Capturing exposures: using automated cameras to document environmental determinants of obesity

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SUMMARY
Children’s exposure to food marketing across multiple everyday settings, a key environmental influence on health, has not yet been objectively documented. Wearable automated cameras (ACs) may have the potential to provide an objective account of this exposure. The purpose of this study is to assess the feasibility of using ACs to document children’s exposure to food marketing in multiple settings. A convenience sample of six participants (aged 12) wore a SenseCam device for two full days. Following which, participants attended a focus group to ascertain their experiences of using the device. The collected data were analysed to determine participants’ daily and setting specific exposure to ‘healthy’ and ‘unhealthy’ food marketing (in minutes). The focus group transcript was analysed using thematic analysis to identify the common themes. Participants collected usable data that could be analysed to determine participant’s daily exposure (in minutes) to ‘unhealthy’ food marketing across a number of everyday settings. Results from the focus group discussion indicated that participants were comfortable wearing the device, after an initial adjustment period. ACs may be an effective tool for documenting children’s exposure to food marketing in multiple settings. ACs provide a new method for documenting environmental determinants of obesity and likely other environmental impacts on health.

Key words: obesity; children

INTRODUCTION
Over the past three decades, the worldwide prevalence of childhood overweight and obesity has increased to unprecedented levels. Internationally, an estimated 170 million children and young people are currently overweight or obese (World Health Organization, 2012). The consumption of an energy-dense, nutrient-poor diet; high in fat, sugar and sodium and low in fibre, has been associated with the increasing prevalence of childhood obesity and non-communicable diseases (NCDs) (World Health Organization, 2011; Ambrosini et al., 2014). Hypertension, insulin resistance, hypercholesterolemia, type 2 diabetes mellitus and orthopaedic complications are all well reported adverse health consequences of childhood obesity (Doak et al., 2006; Oude-Luttikhuis et al., 2009; Han et al., 2010). The stigma associated with obesity can also have detrimental effects on a child’s psychosocial health, with obese children frequently reporting low self-esteem, social isolation and depressive symptoms (Doak et al., 2006; Waters et al., 2011). Furthermore, the tracking of poor dietary patterns and obesity into adulthood increases the risk of developing type 2 diabetes, hyperlipidaemia, cardiovascular disease and certain cancers in adulthood (Doak et al., 2006; Wang et al., 2010; World Health Organization, 2011).

Although the origins of obesity are complex and multifactorial, the pervasive marketing of
high fat, salt and sugar (HFSS) foods (including beverages) is a significant contributor (Cairns et al., 2009; Dorey and McCool, 2009; Mehta et al., 2012; Scully et al., 2012). Food marketing impacts on consumption patterns by shaping children’s food preferences, purchase requests and nutritional knowledge (Hastings et al., 2003; Cairns et al., 2009). Regulation to restrict the marketing of HFSS foods and beverages to children has been identified by the World Health Organization as a cost-effective population-based approach to reduce the prevalence of NCDs associated with childhood obesity (World Health Organization, 2012).

There now exists a considerable body of research into food marketing, much of which is focused on children (Hastings et al., 2003; McGinnis et al., 2006; Cairns et al., 2009; 2013). The majority of this research is, however, siloed providing accounts of the nature and extent of food marketing via single media (Cairns et al., 2013). Of this research, studies on food marketing via television have been the most numerous, but other avenues of food marketing to children are among the growing body of evidence, including: marketing in magazines; packaging; mail outs; billboards; ‘in school’ marketing, sports sponsorship and marketing via emergent media including the Internet and most recently smart phones (Cairns et al., 2009; Montgomery et al., 2013). While together this research provides a picture of the ubiquitous presence of food marketing in children’s environments, children’s actual exposure to the full range of food marketing across all media and in multiple settings remains unknown (Cairns et al., 2013; Halford and Boyland, 2013).

An emerging technological advance, that of wearable cameras, may offer a solution to the problem of capturing children’s exposure to food marketing across multiple media and settings. Automated cameras (ACs) may have the potential to provide the first account of children’s actual exposure to food marketing across media and settings. Doherty et al. (Doherty et al., 2013) make the case of the use of such devices in health research, although Kelly et al. (Kelly et al., 2013) note that by their very nature such devices can be very intrusive, and recommend the use of ethical frameworks to guide their use.

