What's for Lunch? A Socio-ecological Approach to Childcare Nutrition

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ABSTRACT

This paper presents a qualitative study of food-related practices among 16 childcare providers in the Puget Sound, and suggests opportunities for design intervention to promote healthy eating by young children. This paper makes two contributions to interactive systems design. We present childcare as an underexplored site for future research and design. We also describe social ecology systems theory, an approach to qualitative research from the public health field that is relatively uncommon in design research. We believe that the socio-ecological perspective is particularly applicable to design research that addresses human service provisioning, and may also prove useful in describing human cognition and designing interactive systems more generally.

Author Keywords

Food; nutrition; children; social ecology systems theory, design.

ACM Classification Keywords

J.7 Computers in Other Systems

INTRODUCTION

Out-of-home childcare has become a primary learning and eating environment for a majority of young children in the U.S. Almost two-thirds of children under age 5 spend an average of 33 hours per week in childcare, where they receive up to two-thirds of their daily nutrition [40, 52]. At the same time, 8.4% of US children between the ages of 2 and 5 are obese, with significantly higher rates among children of color [14].

Given the extensive use of out-of-home childcare and the high prevalence of obesity and diet-related chronic disease factors in young children, childcare settings offer a vital opportunity to impact young children's diets and their interactions with food [29].

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However, childcare poses particular challenges for interactive systems design. Like other human services, childcare contends with diverse constituencies and conforms to various regulatory pressures, typically with very limited resources. Designing in this space requires close attention to interactions between the people who make decisions, and the environment in which those decisions are made.

To understand how childcare providers procure, prepare, and serve food, we conducted a qualitative study of food practices at 16 childcare facilities and developed a socio-ecological model to account for complex interactions between people, policy, and things. This paper describes the application of the model to our data on childcare food practices and its use as an analytic framework. We also describe the generative potential of a socio-ecological perspective to inform design ideation.

This paper makes two contributions to interactive systems design. We present childcare as an underexplored site for future research and design. We also describe social ecology systems theory, an approach to qualitative research from the public health field that is relatively uncommon in design research. We find the socio-ecological perspective particularly applicable to design research that addresses human service provisioning, and may also prove useful in describing human cognition “in the wild” more generally.

BACKGROUND

Childcare and nutrition

There has been growing interest among interactive systems designers to support healthy eating. Recent work includes systems that encourage users to lose weight [4], eat more healthfully [30], and consider ecological dimensions of the food they consume [46]. Researchers have developed a variety of applications that encourage behavior change including casual games [44], food journals [16], and interactive meal planning applications [27].

Toscos et al. developed an application that enabled parents to monitor their children's dietary and other health habits [50]. Other recent projects include a game that teaches diabetic children about food choice [13], an in-store gaming experience that encourages children to adopt healthy eating habits [24], and an instrumented fork that interfaces with a persuasive game [5].

Several researchers have considered socioeconomic aspects of children's eating. Vylegzhania et al. developed a shopping assistant application for families who receive federal subsidies for food purchases [53]. Schaefauer et al. developed a snack-tracking application for low socioeconomic status families [47]. Amresh et al. developed an interactive comic book that addresses obesity among low-income children [2].

Prior work has often focused on older children and adolescents who “are beginning to gain autonomy over choosing the foods they eat” [3]. However, many of the dietary behaviors leading to the development of obesity and diet-related chronic disease are established in the pre-kindergarten years [9]. For example, children's taste preferences are largely established between the ages of three and five, and younger children are more likely to try new foods than older children [9]. Thus, the childcare years coincide with a pivotal period in the development of eating habits.

Unfortunately, childcare centers have a decidedly mixed record when it comes to nutrition. Studies show large variation in the nutritional quality of foods offered in childcare [6,31,36,39]. Generally, sites that participate in federally reimbursed programs with meal pattern requirements, like as Head Start and the Child and Adult Care Food Program (CACFP), serve more nutritious meals and snacks than sites that do not participate [31]. However, even childcare centers and in-home providers that show high adherence to CACFP requirements commonly serve meals and snacks that exceed saturated fat recommendations, and often lack any fruit or vegetable [36].

Given the importance of the pre-kindergarten years in establishing lifelong food habits and the growing reliance on childcare, early education provides a key opportunity to promote healthy eating [29].

Food Choice

While it is generally understood that childcare plays a crucial role in establishing eating habits, little is known about the factors that influence providers' food decision-making. This is particularly true within the DIS community, where food choice remains a nascent research topic.

Several studies have examined relationships between consumers and food products. Kalnikaitė et al. studied in-store purchasing behavior, and discovered that “people rapidly make decisions based on one or two product factors for routine purchases, often trading-off between price and health” [28]. Gao et al. examined ways that people determine whether a food is “healthy,” and identified several factors including brand association, nutritional content, and portion size [18]. Hupfeld and Rodden examined ways that physical artifacts express identity and shape experience during meals [23].

