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Optimal approaches to the quality control checking of product labels

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Abstract

Quality control checkers at fresh produce packaging facilities occasionally fail to detect incorrect information presented on labels. Despite being infrequent, such errors have significant financial and environmental repercussions. To understand why label-checking errors occur, observations and interviews were undertaken at a large packaging facility and followed up with a laboratory-based label-checking task. The observations highlighted the dynamic, complex environment in which label-checking took place, whilst the interviews revealed that operatives had not received formal training in label-checking. On the laboratory-based task, overall error detection accuracy was high but considerable individual differences were found between professional label-checkers. Response times were shorter when participants failed to detect label errors, suggesting incomplete checking or ineffective checking strategies. Furthermore, eye movement recordings indicated that checkers who adopted a systematic approach to checking were more successful in detecting errors. The extent to which a label checker adopted a systematic approach was not found to correlate with the number of years of experience that they had accrued in label-checking. To minimize the chances of label errors going undetected, explicit instruction and training, personnel selection and/or the use of software to guide performance towards a more systematic approach is recommended.

Keywords: quality control; visual inspection; human error

Optimal approaches to the quality control checking of product labels

1.1 Introduction

Ensuring the quality of packaged fresh produce is of paramount importance at all stages along the supply chain, from grower to supermarket retailer. A vital aspect of this quality control process is to ensure that the printed labels on the produce packaged by packaging facilities are in complete accordance with the specifications stipulated by the supermarket customer. If the label information is not accurate, then significant financial, environmental, and reputational costs will be incurred by both the supermarket and packaging company. Indeed, the cost to the United Kingdom (UK) supermarket industry of label-checking errors is estimated at £8-10m per annum (S. Hinks, Product Technical Manager: Fruit and Floral, Sainsbury's Supermarkets Ltd, personal communication). Broadly speaking, quality control label-checking can be considered a type of visual inspection task (e.g., Drury, 1993, 2006, 2015), in which products are checked by eye by human operatives to verify that they meet the required specifications. Visual inspection has been studied across a broad range of industrial and manufacturing settings (e.g., Drury, 1993; Jameeson, 1966; Melchore, 2011; Rao, Bowling, Khasawneh, Gramopadhye & Melloy, 2006; Rebsamen, Boucheix & Fayol, 2010; Wang & Drury, 1989; Wang, Lin & Drury, 1997). However, to the best of the authors' knowledge and with the exception of some preliminary work (Katz, Smith-Spark, Marchant & Wilcockson, 2015; Smith-Spark, Katz, Marchant & Wilcockson, 2015), label-checking has not been explored previously. The aims of the research reported in this paper, therefore, were to understand how professionals involved in quality control checking actually checked fresh produce labels for errors and to identify whether an optimal approach to label-checking existed. In order to achieve these aims, observations were undertaken in a large-scale packaging facility and interviews were conducted with key quality control operatives. The knowledge gained from the observations and interviews were then used to inform the design of a simulated label-checking task presented to professional label checkers under laboratory-conditions. Before reporting the findings of the field and laboratory work, it is necessary first to set the label-checking task in context. It is thus to a description of the fresh produce packaging process, and quality control thereof, that this paper now turns.

1.2 The fresh produce packaging and labelling process

Supermarket chains place weekly orders for fresh produce by contacting the commercial office of the packaging facility. These orders may specify particular varieties of a fruit or vegetable, designated UK and overseas growers, and promotional offers. This information is entered into a specification sheet for circulation within the packaging facility. The entries on the specification sheet are checked by two members of the commercial team against the communication from the supermarket customer. After checking, the specification sheet is released to staff across the packaging facility, with updates being published as required during its week-long lifespan.

Errors can, and do, occur in the information entered onto the specification sheet by the commercial office but the pack-house was identified by the facility’s management as the priority for investigation. Industrial processes and cognitive behaviors in the pack-house were thus the focus of the remaining work reported in this paper.

The pack-house is where the fresh produce is packaged for transportation to depots and, from there, supermarkets. It is a large-scale operation dealing with over 170 fresh produce Stock Keeping Units (SKUs) a day, and its operation is made even more complex by having to factor in variations in the size, variety, and grower of the produce when packaging the orders. Study of the packaging facility records held by the packaging facility highlighted both the high volume of orders (e.g., 1316 label runs on stone fruit alone in March 2014) and the disproportionate effect of a very small number of label errors eluding quality control checking. Indeed, fewer than 1% of orders contained errors and, of this 1%, less than 5% go undetected during quality control checking (i.e., approximately five in every 10,000 label runs contain errors that go undetected).