An AC, SenseCam, developed by Microsoft Research, Cambridge, UK, was initially trialled, for research purposes, with a memory impaired patient who used the device to capture daily events (Berry et al., 2007). SenseCam has since been used to document active and sedentary travel behaviour in adults and young people (Kelly et al., 2011, 2012), as well as the food purchasing and consumption habits of high school students on the journey to and from school (Matthews et al., 2011).

The SenseCam device is worn around the neck on a lanyard and passively captures wide angle digital images every 10–30 s for up to 24 h (Hodges et al., 2011). The device produces and stores 2000–5000 first-person time-stamped images per day (Hodges et al., 2011). Previous research using SenseCam suggests that the technology has the potential to provide an objective account of the wearer’s behaviour when compared with self-reported participant observations (Kelly et al., 2011) and has established the feasibility of using SenseCam with young people (aged 13–15 years) (Matthews et al., 2011). Together, this research suggests that SenseCam has the potential to be worn by children to objectively document their daily exposure to food marketing. The aim of this study was to assess whether it is feasible, legally, ethically and practically, to have children (aged 12 years) wear an AC to record their exposure to food marketing across media and settings and to assess more broadly the value of this method in capturing exposure to environmental determinants of health.

METHODS

Ethical approval

To inform an ethics application, a literature review was conducted to identify likely legal and ethical issues relevant to children’s use of ACs for this research. This literature suggested that the key issues were: the legality of recording images in public places; the potential to capture images of illegal activity in which the wearer is either participating or witnessing; third party consent to be photographed; parental consent for recording of images in the home environment; ownership of participant-generated images; data handling and storage; privacy and anonymity of participants and third parties; and participant safety (Wang and Redwood-Jones, 2001; Wiles et al., 2008; Raento et al., 2009). Protocol for the management of these issues was developed and outlined in an application to the University of Otago Human Ethics Committee.
This included ensuring the provision of information to participants, requiring informed consent from participants, their parents and the participating school; and the development of protocols for data collection and data handling to protect the privacy, confidentiality and anonymity of participants and third parties captured in the images (Barr et al., 2013). This study received approval from the University of Otago Human Ethics Committee on September 4 2012 (Ref No. 12/222).

**Setting participants and recruitment**

A convenience sample of six participants (aged 12 years) was recruited from an urban school in Wellington, New Zealand. Details of the project were provided to the school, and consent to conduct the research and assist with participant recruitment was sought from the school principal. Participants were conveniently selected for their reliability, maturity, interest in the study and on the basis that they provided written consent and had written parental consent to participate and record images in the home environment.

**Participant briefing**

Prior to wearing SenseCam, a briefing session was held to familiarize participants with the technology and to give instructions for data collection. During this session, participants were informed that they could remove the device at any time. Participants were asked to remove the device before entering: changing rooms; bathroom or shower facilities; or in any other situation or location in which people could be partially clothed; or in which photography is prohibited. Additionally, participants were shown how to activate the privacy button that suspends image capture for a period of 4 min. They were encouraged to engage this function when using the bathroom or changing, or to turn off and remove the device. Due to the novelty of the device, participants were also briefed on how to handle any attention they may receive while wearing SenseCam.

**Data collection**

Participants each wore the SenseCam device for two full days, one week day and one weekend day, during all but personal activities (the equivalent in recording hours, allowing for 9 h of sleep, would be ~15 h per day, totalling 180 h of data for analysis). ViconRevue 3MP SenseCam was used in this study. All children used one SenseCam device in turn. To limit the introduction of bias during data collection, participants were blinded to the explicit aim of the study (to document food marketing).

At the completion of data collection, a focus group was conducted with the children using a semi-structured interview schedule to ascertain their experiences of using SenseCam and being involved in the research. A group debriefing preceded this, where the true aim of the study was revealed.

