered with objects that could potentially be the referent of a spoken word. However, looking at the environment from the infant's point of view reveals that the problem is not as difficult as it seems (Yurovsky et al., 2013). Parents typically label the objects in infants' hands (Custode & Tamis-LeMonda, 2020; West & Iverson, 2017; Yu & Smith, 2012), and – because infants' arms are short – hand-held objects loom large in infants' field of view and block out other competing objects (Smith et al., 2011). Thus, the coincident timing of action, word, and the salience of the referent makes tractable the previously "intractable" problem of ambiguous word referents. Moreover, day-long recordings collected over months reveal that parents' words are often repeated in the same places in the home in the context of daily routines (Roy et al., 2015; Tamis-LeMonda et al., 2019). In this way, child-centered recordings can uncover previously undetected structure in the environment.

11.3.2 Lab versus life

Researchers have always known that learning and development occur in the context of children's everyday environments. But until relatively recently, limitations in recording technologies hampered researchers' abilities to collect objective, rigorous descriptions of children's environments outside of a laboratory setting. Although developmental researchers collected film and audio data in the 1930s and 1940s (Gesell, 1946; McGraw & Breeze, 1941), the unwieldy size and limited recording durations of the original cinematic technologies made them impractical for use outside of the lab for extended periods of time (Adolph, 2016). Instead, many descriptions of children's everyday environments were generated from narrative vignettes (Barker & Wright, 1951; Darwin, 1877), observer ratings (Bradley et al., 2001; Heft, 1979), and self-report (Saccani et al., 2013; Valadi & Gabbard, 2020).

However, advances in recording technologies – notably, small, lightweight, wearable cameras and sensors with large storage capacities – enable researchers to accurately capture children's real-life physical and social environments (for review, see de Barbaro, 2019). For example, both first- and third-person video cameras record infants' access to objects (Fausey et al., 2016; Herzberg et al., 2022). Wearable audio recorders (e.g., LENA) capture language input and ambient noise over extended periods of time (Zimmerman et al., 2009). Wearable inertial sensors capture full-day recordings of infants' body position and time in motion (Franchak et al., 2021). And wearable tags use radio-frequency identification to measure proximity between infants and caregivers (Salo et al., 2021) and track the locations of each child in a classroom relative to their teachers and peers (Messinger et al., 2019).

Data collected in children's everyday environments reveal heterogeneity that is not observed in controlled laboratory settings. For example, many lab-based studies examine infants' interactions with a small set of standardized objects for relatively short periods of time (Hoch et al., under review). But at home, where infants have full access to toys and household objects, they interact with 41–99 unique objects in only two hours (Herzberg et al., 2022). Similarly, caregivers' language to infants during lab-based tasks dramatically differs from language recorded during everyday routines (Tamis-LeMonda et al., 2017). During structured play, caregivers talk constantly, and language input is consistently dense from one minute to the next. But in the context of daily life, language input fluctuates and is interspersed with long periods of silence. And although researchers typically observe children's social interactions with one partner, proximity data recorded in the classroom show that each child has a different network of peers and that some children are in social contact tens to hundreds of times more than others (Messinger et al., 2019). By documenting the diversity of children's everyday experiences, new recording technologies are inspiring new hypotheses about the mechanisms that support learning and development in context (de Barbaro & Fausey, 2022).

Recordings of children's daily lives are extremely rich and generate vast amounts of data. Leveraging these recordings requires innovations in infrastructure and policy frameworks that enable researchers to openly share and annotate large datasets (Mendoza & Fausey, 2021). For example, the SAYCam corpus uses collaborative coding to tag 415 hours of naturalistic, longitudinal headcam recordings from three children (Sullivan et al., 2021). To identify videos of interest, large teams of coders with differing expertise tag videos based on their locations, objects, activities, and the people and body parts in view. In a similar vein, online data-sharing platforms such as the Databrary video library (databrary.org), enable researchers to collectively gather data from more diverse contexts (e.g., geographic, socioeconomic) than any one research team could do on their own (Adolph, 2020; Gilmore & Adolph, 2019; MacWhinney, 2000). For example, the Play & Learning Across a Year (PLAY) project uses Databrary to collect one hour of natural free play from 900+ infants and mothers across the USA (play-project.org). This dataset will also include video tours of the home, digital recordings of ambient noise, detailed demographic information, and data from parent questionnaires (Soska et al., 2021). Because the PLAY and SAYCam datasets will be openly shared, they will enable researchers to generate and validate developmental theories using high-quality data collected in a diverse range of environmental contexts.