Each production line in the pack-house has a number of operatives supervised by a team leader. The team leader consults the specification sheet and generates the order of fresh produce to be delivered from the facility's warehouse. There are several kinds of packaging machine in use on more than 40 production lines in the pack-house (see Figure 1), built by different manufacturers and running various types of software to package fresh produce in different ways (e.g., in plastic punnets, polythene packets or nets). All types of packaging require the presentation of label information to accompany each unit of the packaged product. The specification sheet is the sole source of information from which operatives in the pack-house work when packaging the fresh produce to meet the orders placed by the supermarkets. It provides the information to populate the fields of the label to accompany each unit of the packaged produce, such as best before date, weight, and country of origin. Where labels are not printed directly onto polythene film, the team leader of the production line must complete and submit a label order form to the packaging facility's print room, specifying the information to appear on the printed label. The print room then uses this information to produce a run of labels in line with these specifications and commensurate with the size of the order. The labels are then collected by the team leader who distributes them to the production line operatives to append to each packaged unit.

FIGURE 1 ABOUT HERE

Depending on the type of produce, each label contains a certain number of fields of information, including details such as the type and variety of produce, the best before date, the name of the grower, the country of origin, the barcode, and the weight or quantity of the produce contained in the packaged unit. In addition to the label, a further sticker or ribbon may also be attached to the packaged product. This “flash” label highlights any current promotional offer on the product and also needs to be quality control checked. An example label with an accompanying flash label is shown in Figure 2.

FIGURE 2 ABOUT HERE

1.3 The occurrence of label errors

Due to the complexity of the printing and packaging systems, the availability of particular varieties of fresh produce, and the last-minute nature of some orders from retailers, a technological solution involving full automation of the label production process was not deemed feasible or cost-effective by the packaging company. Instead, the labelling process involves an operative using software to input information from either pull-down menu options or via an alphanumeric keyboard. As a consequence, human error results, occasionally, in mistakes occurring in the information printed on labels.

Errors can occur in any of the label fields, although the likelihood of an error occurring is higher in some fields (i.e., those requiring data entry by a human operative) than in others (e.g., the barcode). These error types range from spelling errors (e.g., relating to the name of the grower of the product) to variety errors (e.g., a variety of grape being stated that differs from the product actually contained in the packaging) to quantity errors (e.g., relating to the number of items contained in the packaged product) through to those with serious implications, be they financial (e.g., stating “Buy one, get one free” instead of “Buy 2 for £2”), health-related (e.g., giving the incorrect best before date), and/or legal (e.g., being labelled as “British grown” but originating from another country).

1.4 The quality control checking process

Each production run undergoes quality control checks by several individuals at different stages in the packaging process, with both team leaders and dedicated quality control staff conducting label-checks. Quality control checking of labels requires the checker to move between two sources of information, verifying the correctness of entries on the product label against those specified on the specification sheet. The information printed on the label must match that appearing on the specification sheet exactly. The quality control checker’s task is to ensure that this is the case for each production run. In addition to label-checking, team leaders and quality control staff alike have a range of tasks to perform in their roles, meaning that label-checking is interspersed amongst other duties. Label-checks are performed as and when production runs begin or end; the frequency and timing of these label-checks thus varies depending upon the number of production runs and their length.

The vast majority of label errors are detected successfully early in the packaging process but, despite several independent quality control checks at different stages of the production run, some labelling errors still leave the packaging facility undetected. Such errors have serious consequences for both the packaging company and the retail company that they are supplying, resulting in monetary fines and the recall of otherwise perfectly good fresh produce from distribution depots or the shop floor itself, either for repackaging (where the shelf-life of the product allows) or replacement with correctly labelled goods.

1.5 In situ observations and interviews

In order to avoid the costs associated with labelling errors and maintain business reputation, it is essential from a quality assurance perspective to reduce the chances of label errors going undetected. Given the absence of a technological solution to the problem, the focus for error reduction had, instead, to be on understanding and, subsequently, shaping or constraining the behavior of human operatives who undertake quality control checks. The initial steps of the present research entailed (a) observations of the packaging processes and quality control procedures at the packaging facility, (b) the methodical examination of historical error data, and (c) interviews with key operatives. This was done in order to inform the approach taken to the subsequent controlled laboratory experimentation.