Comber et al. conducted contextual inquiry of food-related practices in 10 UK households [15]. They describe food

selection, preparation, and consumption practices as being shaped by a number of social and cultural factors and found that “[h]ealthy and balanced eating were not primary concerns for most households” [15].

There have been few studies specific to childcare food practices. According to prior work, childcare providers consider developing healthy eating behaviors in children and promoting social behavior at mealtimes among their most important responsibilities [39, 45]. A UK study found that providers place great emphasis on the social aspects of food, including eating together and sitting around a shared table [39]. An American study found that 90% of providers reported talking to children about eating healthy foods on a regular basis [51]. Another US study found that providers were confident about their ability to shape children's tastes, but struggled with the logistics of family-style meals and managing children's intake [32].

Despite the importance that providers place on healthy eating, researchers have found correlations between time that young children spend in childcare and increasing risk of being overweight as they grow older [8, 21, 33]. Benjamin et al. have called for more in-depth studies of providers' practices to better understand the reasons for these findings [8].

Social Ecology Systems Theory

Given the complex interplay of factors involved in food-related decision making described by prior work, we adopted a socio-ecological approach to our research.

Socio-ecological models have been used by public health researchers to describe complex interactions between people and their environment as they pertain to violence [49], cancer [12], and chronic disease [37]. Although not widely employed within the design research community ([26] is a notable exception), we find socio-ecological models an effective way to describe complex interactions between people and their environment, and to identify opportunities for design intervention.

Socio-ecological models derive from Bronfenbrenner's social ecology systems theory, which describes four levels of environmental influence [11]:

Microsystem: an individual's direct interactions in specific settings, such as interactions within one's immediate family or workgroup.

Mesosystem: interrelations among various settings in which the individual is involved. These may include interactions between a child's teacher and parents, or between a doctor and her patient's insurance provider.

Exosystem: forces within the larger social system in which the individual is embedded, for example, the influence of workplace stress on an employee's children.

Macrosystem: cultural values, customs, and laws. Examples include cultural beliefs about honoring elders or the

importance of selected foods in establishing cultural identity, like eating turkey on Thanksgiving.

Each of these systems affect and are affected by each other [17]. An ecological systems perspective therefore offers a framework for describing individual change within a social change context [37]. As designers, we find this aspect of socio-ecological systems theory particularly attractive, because it suggests that behavior may be influenced through interventions at many levels.

Design researchers have become increasingly interested in methods and frameworks that can account for interplay between stakeholders and artifacts [10]. Social ecology theory contributes to the “ecological turn” in design research [48] with a framework that accounts for a wide range of human and non-human actors (e.g. people, products, physical environments, institutional policies, cultural norms). Importantly, social ecology systems theory acknowledges both direct and indirect influences on behavior, and provides a structured approach to identifying environmental factors and articulating relationships between them.

Employing social ecology systems theory typically involves adapting Bronfenbrenner’s model to a particular domain. For example, Joeng et al. developed a socio-ecological model of pediatric asthma that described the influence of family, community, society, and the environment [26]. The Centers for Disease Control (CDC) describes a socio-ecological model of violence as having four levels: the individual, her relationships, her community, and her society [49]. Elsewhere within the CDC, a socio-ecological model of cancer has five levels: personal, interpersonal, organizational, community, and policy [12].

Gregson et al. [19] developed a socio-ecological model of nutrition choice, which suggests analysis at the individual, interpersonal, institutional, policy, and community levels. Lynch et al. developed a three-tier socio-ecological model of Canadian childcare providers’ food-related activity, including the individual, community, and societal systems [34]. Our study extends this prior work to the US context, and provides a more nuanced model that accounts for a broader set of influences.

METHODS

We conducted a qualitative study of food-related practices among 16 childcare providers in the Puget Sound, an area of Washington State centered on Seattle. We developed a socio-ecological model of childcare food practices, which we used to analyze our data and also as a guide for design ideation.

Participants

In May 2014, a study invite and materials was sent to childcare providers via e-mail listservs. Interested participants were instructed to apply for study consideration via a secure online survey that screened for inclusion criteria (i.e. solely or primarily responsible for food decisions, located in the Puget Sound region, serving at least one meal

per day, and enrolling children from ages two to six). Because food quality is often associated with financial resources, we screened for participation in federal subsidy programs to determine whether a center served low-income children. We also screened for in-home providers vs. centers. Maximum variation sampling was used to recruit providers to ensure good representation across factors [38].

Twenty-six providers filled out the online survey. After an initial sample of 10 participants was enrolled and interviewed, the research team discussed the interviews to determine whether new themes, factors, or experiences were still emerging (saturation testing) [38]. In total, 16 participants, each representing a unique childcare site, were interviewed from June–September 2014 until the research team felt that theme saturation had been reached [38]. All participants were female and held primary responsibility for food-related decision making, often in addition to other non-food related duties (for example, several were executive directors who preferred to be directly involved in food shopping, at least in part to ensure regulatory compliance). 12 operated childcare centers, reflecting difficulties recruiting in-home providers who are typically less involved in formal and informal daycare networks. 7 subjects participated in CACFP, 10 received subsidies from the Department of Health and Human Services, and 4 received no subsidies.