**Data analysis**

Following data collection, the images were downloaded onto a laptop and were reviewed manually (by M.B.) to identify and code all food marketing captured in the images. Food marketing was defined as all: ‘Broadcast, print and digital advertising; packaging, labelling and point of sale promotions; branding and sponsorship; merchandising and the use of licensed or brand-based characters’ [Cairns et al., 2013] p. 211]. A pre-coded schedule was developed to record data on the brand, product and location of the food marketing, and the time the exposure occurred.

**Classifying foods and brands as ‘healthy’ or ‘unhealthy’**

The classification of food or beverage products as ‘healthy’ or ‘unhealthy’ was undertaken using the Food Standards Australia and New Zealand (FSANZ) Health Claims Nutrient Profiling Calculator (Food Standards Australia & New Zealand [FSANZ], Undated). Where the marketing was only represented by the brand name or logo (i.e. no picture or reference to a specific food), foods within the identified company’s New Zealand product range were analysed using the FSANZ calculator to determine the brand’s overall profile. The nutritional information for all products and brands was collected between September and November 2012.

**Collection of nutritional information**

Nutritional information was collected from Nutritional Information Panels on product packaging (where available); The Concise New Zealand
Food Composition Tables (Sivakumaran et al., 2012) and product websites.

Calculating exposure to food marketing

Image data were analysed to determine participants’ total and setting specific exposure, in minutes, to the captured food and beverage marketing. Ten-second exposures were collated for each setting and participant and averaged across all participants. Participants’ exposure to ‘healthy’ and ‘unhealthy’ food and beverage marketing was determined for each distinct setting and across all settings identified in their images. Data were analysed in such a manner that every image was assumed to represent 10 s of exposure to the product or brand (the approximate time between image capture). The focus group discussion was recorded, transcribed and analysed using thematic analysis to identify the following themes among participant responses: their attitude to wearing SenseCam; dealing with attention from third parties; their response to being blinded to the purpose of the study; and their experience of participating in the research project.

RESULTS

Using SenseCam, we were able to collect data on the food marketing present in a range of children’s environments. Furthermore, we were able to analyse a sample of this data using the trialled methods to determine children’s exposure to food marketing across a variety of everyday settings.

Data collection

Despite wearing SenseCam for 2 days each, the actual data collected (recorded) per participant was less than expected, ranging between 4 and 8 h with participants collecting an average of 5 h and 34 min of data per day. The reasons for this smaller than anticipated data set include: operational issues with the SenseCam unit; battery life of the device; and compromised quality of collected images due to low or artificial light. The key operational issue identified was the jamming of the camera. While the device appeared operational, once the recorded data were downloaded and reviewed, only one image was displayed for the duration of the recording. Battery life further compromised device operation. Despite overnight charging after every use, the battery life of the device was inconsistent resulting in variable operation and the capture of considerably less data than anticipated.

The SenseCam device contains a 3-megapixel camera fitted with a fish eye lens to capture a 180 degree view of the wearers’ environment (Vicon Motion Systems Ltd, undated). However, in artificial or low light SenseCam produced blurred photos that could not be analysed due to their poor quality, resulting in small data losses (~10%). Despite these issues, a sample of the collected data (17 h 9 min of images) was used to trial the proposed methods of coding and analysis.

Analysing exposure to healthy and unhealthy food marketing

Participants captured exposure to 22 food and 10 beverage products and 11 brands (e.g. Coca-Cola, McDonald’s). Manually identifying and recording all of the food marketing in each participant’s images required ~16 min for each hour of participant image data. This process was particularly time consuming if the participant had captured images inside a convenience store or supermarket, as all identifiable food or beverage products were recorded. Furthermore, downloading the data took ~45 min per day of data collected due to the large file size of the images.

Focus group results

Overall, participant responses suggest that wearing SenseCam during everyday activities is an acceptable practice. The consensus among participants was that, following an initial adjustment period to its presence; they became unaware of wearing the device. One participant recalled: ‘The only time I remembered it was there was when somebody pointed it out. I’d forget most of the time’. (Boy, 12 years).