11.4 Conclusion

Heft (1988) argues that all methods of description highlight some features of the environment while neglecting others. Accordingly, researchers must carefully consider the consequences of their chosen descriptive method for behavioral analysis. By taking inspiration from a functional approach to environmental description, new technologies that capture meaningful features of the environment, reflect the individual's immediate experience, relate to behavior, and capture development are advancing our understanding of children's environments.

References

Adolph, K. E. (2016). Video as data: From transient behavior to tangible recording. *APS Observer*, *29*, 23–25.

Adolph, K. E. (2019). An ecological approach to learning in (not and) development. *Human Development*, *63*, 180–201.

Adolph, K. E. (2020). Oh, behave! *Infancy*, *25*, 374–392.

Adolph, K. E., & Berger, S. E. (2006). Motor development. In D. Kuhn & R. S. Siegler (Eds.), *Handbook of child psychology*, 6th ed., Vol. 2, Cognitive Processes (pp. 161–213). New York: Wiley.

Adolph, K. E., & West, K. L. (2022). Autism: The face value of eye contact. *Current Biology*, *32*(12), 577–580.

Barker, R. G., & Wright, H. F. (1951). *One boy's day: A specimen record of behavior*. New York: Harper Brothers.

Bradley, R. H., Corwyn, R. F., McAdoo, H. P., & Garcia Coll, C. (2001). The home environments of children in the United States part 1: Variations by age, ethnicity, and poverty status. *Child Development*, *72*(6), 1844–1867.

Custode, S. A., & Tamis-LeMonda, C. (2020). Cracking the code: Social and contextual cues to language input in the home environment. *Infancy*, *25*, 809–826.

Dadvand, P., Nieuwenhuijesen, M. J., Esnaola, M., Forns, J., Basagana, X., Alvarez-Pedrerol, M., … , Sunyer, J. (2015). Green spaces and cognitive development in primary schoolchildren. *Proceedings of the National Academy of Sciences*, *11*(26), 7937–7942.

Darwin, C. (1877). A biographical sketch of an infant. *Mind*, *2*, 285–294.

de Barbaro, K. (2019). Automated sensing of daily activity: A new lens into development. *Developmental Psychobiology*, *61*, 444–464.

de Barbaro, K., & Fausey, C. (2022). Ten lessons about infants' everyday experiences. *Current Directions in Psychological Science*, *31*(1), 28–33.

Evans, G. W. (2006). Child development and the physical environment. *Annual Review of Psychology*, *57*, 423–451.

Fagard, J. (2000). Linked proximal and distal changes in the reaching behavior of 5- to 12-month-old human infants grasping objects of different sizes. *Infant Behavior and Development*, *23*, 317–329.

Fausey, C. M., Jayaraman, S., & Smith, L. B. (2016). From faces to hands: Changing visual input in the first two years. *Cognition*, *152*, 101–107. doi:10.1016/j.cognition.2016.03.005

Franchak, J. M. (2017). Head-mounted eye tracking. In B. Hopkins, E. Geangu, and S. Linkenauger, *The Cambridge encyclopedia of child development* (pp. 113–116). Cambridge, UK: Cambridge University Press.

Franchak, J. M. (2019). Changing opportunities for learning in everyday life: Infant body position over the first year. *Infancy*, *24*(2), 187–209.

Franchak, J. M. (2020). The ecology of infants' perceptual-motor exploration. *Current Opinion in Psychology*, *32*, 110–114.

Franchak, J. M., & Adolph, K. E. (2010). Visually guided navigation: Head-mounted eye-tracking of natural locomotion in children and adults. *Vision Research*, *50*, 2766–2774. doi:10.1016/j.visres.2010.09.024

Franchak, J. M., Celano, E. C., & Adolph, K. E. (2012). Perception of passage through openings cannot be explained geometric body dimensions alone. *Experimental Brain Research*, *223*, 301–310.

Franchak, J. M., Kretch, K. S., & Adolph, K. E. (2018). See and be seen: Infant-caregiver social looking during freely mobile play. *Developmental Science*, *21*, e12626.

Franchak, J. M., Kretch, K. S., Soska, K. C., & Adolph, K. E. (2011). Head-mounted eye tracking: A new method to describe infant looking. *Child Development*, *82*, 1738–1750.

Franchak, J. M., Scott, V., & Luo, C. (2021). A contactless method for full-day, naturalistic motor behavior using wearable inertial sensors. *Frontiers in Psychology*, *12*, 701343.

Gesell, A. (1946). Cinematography and the study of child development. *The American Naturalist*, *80*, 470–475.

Gibson, E. J. (1992). How to think about perceptual learning: Twenty-five years later. In H. L. Pick, P. van den Broek, & D. C. Knill (Eds.), *Cognition: Conceptual and methodological issues* (pp. 215–237). Washington, DC: American Psychological Association.