Semi-structured interviews and site visits

A semi-structured interview format was used because it was uniform and flexible, and allowed for new topics and follow-up questions to emerge. The interview guide was informed by a literature review on childcare food provisioning. A set of open-ended questions was designed to explore meal planning, food procurement, food choice, food service, program policies, curriculum and activities, and staff perceptions and values. The interview guide was peer reviewed by two collaborators from the childcare community. The final interview guide consisted of broad, open-ended questions that encouraged active reflection. Example prompts include “How do you decide what foods to serve?,” “What does ‘healthy’ food mean to you?,” and “What information sources do you rely on?”

Interviews were conducted at participants’ worksites. Participants were offered a gift card for completion of the study. Interviews lasted an average of one hour and were conducted by the same researcher to ensure consistency. Each interview included a review of recent menus and shopping receipts, and a site tour of food preparation, storage, and service facilities and any current food-related curricular activities (e.g., gardening).

Analysis

Interviews were audio-recorded and still photos and field notes were taken to record key items highlighted by interviewees. Audio-recordings were professionally transcribed verbatim. An inductive approach was used to guide data analysis [42]. Using the interview guide, a

preliminary codebook with themes was created by the research team. Additional themes were identified as they emerged from the data. This process continued until agreement was reached that the codebook contained all relevant themes. Two researchers independently coded two transcripts and reviewed coding conflicts and reconciled them by discussing discrepancies and reaching consensus. One researcher coded the remaining transcripts in conjunction with regular discussion meetings with a team member trained in qualitative research. Each theme and the variations in how it was perceived are described in the results section below and presented with illustrative quotes.

A SOCIO-ECOLOGICAL MODEL OF FOOD PRACTICES

We identified a range of factors that influenced food practices, including personal preferences, financial considerations, federal regulations, and ideological commitments. Taking a socio-ecological approach, our analysis emphasized relationships between the sources of those influences.

Ten key sources emerged from our thematic analysis: kids, parents, staff, workplace characteristics, vendors, professional associations, media, regulation, culture, and providers’ personal characteristics. These were grouped into socio-ecological categories describing interactions at increasing levels of remove from the participant. The resulting model of food choice consists of five socio-ecological groupings, or “levels” (figure 1).

Figure 1: A socio-ecological model of childcare food practices, showing key influencers at each level.

We now turn to consideration of how actors at each stage influence childcare food practices.

Individual Level: Personal characteristics

Providers’ personal characteristics, including their perceptions and values, and their training, education, and professional experience, play a significant role in shaping food procurement and service decisions.

Perceptions and values

Participants described food selection as a deeply personal activity, mentioning that they eat with the children and won’t serve anything that they wouldn’t eat themselves. Several providers linked food choice to their own health concerns, including weight management, diabetes, and food allergies.

Providers’ childhood experiences also shaped their food practices. Several mentioned wanting to recreate nostalgic experiences, including picking tree fruit and growing vegetables. Memories seems particularly significant for providers who had grown up in rural areas, many of whom indicated that urban children are less exposed to agricultural activities and lack relationships with their food sources.

Providers also cited negative childhood food memories, including preponderances of processed and unhealthy foods, as influencing decisions about serving fresh produce and removing fried foods from childcare menus.

Participants used words like “nutritious,” “healthy,” “fresh,” “tasty” and “high quality” to describe food selection criteria. These are highly subjective terms, and are bound up with a host of other, often implicit biases. Providers also apply ethical and ideological lenses to food choice, including concerns about environmental sustainability and animal welfare. Anti-corporate sentiments were also common (but not universal); many participants made statements like, “I’m in favor of small family farms and I’m unhappy with what large corporate farming has done to our country. I prefer to support the small organic farms. I think it’s better for the dirt. I think it’s better for the world. I think it’s better for the kids for the future.”

Perhaps most significantly, food practices were infused with a sense of mission. All participants described childcare as a “passion” or a “calling.” For some, the decision to work in childcare was explicitly linked to food issues; for example, one participant left a successful career in food service to become a chef at a large childcare center because, “I thought it was really important to get children to eat and to understand really healthy food at a very early age.”

For others, food was linked to a broader social change agenda. One participant described passing her values on to the children in her care:

“We’re not a money-making organization... we want to change society, okay? So our mission is to make sure the children get the food they need, make sure they’re getting their activities, make sure they’re getting their cognitive learnings, all of these things, so that they’re ready to change what’s happening out there... So I’m probably creating a bunch of rebels, but ... you know, [Laughter] that’s fine.”

Education / professional training

Several participants had undergraduate and/or graduate degrees in child development, and referred to courses in child nutrition taken in school.

Most of our subjects reported seeking supplemental food-related training because of personal interest in the topic. New skills or knowledge learned influenced food practices. For example, one training session was described as “a one-hour, quick informational thing, but it was really an eye-opener for me. And then I came back here and tried to tell my teachers about it because at the time they were a group that really liked sweet stuff in the morning and I was like, no, I need more protein.” Another described how a trainer “taught us how to make a chocolate cake using beets and the kids would never know. We tell them afterwards [Laughter].”