Being approached by third parties, while wearing SenseCam, was an experience reported by all participants. In dealing with the attention, participants all recalled that they explained SenseCams’ function and purpose, following which most parties were unconcerned with the device’s presence. If there was a concern, participants reportedly turned the device off. While explaining why they were wearing the device, the group reported that they did not use the purpose-developed information cards at any time. Despite this, all agreed that they appreciated having the information cards available.
Apart from when using bathroom and changing, participants primarily removed the device while engaging in physical activity. Participants also recalled removing the camera during certain school classes if their teachers did not want them to wear the camera. For example, participants were asked to remove the device during an art class as it was capturing sacred Māori artwork. However, responses indicated that they were not asked to remove the device by members of the public or in any other situation.

Participants were surprised to learn of the true study aim. However, when asked about the aim being concealed from them, each of the participants admitted they would have changed their diet and what they had allowed to camera to capture had the known of the study’s aim. One participant stated: ‘I think it’s good because otherwise we would have probably changed what we ate.’ (Boy, 12 years). Another participant recalled her experience of collecting data as ‘kind of just doing a normal day’ (Girl, 12 years).

As to the notion of there being a significant burden placed on the participants, participants were unanimous in agreeing that they would be able to wear the device for a longer period than they had during the pilot study. When asked what they thought about participating in the project, the group consensus was that they would all do it again. The children described their experience of participating in the study as: ‘cool’; ‘fun’; ‘exciting’ and ‘special’, ‘because nobody else got to do it’.

**DISCUSSION**

The current pilot study suggests that it may be feasible to use ACs to capture children’s exposure to food and beverage marketing across and within settings. Further, the methods of data analysis developed for this study may be effective in quantifying children’s exposure to unhealthy food and beverage marketing.

The use of ACs, or similar recording technology, in research raises a number of ethical and legal concerns. Yet, the findings from the ethical approval process in this study, and that of previous research (Kelly et al., 2011, 2012; Matthews et al., 2011), indicate that the ethical and legal issues associated with the use of ACs can be adequately addressed with a rigorous study protocol as demonstrated here and also recently by Kelly et al. (Kelly et al., 2013).

However, the pilot study does not support the use of the ViconRevue 3Mp SenseCam for research of this nature. The issues we experienced during data collection do not appear to be unique to this study, as previous authors have reported various operational issues with the SenseCam device (Kelly et al., 2011, 2012; O’Loughlin et al., 2013; Oliver et al., 2013). Notably, our finding that images taken in artificial or low light could not be analysed due to their poor quality has been reported previously (Kelly et al., 2011, 2012; Oliver et al., 2013) and appears to be a major limitation in the use of this particular device. This finding is significant as the reduced recording time and poor quality of images taken in low or artificial light may result in an underestimate of participant’s exposure to food marketing. Although some issues are well known, the limited battery life and lengthy charge time, however, have not been reported previously. Technological developments mean that new devices are now available that likely overcome these difficulties, such as the Autographer.

The plethora of data collected using ACs provides a rare and comprehensive insight into various aspects of children’s environments. However, the manual coding and analysis of such a body of data is time-consuming. Emerging research suggests that this process could be aided with the use of brand recognition or event segmentation software which would enable the collapsing of similar images into ‘events’ or ‘albums’ facilitating more time efficient coding and analysis (Doherty et al., 2011; Gurin et al., 2013).

Coding and analysis of the food marketing in supermarkets and retail outlets is an additional challenge. Recently, a tool has been developed to assess the ‘promotional environment’ within grocery stores in the USA (Kerr et al., 2012). The use of a tool to pre-classify exposure to marketing in retail outlets as ‘healthy’ or ‘unhealthy’ may aid in streamlining the coding and analysis process.

In the present study, each image containing food marketing was coded to represent a 10 s period of exposure to food marketing. However, this method may lead to an overestimate of exposure time as it cannot be known if the food marketing recorded in a 10 s frame was within the wearer’s field of view/environment for the entire 10 s period. Where the food marketing appears in a continuous sequence of images, it would be reasonable to assume that the wearer
was exposed to the food marketing during this time. However, it is not possible to determine at what time marketing appears between frames and therefore to determine this exposure. In future research, a conservative approach to analysis could be adopted. For example, where food marketing appears in an isolated image, this could be coded as a 5 s exposure as opposed to a 10 s exposure, with 5 s representing a midpoint between 0 and 10 s. Further, the last image in a sequence containing food marketing could represent 5 s of exposure as the exact length of time the wearer was exposed to food marketing, when it appears in the last frame, is difficult to determine.

