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Consumers' visual attention to fruit defects and disorders: A case study with apple images

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ABSTRACT

High quality fruit are demanded by consumers across the globe. The presence of localized small necrotic areas within the flesh, which may or may not be visible at the surface of fruit (e.g., physiological disorders, bruises, rots), can negatively affect perception of fruit quality and consumers' willingness to purchase/consume. Research on how consumers' visual attention is drawn to different symptoms is lacking, but offers the potential to understand how defects influence consumers' decision-making. In this context, the aim of the present study was to evaluate consumers' visual attention to defects in fruit and to evaluate the relationship between visual attention and rejection (i.e., decision not to re-purchase). Using apples as a case study, consumers ($n = 123$) completed two experimental tasks involving eye-tracking technology. First, consumers completed a free-viewing task, which included apple images with different severities of three defects (internal browning, bruising and cavities). Second, they saw seven apple images with different degrees of bruising and indicated their future purchase intention. In the apple images without defects, consumers mainly fixated their gaze on the core and the seeds of the apple. However, as the degree of symptoms increased, consumers shifted their attention and fixated their gaze on the area affected by bruises or disorders. Consumers' visual attention toward the defects, and their future rejection of purchases of apples, increased with the severity of the defects. Using survival analysis, the relative areas of bruising that corresponded to rejection by 25% and 50% of consumers was estimated as $2.3 \pm 0.5\%$ and $4.8 \pm 0.7\%$, respectively. The present work suggests that attentional capture of fruit disorders can predict consumers' rejection and contribute to setting quality standards. Such standards effectively guide the fruit industries in consumer-led innovation and development of production systems.

1. Introduction

Across the globe, consumer demand for high quality fruits is increasing (Harker et al., 2003; Opara and Pathare, 2014; Pace et al., 2011). Consumer satisfaction with fruit quality has become one of the main objectives of the production chain, as well as a key determinant of profitability (Doerflinger et al., 2015).

Appearance plays a primary role in consumer perception of fresh fruits (Kader, 2002). It is the main sensory characteristic that consumers take into account when evaluating fruit quality and making their purchase decisions (Ares et al., 2009; Nicolaï et al., 2009). Although internal appearance and defects (e.g., physiological disorders, bruising, rots) cannot be evaluated at the time of purchase, it affects consumers' quality perception and their willingness to purchase/consume (Kader, 2002; Prusky, 2011; Gamble et al., 2010). Encountering fruit with low internal visual quality can negatively affect consumers' trust in a specific cultivar, brand, and retail store, and decreases their willingness to repeat purchase.

The most difficult defects and disorders to deal with are those that develop during storage due to dysfunction in fruit metabolism (Wills et al., 1998). They manifest as general discoloration across the pericarp and/or core tissue, appearance of localized patches of discoloration, spots of necrotic tissue and appearance of cavities within the flesh (Snowdon, 1990; Meheriuk et al., 1994). There is pressure on the industry to minimize disorders as they contribute

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to quality downgrading and are one of the main determinants of product losses, which represent societal and economic resource waste (Opara et al., 2007; Prusky, 2011; Van Zeebroek et al., 2007). In response to these pressures, methods for non-destructive defect sorting have been developed using technologies such as near infrared spectroscopy and magnetic resonance imaging, which have been used in some packhouses to exclude poor quality fruit (Clark et al., 2003; McGlone et al., 2005). These rely on complex algorithms to segregate fruit with defects and disorders, and their success partly depends on adjustment of the algorithms to fine-tune the criteria that define what fruit are deemed in or out of specification.

The capability for studying disorders is a common platform within most applied postharvest research and quality programmes (Hertog et al., 2007; Nicolaï et al., 2009) and reflects the industry need to meet standards for allowable severity and incidence of disorders in lines of fruit (Kader, 2002; OECD, 2010). These standards are variously imposed through industry and government regulations, and at various stages along the distribution chain from grower marketing organizations through to retailers. Changes in storage technologies, the release of new cultivars and the expansion of growing regions have led to the discovery of new disorders and/or identification of existing disorders that had not been identified before in a particular product (Elgar et al., 1999; Harker et al., 1999; Johnston and Brookfield, 2011). Anecdotally, the discovery of these often unanticipated disorders stimulates intense conversations among scientists and within industry about what degree of symptoms and overall rate of incidence are acceptable/unacceptable. Generally this is a discussion that draws on the subjective opinions of technical experts and often without quantitative means to determine how much of a disorder is a problem.