Several providers reported prior professional food service experience. One was a professional pastry chef who previously owned two bakery/cafes, another received a

degree from a culinary school and ran a catering company, and a third reported years of restaurant work. These participants said that their professional experience was indispensable in their ability to effectively provide food for their childcare centers, citing their ability to negotiate with vendors and manage costs by not relying on prepared foods. We also observed their highly efficient use of space, time, and materials, particularly when compared with providers without professional culinary experience.

Interpersonal: staff, children and parents

Staff: preferences and expertise

In larger childcare centers, food procurement, preparation, and service duties were shared by multiple staff members, including teachers, administrators, and in some cases, dedicated chefs. These centers typically held regular staff meetings, where food issues were common topics of conversation; one provider cited a recent decision to switch to whole grain rice as resulting from staff suggestions. In-home childcare providers described their own family members' influence on food decisions – for example, one participant described the challenges of preparing meals for preschool-aged children than would also appeal to her teenaged son.

Kids: preferences, nutritional and developmental needs

Providers described children eating best when food is “presented in a form that children will actually eat” and “when they really like what they are tasting.” This requires catering to children’s palates and to their physical abilities. As one provider explained, “I have to roast almost all the vegetables here. First of all, softness, because of the age, but also because it sweetens it and it makes it delicious.” Many providers expressed concern with establishing lifelong dietary habits, and the specific need to introduce a variety of foods, “because you’re not just feeding them for now; you’re feeding them for when they’re 50.” Significant attention was paid to encourage children to try new foods through repeat exposure (“with kids you have to serve them things at least 10 times before they’ll even think about eating it”).

Family-style dining was seen as encouraging experimentation (“most of the kids, they eat it because they see the other kids eating it”), and was linked to other developmental issues, “[b]ecause that’s what you’re supposed to do at home and we’re learning that we’re a community, learning manners, like we wait for each other before we eat, how we serve ourselves, how we set the table, so just teaching them the values and preparing them for as they get older.”

Most participants also used food engagement projects, especially gardens, to influence children’s palates. One provider commented, “My opinion professionally and as a parent, if kids have some skin in the game about food, like if they got to plant the broccoli or the tomato or the potato and they have to come up and... water, or weed, or put dirt on the top of it, and watch it grow, they have more of an interest in

it. If kids have some connection to it, they’ll eat it or they’ll at least try it.” Food projects are also used to incorporate lessons about the environment, math and science, or to celebrate the cultural diversity of families.

Providers were centrally concerned with children’s dietary and developmental requirements, linking healthy eating with physical development, affect, and ability to concentrate. Some participants described nutrition in terms of specific vitamins and proteins, while others described children’s nutritional needs in terms of balancing different food groups.

Allergies and food intolerances were common topics in provider interviews. Food allergies and intolerances to nuts, dairy, eggs, and gluten were most frequently cited concerns; berry and soy allergies were mentioned, and we observed lengthy allergy lists posted in kitchens at nearly every site. Providers reporting spending a considerable amount of time daily, maneuvering through food allergies and intolerances, which could vary widely depending on which children were in care on any given day.

Parents: preferences, values, culture

Participants discussed the influence of parental food preferences and eating habits. Some parents request that cultural, religious, and other factors play into the foods that are served or avoided, such as preparing vegetarian or vegan foods or avoiding certain meats.

Some providers portrayed parents as promoting healthier food service by actively monitoring childcare menus and approaching staff with requests and concerns. But parents were also seen by some as barriers to healthy eating, “a lot of times at home children don’t get healthy food and so it’s really important that we give them that while they’re with us.”

Many participants mentioned organic foods as parents’ most common concern about their children’s food. Providers reported purchasing organic milk, fruits and vegetables in response to parental demand. Several providers mentioned the value of serving organic milk for “marketing... parents like that we serve organic milk and that’s a big draw for them.”

Several providers saw a disconnect between parents’ avowed interest in nutrition, and their actual involvement with food. One said, “I really have never caught parents checking them out [the menus],” while another reported “...they’ll talk about organic, and then it stops.” Several providers explained that parents “vetted” food service during the initial childcare selection process, but rarely raised food concerns after their children were enrolled. They also reported winning parents’ trust, “[parents] never had to ask me about... because they already know how strongly I feel about nutrition. It’s not an issue. They actually say they eat better here than they do at home sometimes.”

Institutional: workplace characteristics*Financial resources*

Providing healthy meals with limited resources was a common concern (but not a universal one; some participants felt their food budgets were adequate). Providers discussed numerous strategies, including purchasing sale items and preferring fresh or frozen produce to prepared foods. Providers also talked about increasing food budgets by prioritizing food over other expenditures.