Gibson, J. J. (1979). *The ecological approach to visual perception*. Boston, MA: Houghton Mifflin.

Gilmore, R. O., & Adolph, K. E. (2019). Open sharing of research video: Breaking down the boundaries of the research team. In K. L. Hall, A. L. Vogel, & R. T. Croyle (Eds.), *Strategies for team science success: Handbook of evidence-based principles for cross-disciplinary science and practical lessons learned from health researchers* (pp. 547–583). Cham: Springer.

Heft, H. (1979). Background and focal environmental conditions of the home and attention in young children. *Journal of Applied Social Psychology*, *9*(1), 47–69.

Heft, H. (1988). Affordances of children's environments: A functional approach to environmental description. *Children's Environment Quarterly*, *5*, 29–37.

Heft, H. (1989). Affordances and the body: An intentional analysis of Gibson's ecological approach to visual perception. *Journal of the Theory of Social Behavior*, *19*(1), 1–30.

Heft, H., & Wohlwill, J. F. (1987). The physical environment and the development of the child. In D. Stokols & I. Altman (Eds.), *Handbook of Environmental Psychology*, Vol. 281–328. New York: Wiley.

Herzberg, O., Fletcher, K. K., Schatz, J. L., Adolph, K. E., & Tamis-LeMonda, C. (2022). Infant exuberant object play at home: Immense amounts of time-distributed, variable practice. *Child Development*, *93*, 150–164.

Hoch, J. E., Hospodar, C. M., Alves, G., & Adolph, K. E. (under review). What factors encourage infants to move? Effects of environmental factors, social factors, and months of walking on infants' locomotor practice.

Hoch, J. E., Rachwani, J., & Adolph, K. E. (2020). Where infants go: Real-time dynamics of locomotor exploration in crawling and walking infants. *Child Development*, *91*, 1001–1020.

Jayaraman, W., Fausey, C. M., & Smith, L. B. (2015). The faces in infant-perspective scenes change over the first year of life. *PLoS One*. doi:10.1371/journal.pone.0123780

Kaye, K., & Fogel, A. (1980). The temporal structure of face-to-face communication between mothers and infants. *Developmental Psychology*, *16*(5), 454–464.

Kretch, K. S., & Adolph, K. E. (2017). The organization of exploratory behaviors in infant locomotor planning. *Developmental Science*, *20*, e12421.

Kretch, K. S., Franchak, J. M., & Adolph, K. E. (2014). Crawling and walking infants see the world differently. *Child Development*, *85*, 1503–1518.

MacWhinney, B. (2000). *The CHILDES project: Tools for analyzing talk*, 3 ed. Mahwah, NJ: Erlbaum.

McGraw, M. B., & Breeze, K. W. (1941). Quantitative studies in the development of erect locomotion. *Child Development*, *12*, 267–303.

Mendoza, J. K., & Fausey, C. (2021). Quantifying everyday ecologies: Principles for manual annotation of many hours of infants' lives. *Frontiers in Psychology*, *12*, 710636.

Messinger, D. S., Prince, E. B., Zheng, M., Martin, K., Mitsven, S. G., Huang, S., …, Song, C. (2019). Continuous measurement of dynamic classroom social interactions. *International Journal of Behavioral Development*, *43*(3), 263–270.

Payne, A. C., Whitehurst, G. J., & Angell, A. L. (1994). The role of home literacy environment in the development of language ability in preschool children from low-income families. *Early Childhood Research Quarterly*, *9*(3), 427–440.

Quine, W. (1964). *Word and object*. MIT Press.

Roy, B. C., Frank, M. C., DeCamp, P., Miller, M., & Roy, D. (2015). Predicting the birth of a spoken word. *Proceedings of the National Academy of Sciences*, *112*, 12663–12668. doi:10.1073/pnas.1419773112

Saccani, R., Valentini, N. C., Pereirra, K. R. G., Muller, A. B., & Gabbard, C. (2013). Associations of biological factors and affordances in the home with infant motor development. *Pediatrics International*, *55*, 197–203.