Overall, participant responses indicated that they were comfortable wearing the device after an initial adjustment period and the majority of the group confidently handled any attention they received while wearing the device. Although not used, the information cards and pre-prepared statement provided the participants with peace of mind during the data collection. Similar findings have been reported previously (Kelly et al., 2011). Our research again demonstrates the benefit of an ethical framework to guide research in an area that can be perceived as intrusive (Kelly et al., 2013). Concealment of the aim of this study was necessary to capture images of food marketing seen by children on a typical day and was supported by participant responses. This form of deception is commonly used in research to reduce the recall bias associated with the reporting of desirable health-related behaviours (Athanassoulis and Wilson, 2009).

Strengths
To our knowledge, this study was the first that sought to develop a method of capturing children’s exposure to food marketing across more than one setting and via multiple media. The legal and ethical issues associated with the use of ACs in research were identified and adequately addressed to obtain ethical approval to conduct this research. This field test enabled us to trial the available technology and the purpose-developed methods of data collection and analysis.

The participants in the current pilot were responsible for data collection and reporting back on the methods and processes used to conduct this research. Despite the burden associated with participating in this research, it was observed that the participants were committed, reliable and enthusiastic, and contributed substantially to our understanding of the issues associated with the use of SenseCam and wearing the device during most aspects of everyday life. While the participants were selected for their maturity and reliability, given the ease with which they undertook the research, it seems likely that most other children would cope well with such research. These findings add to the growing body of evidence that children are able to competently and actively participate in the research process (Thomson, 2008; Graham and Fitzgerald, 2010; Kellet, 2010).

Limitations
As this was a feasibility study, a key limitation of this study concerns the conclusions that can be drawn about the results. A sample of six children were conveniently selected to participate, limiting the generalizability of these findings, as those that participated may have been more likely to be engaged in the research process than those selected to participate at random. For example, less motivated children may record less data. However, this could be overcome by sending text messages to children or their parent’s reminding them to wear the camera during the data collection period. Although self-selection bias may have been operating, it is difficult to eliminate in studies of this nature, as participation must be voluntary for ethical reasons and due to the burden of participation.

As SenseCam is worn around the neck and sits high on the chest, it does not capture the wearer’s environment at eye level. A further limitation of the device is that it can only capture what is directly in front of the wearer, and may not capture the full extent of the food marketing within the wearer’s field of view. Together, this may lead to an underestimate of children’s exposure to food marketing.

Implications
Findings from the pilot study indicated that ACs can be used to capture children’s exposure to food marketing. The authors have commenced a large study that will confirm whether this is the case. The images collected using an AC could provide data on additional influences from children’s food and physical activity environments, including: children’s exposure to alcohol marketing; food availability in children’s environments, opportunities for physical activity and
CONCLUSIONS

ACs may be an effective tool for documenting children’s exposure to food marketing in a number of settings. However, there are a number of legal, ethical and practical considerations associated with their use in research. Our findings suggest that these legal and ethical issues can be adequately addressed through study design and the development of data collection, storage and dissemination protocols that protect the privacy and anonymity of the study participants.

Practically, the trialled methods of image coding and analysis can be used to determine the average length of participants’ exposure to food marketing in multiple settings. However, more reliable camera devices are required and should be used in conjunction with automated software to facilitate time efficient analysis of large image data sets. Participant experiences of using the AC suggested that wearing the camera and allowing it to document their environment was acceptable and enjoyable.

The marketing of HFSS foods is contributing to the increasing prevalence of childhood obesity and NCDs. A comprehensive account of the extent and nature of children’s exposure to food and beverage marketing and the settings in which these exposures occurred would assist in determining effective interventions in this domain. ACs provide a new method for documenting environmental determinants of obesity and likely other environmental impacts on health.

REFERENCES