Labor costs also factor into food decisions. Preparing fresh foods requires more staff time, which influenced decisions to buy fresh or canned produce. One center described the activities of the full-time chef: *“Because we do a lot of things from scratch and so it does take a lot more time, and washing fruits and vegetables and chopping up fruits and vegetables takes more time than opening a can, which we do use canned too to supplement.”*

Time allocations for food preparation also directly relates to staff experience. As one home childcare director explained, *“I am so fast now. I would say 45 minutes every morning average. On this day, the time consuming thing is to cut the coleslaw, cut the cabbage.”* In some cases, increased staff time results in more experimentation. One participant, a chef at a large center, explained the benefits of a recent management decision to increase time for an assistant chef, *“She got us up to 30 hours instead of 20, which has been wonderful, very helpful. We've really been able to explore things with the menu that we couldn't have done before.”*

Space and equipment

Food practices are also contingent on space and equipment available at the childcare facility. In-home daycares typically operate residential kitchens with consumer-grade equipment, which may not be well-suited for commercial-scale food production. Childcare centers often occupy physical spaces that were designed for other purposes (church basements are a common site), and may not offer adequate food preparation or storage facilities.

Staff who felt they were working in inadequately equipped kitchens tended to rely more heavily on prepared foods. Storage space was also a factor in procurement habits. More storage enables bulk shopping, while less storage affects the number of items purchased during each shopping trip. Centers with ample storage space typically keep more dry goods and frozen items on hand, which can help reduce costs and mitigate reliance on prepared foods.

Institutional policy

In some cases, curriculum and menus are set by a larger corporate, nonprofit, or public organization, which can limit autonomy by local decision makers.

Many daycare centers have food-related policies. No-nut policies were the most prevalent. In some cases, the policies were in place because of specific children with allergies, while in others the policies were more proactive. For one

participant who ran in-home childcare, though, no-nut policies are a point of contention: *“I'm not nut-free. Because in real life, children are going to have to learn how to function in the real world. It's not like you're going to go everywhere and they're going to go, ‘Okay, we have no peanuts and no almonds.’ I won't do that, ever, because there's too many families here that like peanut butter sandwiches.”*

Community: vendors, professional associations, media*Vendors*

Vendors exercise direct influence over food procurement. They set prices, and decisions made by vendors about which products to stock have direct bearing on what sorts of foods are available to childcare providers. These impacts are amplified when childcare centers have limited choice in vendors. Rural providers, for example, may have fewer options than their urban counterparts, and national childcare companies may enter into contracts with large food distributors that limit the autonomy of branch directors. As one participant said in describing a lack of variety in her centers' menus, *“it just feels like we're regurgitating the same things over and over again because that's what we have to choose from.”*

Most providers employ multiple vendors, generally relying on each for distinct categories of products (e.g., produce, dairy, prepared foods). However, there is also a fair amount of flexibility in vendor selection, *“I usually go to Costco, Cash & Carry, sometimes Walmart because they're a lot cheaper than Safeway. Safeway because it's close, if I have to. QFC occasionally, they're a little bit more overpriced, but they have a lot of fresh vegetables that I like, more so than Safeway. Safeway's vegetables aren't as fresh. If we're driving by sometimes and see a produce stand, we'll stop by. If you see somebody selling watermelons really cheap, hey, that's a good deal. We'll stop by there.”*

There can be disconnects between retail outfits and institutional buyers' needs. Several participants reported attempts to incorporate community-supported agriculture (CSA) into their centers. These efforts had failed despite participants' commitments to the CSA model, primarily due to lack of predictability.

Vendor business practices can also influence purchasing decisions: *“Costco... it's not super affordable, but I like their business practices. I would much rather support them than Walmart because I have friends that work there and they treat their employees well.”*

Finally, one participant described trust and liability as important components of her decision making: *“you hear about the E. coli outbreaks and things like that, so at least, when I go to Costco or I go to Walmart, I know exactly who to blame if [Laughter] something I'm getting makes all my kids sick.”*

Professional associations

As a field, childcare is rapidly professionalizing. This shift is seen in the advent of professional associations and accreditation schemes, as well as in the language that practitioners use to describe their work. As one respondent put it, *“it really frustrates me when people come in here and say, I'm looking for a daycare. We really get angry by that because we're not a daycare... A daycare makes me think of just someone that babysits your kids. We're a school. We give a full curriculum, we're educating your children, we're teaching them real life skills. So we're not just caring ... I mean we're not just babysitting.”*

Participants discussed their involvement with organizations like the Childcare Directors Association of Greater Seattle (CDAGS) and the Service Employees International Union (SEIU) as important sources of mentoring, training, and informal information-sharing across a variety of food-related topics including budgeting, behavior, and nutrition.

Recasting childcare as a profession has implications for decision-making at the center and classroom level. Accreditation programs including Montessori, Waldorf, and the National Association for the Education of Young Children (NAEYC) include strict requirements for many aspects of childcare, including food. NAEYC, for example, includes 16 requirements for “Ensuring Children's Nutritional Well-being,” including that “food is prepared, served, and stored in accordance with the U.S. Department of Agriculture (USDA) Child and Adult Care Food Program (CACFP) guidelines” [1].