Salo, V. C., Pannuto, P., Hedgecock, W., Biri, A., Russo, D. A., Piersiak, H. A., & Humphreys, K. L. (2022). Measuring naturalistic proximity as a window into caregiver-child interaction patterns. *Behavior Research Methods, 54*, 1580–1594.
Smith, L. B., Jayaraman, S., Clerkin, E., & Yu, C. (2018). The developing infant creates a curriculum for statistical learning. *Trends in Cognitive Sciences, 22*, 325–336. doi:10.1016/j.tics.2018.02.004
Smith, L. B., Yu, C., & Pereira, A. F. (2011). Not your mother's view: The dynamics of toddler visual experience. *Developmental Science, 14*, 9–17. doi:10.1111/j.1467-7687.2009.00947.x
Smith, L. B., Yu, C., Yoshida, H., & Fausey, C. M. (2015). Contributions of head-mounted cameras to studying the visual environments of infants and young children. *Journal of Cognition and Development, 16*(3), 407–419.
Soska, K. C., Xu, M., Gonzalez, S. L., Herzberg, O., Tamis-LeMonda, C. S., Gilmore, R. O., & Adolph, K. E. (2021). (Hyper)active data curation: A video case study from behavioral science. *Journal of eScience Librarianship, 10*, e1208.s.
Sullivan, J., Mei, M., Perfors, A., Wojcik, E., & Frank, M. C. (2022). SAYCam: A large, longitudinal, audiovisual dataset recorded from the infant's perspective. *Open Mind: Discoveries in Cognitive Science, 5*, 20–29.
Tamis-LeMonda, C. S., Kuchirko, Y., Luo, R., & Escobar, K. (2017). Power in methods: Language to infants in structured and naturalistic contexts. *Developmental Science, 20*, e12456. doi:10.1111/desc.12456
Tamis-LeMonda, C. S., Custode, S., Kuchirko, Y., Escobar, K., & Lo, T. (2019). Routine language: Speech directed to infants during home activities. *Child Development, 90*, 2135–2152. doi:10.1111/cdev.13089
Tronick, E., & Cohn, J. (1989). Infant-mother face-to-face interaction: Age and gender differences in coordination and the occurrence of miscoordination. *Child Development, 60*(1), 85–92.
Valadi, S., & Gabbard, C. (2020). The effect of affordances in the home environment on children's fine-and gross-motor skills. *Early Child Development and Care, 190*(8), 1225–1232.
Warren, W. H. (1984). Perceiving affordances: Visual guidance of stair climbing. *Journal of Experimental Psychology: Human Perception and Performance, 10*, 683–703.
West, K. L., & Iverson, J. M. (2017). Language learning is hands-on: Exploring links between infants' object manipulation and verbal input. *Cognitive Development, 43*, 190–200.
Wohlwill, J. F., & Heft, H. (1977). Environments fit for the developing child. In H. McGurk (Ed.), *Ecological factors in human development*. Amsterdam: North Holland.
Wohlwill, J. F., & Heft, H. (1987). Environmental cognition in children. In D. Stokols & I. Altman (Eds.), *Handbook of environmental psychology* (pp. 175–204). New York: Wiley.
Yu, C., & Smith, L. B. (2012). Embodied attention and word learning by toddlers. *Cognition, 125*, 244–262. doi:10.1016/j.cognition.2012.06.016
Yurkovic-Harding, J., Lisandrelli, G., Shaffer, R. C., Dominick, K. C., Pedapati, E. V., Erickson, C. A., … , Kennedy, D. P. (2022). Children with ASD establish joint attention during free-flowing toy play without face looks. *Current Biology*, 32(12), 2739-2746.
Yurovsky, D., Smith, L. B., & Yu, C. (2013). Statistical word learning at scale: The baby's view is better. *Developmental Science, 16*(6), 959–966.
Zimmerman, F. J., Gilkerson, J., Richards, J. A., Christakis, D. A., Xu, D., Gray, S., & Yapanel, U. (2009). Teaching by listening: The importance of adult-child conversations to language development. *Pediatrics, 124*(1), 342–349.

12

TOWARD A PSYCHOLOGICAL ECOLOGY

Harry Heft

12.1 Introduction

On the opening page of *Midwest and Its Children: The Psychological Ecology of an American Town*, Barker and Wright (1955/1971) explain what they mean by the phrase in the subtitle, "psychological ecology":

> The term *ecology* comes from a Greek word meaning 'home,' or 'homeland.' In the biological sciences, ecology refers to the study of the relations between homelands or habitats of plants and their functions, structures, and population characteristics. The present study is a *psychological analogue of this conception of ecology*. (p. 1, emphasis added)

The phrase "psychological ecology" aptly captures the focus of much of my scholarly work which has been to explore what an ecological approach would mean for the science of psychology.[1]

An ecological science requires an in-depth familiarity with the relations among living things and their habitats as they mutually exist apart from experimental interventions. Such an effort *presupposes* a terminology that captures the basic phenomena and the entities of the domain of study, whether they be plants or animals, *prior to* the application of abstract formulations or classifications. Such a terminology is foundational to any domain of the life sciences. It typically precedes, as well as continues to accompany, experimental efforts. An ecological science asks in a given domain of study: what is "there" in the environment, and how are those things interrelated?

It struck me at an early point in my studies that, for the most part, the science of psychology lacked a terminology for the environment that was adequate to the ways in which humans *experience* and *engage* their everyday world. Early in its