Observations taken in the pack-house indicated that each label check generally took operatives, working at a comfortable and natural self-paced rate, around 20s to determine whether all the fields of information presented on the label corresponded exactly with the information presented on the specification sheet for that order. As each label was checked, quality controllers filled in a check sheet. This check sheet required each item of information on the label to be checked off as it was compared with information on the specification sheet. Once each field of information had been verified as correct, the sheet was to be signed off by the checker.

Study of the historical error data kept by the packaging facility allowed insights into the nature of label-checking errors in situ. Incorrect best-before dates were the most commonly occurring error type amongst those detected during quality control checking in the packaging facility. There were two distinct peaks in the frequency of errors occurring. These occurred either side of a 9am break for operatives on the morning shift (which started at 7am). Interviews with operatives revealed this period generally to be the busiest part of the day. There were fewest errors committed during the night shift. However, it should be noted that only a small number of production lines run at night (typically three) and these tend to be the simplest production runs to fulfil.

Interviews with key pack-house operatives also revealed that each had considerable practice in checking labels, ranging from months to years. They all reported knowing what items of information the labels needed to contain and that their task entailed comparing these for accuracy against the definitive information on the specification sheet. However, none had received any explicit instruction or training about the most effective way to approach the task. In other words, they understood what to do but not how best to do it (cf. Hollnagel, 2006). The main reason for the lack of instruction was that no information was available to either management or workers as to what comprised the optimal approach to checking. Indeed, this lack of knowledge had been identified by the facility's management and was the driving force behind the current research. Without explicit guidance, the approaches adopted by operatives were likely to be idiosyncratic and varied. In support of this assumption, differences in approach and strategies taken by participants have been highlighted on visual inspection tasks (e.g., Charles, Johnson & Fletcher, 2015; George, 1972).

1.6 Taking the work into the laboratory: The simulated label-checking task

Having obtained a broad understanding of quality assurance practices in situ, the next step of the investigation was to undertake a controlled laboratory study to examine the actual behavior of quality control staff when checking labels. Experienced quality control operatives were tested under laboratory conditions on a simulated label-checking task designed to resemble closely that undertaken on a daily basis in the packaging facility. It required the participants to determine whether the fields of information on a given label matched those presented on the specification sheet. To learn how participants went about the task, eye movements were logged as the participant compared information on the printed label with that presented on the specification sheet. Since the focus of the project was on label error detection failure, label "errors" were present on 20% of trials, with there being a difference in a single field of information between the label and the specification sheet. As well as examining overall accuracy, finer-grained analyses were made of participants' responses on trials where there was a lack of congruence between a single field of information on the label and that presented on the specification sheet.

A high level of accuracy was expected from all participants, given their professional experience with label-checking. However, on the basis of the interview data and archived records, individual differences in accuracy were expected to emerge, with some professional label-checkers being more proficient at detecting errors than others. Given that no instruction was provided on how to perform label-checks and the participants approached the task freely (much as they would at the packaging facility), it was expected that individual differences would be found in their eye movements and that these differences might be related to differences in accuracy of performance. Comparisons of the label-checking behavior of the most and least accurate performers were undertaken to identify the approach most likely, if adopted, to yield the optimal level of accuracy.

2.1 Method

2.1.1 Participants

Sixteen label-checkers (12 females, four males; mean age = 30 years, *SD* = 6) took part. They were recruited from a large-scale UK fresh produce packing facility where they had been employed for at least six months (mean = 5 years, *SD* = 4). Every participant had substantial experience in checking labels as part of their professional role as quality controllers. Taking part in the study contributed to the participants' regular working week and, as a consequence, they were paid their basic rate of pay plus travel expenses by their employer when attending laboratory testing. None of the participants had completed a work shift on the same day as testing.

2.1.2 Materials

An EyeLink Desktop 1000 eye tracker (SR Research Ltd., Ontario, Canada) was used to record eye movements. A head-rest, positioned at a distance of 55cm from a 21" colour CRT monitor with a refresh rate of 60Hz, was used to minimize head movement during label-checking. The dominant eye of each participant was identified using the Miles test (Roth, Lora & Heilman, 2002) and was subsequently tracked during the label-checking task. Experimenter Builder (Version 1.4.128 B; SR Research Ltd., Ontario, Canada) was used to control the stimulus events.

On each label-checking trial, seven fields of information were displayed on both the product label and the specification sheet. The number of fields was held constant since differences in visual search performance have been identified in relation to search size (e.g., Drury & Clement, 1978).