Peer support is seen as a crucial bulwark against the perceived lack of state support, particularly when compared with K-12 education: *“There's not a lot of support.... I mean, elementary school teachers get all this... training and all these things. We don't get anything... I was just thrown in, figured it out and asked my fellow directors questions as they arose, and you just make mistakes and learn from them, which is unfortunate, but there's no money that goes into this ... really, it's just asking each other for help.”*

The availability of peer support varied widely. Larger daycare centers, particularly those linked to national organizations, typically had structures in place to connect staff with their counterparts at other sites on a weekly or monthly basis, while at-home daycare providers were more reliant on informal networks.

Media

Participants reported spending significant time online searching for recipes and curriculum ideas. Several providers reported using well-known internet search engines and popular social media platforms to find food and curriculum ideas (although, interestingly, none reported posting their own information online). Specialized food and child nutrition websites were also cited as important information sources, as were websites offered by federal, state, and local agencies. One provider acknowledged that she also looked to

competitor's services: *“for my food ideas, sometimes I'll go into other centers' websites and see what they're having for snacks, and sometimes I'm excited and sometimes I'm not.”*

Providers also cited food-related print and television programming as important influences. Several mentioned reading both general-interest and specialty publications for recipes and curriculum ideas. Providers also reported watching food-related television programming, and identified several television chefs by name.

Several pointed out that that most cookbooks are geared towards home cooks, and aren't always easily adaptable to institutional settings. One provider described her experience thusly, *“I do a lot of work with cookbooks, so I just get a cookbook and then I have to do it to scale. So that was tricky for me the first year. So that's where this book came in handy. I found this ... the USDA puts out these books... what was good was it scaled up for 64 to 150 servings.”*

On the whole, providers were ambivalent about ordering food online. While a few were distrustful of online shopping, others appreciated the convenience. Several had negative experiences with online food ordering. Substitutions were particularly problematic. Online grocery services typically substitute “similar” items for out-of-stock products; however, a retailer's notion of comparable food may not jibe with provider perception or regulatory requirement.

In-home providers reported difficulty meeting minimum requirements for online ordering, in part due to a lack of storage space. Some providers also reported concerns about the quality of food that is ordered online, *“They pick out your produce and they pick out your meat, so you get what you get. I won't say it was horrible, but I wouldn't say it would be something I would have chosen.”*

Societal: culture, policy and regulation

Societal factors include informal influences, like culture, and formal ones, like government policy and regulation.

Culture

Childcare providers' perceptions and values are shaped by culture. Several participants described themselves as “foodies” to indicate their relationship to food and eating. The privileging of small-scale food production and distrust of government and corporations expressed by many participants seemed to reflect the distinct character of the pacific northwest, although two cited their Vermont heritage as a way of explaining commitments to local and sustainable agriculture.

Parental and staff concerns with organic and gluten-free foods reflect broader contemporary food trends. Seasonal influences also play a role, with providers adjusting menus to reflect holidays and changes in season. Birthday celebrations were another commonly cited factor, often described as exceptional events when sugar is served.

Policy and Regulation

Government influence on childcare food procurement is

deep and pervasive. All of our participants are licensed by the state, which includes guidelines for food provisioning and service. Most subjects also participated in federal and local food subsidy programs, which underwrite the cost of food service particularly to low-income children.

CACFP is the most significant program. It includes numerous nutrition and meal planning requirements that dictate nutritional content, suggest specific foods, and establish requirements on variety and serving size. Government programs also influence decisions about sourcing food. Several participants described discouraging parents from preparing food for their children, for example, because home meals aren't reimbursed by CACFP, or because requirements mandate all foods (including birthday cakes and other treats) be prepared by licensed, commercial kitchens. Food safety requirements also require food vendors have expensive tracking mechanisms in place, which disqualifies farmers' market vendors.

Government regulation also impacts space and labor usage. Several participants cited state requirements that they maintain emergency food supplies (although there was substantial disagreement over the precise amount), which demanded storage facilities that might otherwise be used for other purposes. Government programs impose reporting requirements, including tracking daily food service, that require significant amounts of staff time. They also offer training, nutritional information, and other support.

Interestingly, we found several examples of childcare facilities that didn't participate in CACFP, but which nonetheless adhered to its guidelines. In several cases, a childcare center had formerly received CACFP funding, and simply kept their menus in place after their participation lapsed. Some of these providers reported adhering to CACFP because they imagined enrolling in the program again in the future, while others said that it was simply easier to keep the existing menus than to develop new ones.

INTERACTIONS ACROSS THE MODEL

The socio-ecological perspective helps us make sense of complex practices, by highlighting ways that interactions between actors across socio-ecological levels shape decisions.

Importantly, the childcare context surfaces environmental dimensions of behavior that may be difficult to recognize in retail consumers. We typically imagine consumers as more or less autonomous actors who bring unique blends of preferences, values, and other factors to bear on purchasing decisions. For childcare providers, these factors are distributed across networks of influences. For example, children's taste preferences are significant (and inconsistent – for example, some kids love broccoli while others detest it). However, providers are also responsive to staff and parent preferences and values.