Despite the widespread development of methods for measuring the visual quality of fruits (e.g., Brosnan and Sun, 2004; Opara and Pathare, 2014), there has been little attempt to quantify what degree of disorder symptoms (i.e., lack of quality) depress consumer satisfaction and deter purchasing. The current research contributes to a closing of this knowledge gap through an exploratory study that investigates the use of eye-tracking technology for measuring how consumers visually appraise fruit and link that to future purchase decisions.

Visual attention, defined as the degree to which consumers look at a stimulus, is a prerequisite for information acquisition and is a key step in their decision-making process (Solomon et al., 2002). When looking at a stimulus, the brain uses attentional mechanisms to select a subset of information for further processing, suppressing processing of non-selected information (Wedel and Pieters, 2007). Research has shown that the characteristics of a stimulus

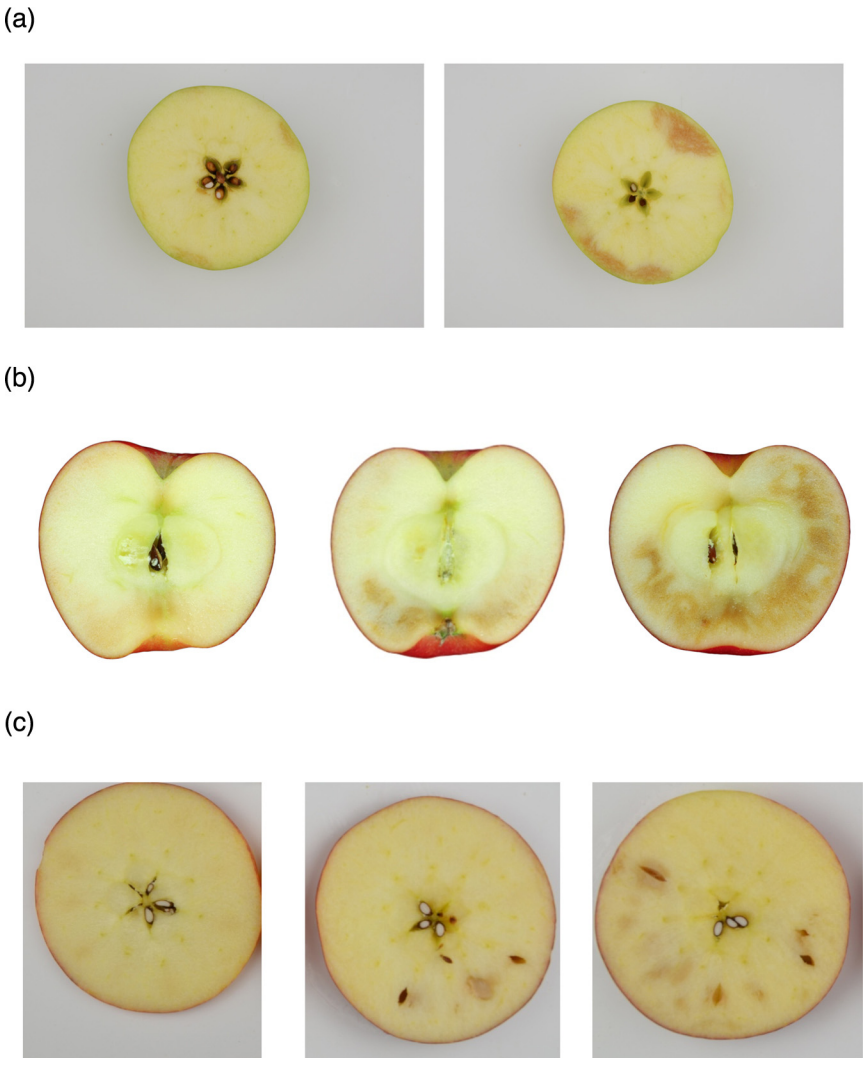

Fig. 1. Apple images with different degree of three disorders used in the free viewing task (Obj. 1): (a) bruising (3.2% and 24.8% affected area), (b) internal browning (5.4%, 13.3% and 43.4% affected area), (c) internal browning and cavities (1.2%, 4.8% and 15.8% affected areas).