Similarly, nutritional requirements – how foods are understood as “healthy” – flow in part from children's

developmental needs, but are also proscribed by the government and interpreted by providers, with input from parents, staff, and the media. Food preparation – the ways that meals are cooked – are influenced by cost, but also by staff expertise and values, local availability of various ingredients, and the equipment and physical plant of the childcare center.

Appreciating the socio-ecological dimensions of food practices leads us to conceive providers as proxies for a host of interested parties. That is to say, in making decisions and enacting practices, childcare providers actively interpret a wide array of human, material, and institutional stakeholder perspectives.

This work often involves negotiating between competing, even conflicting, demands. Providers also actively work to exert their own influence back across the model. For example, kids' taste preferences are seen as malleable, and indeed, many providers see a primary responsibility in melding children's habits to their vision of what constitutes “good” eating (which in turn are influenced by a host of socio-cultural factors). We found numerous other examples of providers attempting to shape the decision making environment by arguing with parents, training staff, and advocating regulatory changes.

Providing healthy meals that are acceptable to dozens of children and their parents, meet state requirements and providers' own sense of propriety, and are constrained by tight budgets and limited staff and material resources imbues even the most mundane decisions with almost unfathomable levels of complexity. By helping to make this complexity legible, the socio-ecological approach lets us appreciate the scale of difficulties that childcare providers face in feeding their charges, and enables us to identify opportunities for design intervention.

RECONSIDERING FOOD + INTERACTIVE SYSTEMS

Although heavy users of computers and mobile technology, and deeply engaged with contemporary food culture, none of our participants reported using food-choice software in a professional capacity. This, despite the ready availability of literally hundreds of such apps for download. The absence of these solutions in professional practice points to a gap between the features that these products offer (and by extension, their underlying models and assumptions), and the requirements of childcare food provisioning. Simply put, many existing food choice technologies are of limited utility for childcare providers.

For one thing, existing products may rely on overly simplistic understandings of food. Previous work has suggested that price is the most important factor determining consumer food choice (e.g. [46,28]). However, we found that while financial considerations were significant for childcare providers, they were not considered to be a sole or even primary factor in decision making.

Our model suggests deeper disconnects between current

technologies and providers' practices. Food-choice applications are generally focused on the individual and, to a lesser extent, interpersonal levels. They tend to assume that consumers shop for themselves and their immediate family, and are primarily motivated by one of a fairly limited set of possible concerns (e.g. losing weight, avoiding allergens, saving money, shopping sustainably, or running out of milk). As we have seen, these concerns are certainly in play for childcare providers, but are balanced against a range of factors, and are complicated by the fact that, as institutional buyers, childcare providers make food decisions on behalf of large numbers of eaters with varied preferences and developmental needs.

Another reason for the limited appeal of consumer software is that childcare providers' food practices don't fit within the "corrective technology" framework described by Grimes and Harper [20]. Persuasive technologies that attempt to "fix undesirable behaviors" like snacking or not eating enough vegetables while overlooking social, cultural, and aspirational dimensions of food are poorly matched to the childcare context.

Institutional and societal influences also limit the appeal of online shopping. Reporting and staffing requirements lead providers to plan menus weeks in advance, which can be a barrier to online food shopping services with unpredictable inventory and unannounced product substitutions. While vendors' unexpected food replacements may seem funny or annoying to residential consumers [43], they are deeply problematic for childcare providers.

Finally, given prior interest among DIS researchers in small-scale and community supported agriculture CSA (e.g. [22,41]), we should point out that the relative rigidity of childcare food service also curtails providers' ability to participate in farm-to-table programs. While a family cook can adapt to an unexpected influx of, say, kale, from a CSA, in-home daycare providers have limited flexibility to make alterations.

We also found little reliance on commercial food services, due in large part to influences at the individual and institutional levels. We heard numerous accounts of struggles with industrial food services, including minimum requirements for delivery services and the high cost of institutional catering services. Disconnects seemed particularly pronounced for childcare providers who lack professional food service experience. These providers were less capable of negotiating with vendors, and also had difficulty making sense of industrial volume and pricing schemes.

The apparent lack of fit between current technology and services, and the requirements of childcare food practices suggests the need for new approaches to interactive systems design that can account for the complex interplay of factors we find in real-world decision making. In the next section, we suggest several directions for future design research.

DESIGN OPPORTUNITIES

We identify several opportunities for design intervention.

Information-seeking is a central concern for childcare providers. Providers are continuously on the lookout for recipe and curricula ideas, on much of what they find is not immediately suitable to their needs. Most cookbooks and recipe websites, for example, are geared towards home cooks, and require significant adaptation for use in institutional settings. While there are a number of curriculum development resources, most focus on K-12 education, and may not be suitable for younger children. Creating repositories of childcare-specific recipes and curricula would be of immediate benefit, as would enabling providers to exchange ideas, resources, and messages.

Logistical concerns are also paramount. Childcare providers often have limited financial and staff resources available, and struggle to manage the practicalities of planning menus, purchasing supplies, and transporting and storing food. Several participants reported using online food ordering services, with mixed results. While there are some online menu planning resources available, they are fairly rudimentary and could be improved. Adapting online shopping services to describe products and services in ways that make sense to childcare providers could increase adoption.

These examples will likely seem familiar to many readers, as they build on established design tropes and cast the decision-maker as the primary focus of design activity. However, the socio-ecological perspective broadens our view of food decision making, and suggests other, perhaps less obvious, design interventions by shifting our attention towards other actors.

For example, at the interpersonal level, providing parents with better information about menus and food service when they are choosing a childcare facility could encourage changes in food service. Similarly, applications that allow parents and providers to monitor children's eating habits both in and outside of childcare would enable more holistic, cooperative, and effective approaches to child nutrition and food habit-forming.

Moving to the community level, educating small scale farmers about providers' needs and reworking CSA services for greater predictability and consistency could lead to greater inclusion of locally-grown, small-scale produce on childcare menus. Doing this effectively might require cooperation by multiple small-scale farmers and childcares. It might also suggest that farmers invite childcare providers' involvement in crop planning at the beginning of the growing season.

At the institutional level, material conditions exert significant influence over providers' ability to serve fresh, healthful foods. Redesigning interior spaces to maximize storage and efficient space utilization can reduce reliance on prepared foods. New equipment that enables untrained cooks

to produce commercial-scale meals quickly, inexpensively, and with minimal space requirements will allow providers to make greater use of fresh and raw ingredients.

Interventions at the societal level, especially those involving policy and regulation, may have the broadest effects. As one of our informants pointed out, simply increasing CACFP requirements for fresh produce foods would have dramatic impacts on childcare food service. While policy changes may seem to some to be outside the realm of interactive systems design, it is worth noting that many regulations rely on technical components for implementation and enforcement. For example, childcare providers don't typically source food from farmers' markets, in part due the lack of effective food traceability. Developing low-cost food tracking solutions would enable farmers' market vendors to become eligible for CACFP reimbursement, which in turn would make them much more attractive to childcare centers.

Considering interactions across the societal, community, and personal levels suggest a need to connect providers, retailers, professional organizations, and policy makers. For instance, knowing that reimbursable items are more attractive to childcare providers could influence vendors' inventory and marketing decisions, particularly if consortia of small-scale childcares were able to pool resources and coordinate purchasing activities. Connecting professional food service workers with childcare providers could improve resource management and negotiations with vendors. Finally, coalitions of childcare providers, food producers, and local officials need tools to help them develop support networks and advocate for policy changes that would have sweeping impact across the childcare sector.

These are a few of the design opportunities that we discovered by using our model generatively, to inform brainstorming and ideation. From a design research perspective, these examples are interesting because they de-center the research subject [25]. Rather than assume a childcare provider is a sole, or even primary actor, they indicate that we may also influence food practices by addressing relationships between other actors including parents, retail environments, professional organizations, and government. More generally, they suggest an approach to design that finds innovation through holistic investigation of socio-ecological context.

It is worth noting that many of the design interventions described above require a realignment of stakeholder interests that can be difficult to achieve. This suggests an expanded notion of design practice that extends beyond specifying the form and function of interactive artifacts, to include relationships between socio-ecological actors and the policies that govern them. In other words, we see socio-ecological systems as both the context and object of design – they are the environments in which technology is experienced, and are themselves the products of human intention. While this perspective may seem novel to some,

we believe that it is consistent with established design movements including service design [35] and sociotechnical system design [7].

CONCLUSIONS: BEYOND CHILDCARE

Childcare providers are key to improving young children's nutrition. But, providers don't operate in a vacuum. Rather, they act as proxies for a variety of interests, including children, parents, professional associations, and government regulators. Their actions are shaped by broad social trends, intertwined with ideological commitments, and imbued with a strong sense of mission. In other words, they are bound up in complex sociotechnical systems.

In our view, socio-ecological models provide a useful way to make sense of messy, complex real-world decision making. Our model makes relationships between actors explicit, rendering them legible for analysis. The model also helps to de-center design thinking, by allowing us to map out a diverse set of actors who influence behavior at various scales of remove – from the local to the societal. Each of these actors, and the relationships between them, offer opportunities for design intervention.

We also believe childcare is representative of a class of organizations that offer human services outside of a governmental context. Other examples include community health clinics, senior centers, food banks, religious organizations, homeless and domestic violence shelters. Many of these organizations serve food. More importantly, they are all in the business of providing basic human services to vulnerable populations, and operate in a gray area between industry and the public sector. If we are to fully understand, and ultimately design for, these organizations, we need approaches to design research that account for complex interplay between people, policy, and things.

Finally, we note that social ecology systems theory was developed to describe behaviors of individuals operating in unofficial capacities. Our intuition suggests that socio-ecological approaches may be applicable to a wide array of everyday design contexts. We look forward to future explorations of this potential.

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