A gaze-contingent paradigm was used to present the stimuli, such that the specification sheet was displayed when the participant's eyes were directed at the top half of the monitor screen and only the product label was shown when the participant's eyes were fixated on the bottom half of the screen. Adopting this gaze-contingent approach ensured the real-world label-checking task and the laboratory test were similar in terms of the cognitive processes likely to be involved, in particular by incorporating the need for checkers to shift attention between one source of information and the other whilst maintaining the information in short-term memory.

Scans of 100 fresh produce labels were provided by the packaging company for use as stimuli (see Figure 2). The label itself contained six fields of information, namely the product name, grower, variety, quantity, best before date, and barcode. These six fields were accompanied by a flash label presented to the right-hand side of the label itself, detailing a current promotional offer on the product in question. The label stimuli were scans of existing product labels presented in the standard format belonging to the packaging company's largest supermarket customer. They were displayed at 100% of their original size, which varied depending on the label type (height range = 339–364mm, length range = 411-791mm).

Corresponding fields of information were presented on the specification sheets (for an example, see Figure 3). These were set out in a simplified version of the packaging company's standard spreadsheet format, with one column for each of the seven fields of information and five different products displayed in rows on each sheet.

FIGURE 3 ABOUT HERE

There were two blocks of 50 trials presented in each testing session. In each block, 40 trials were congruent in that the information on the produce label matched exactly that shown on the specification sheet. On a further 10 non-congruent trials, there was a discrepancy in one field between the information displayed on the specification sheet and that which appeared on the produce label (e.g., the specification sheet stating the quantity of plums contained in a punnet as being six but the label stating it as being four). These non-congruent trials thus constituted 10 label "errors" consisted of one barcode error, three quantity errors, two flash label errors, two best before date errors, one variety error, and one grower error. The relative proportions of each type of “error” were based on pack-house error records and reflected the frequency with which each error type had occurred over the 12 months prior to the study taking place. Since task complexity has been found to influence visual inspection performance (Gallwey & Drury, 1986), it was decided to keep the number of “errors” present on any given label constant at one. This had the added benefit of simplifying the instructions given to participants and the nature of the response required from them (i.e., a Yes/No button press was needed instead of a more complex response involving an indication of which, or how many, fields were non-congruent, either through key presses or use of a mouse).

2.1.3 Design

A within-subjects design was used to determine whether there were significant differences in performance between Blocks 1 and 2. If no differences were found, then performance could be collapsed across blocks for subsequent analyses. Measures were taken of accuracy (both overall and for non-congruent trials) and response time.

Two further eye-tracking variables were analyzed for the 20 non-congruent trials only. Firstly, a look-frequency measure indicated the number of times that a participant checked between a label and the specification sheet. Secondly, the number of intervening fixations, i.e., the number of fixations interposed between looking at a non-congruent entry on a label and fixating on the corresponding “correct” field on the specification sheet, was also recorded. The latter variable provided an indication of the extent to which a direct comparison of corresponding items of information was made by the checker, with no other information intervening.

Between-subjects comparisons of the eye movements of the participants with the highest and lowest label-checking accuracy were undertaken to see whether accuracy was linked reliably with eye movement patterns.

2.1.4 Procedure

Full ethical approval was granted by the university research ethics committee at the first author’s institution. The participants gave informed written consent to participate in the study and were tested individually. At the start of the testing session, each participant was provided with detailed information about the layout of the labels and specification sheet, the kinds of labelling errors that might occur, and instructions for completing the task.

Two short practice tasks preceded the label-checking task proper in order to familiarize the participants with the gaze-contingent nature of performance. Firstly, they performed a visual search task in which they were instructed to find specific items of information on the label and fixate on them for one second. There were seven such practice trials to cover the seven items of information on the label. After the visual search task was completed, a second gaze-contingent task was presented. This required the participants again to locate a particular area of the specification sheet and fixate on it for one second. However, the participants had then to find the corresponding item of information on a label, also fixating there for one second. The participants were required to perform this task at 100% accuracy before being allowed to perform the label-checking task itself.

The label-checking task was presented in two blocks of trials, with the blocks interpolated by a range of cognitive tests unrelated to label-checking. Each label-checking trial consisted of the presentation of a specification sheet and a produce label with one or other being displayed on the monitor screen at any given time. The participants were instructed to check the information on the label against the corresponding entries on the specification sheet. They were told that some, but not all, of the labels would contain an error. The participants were asked to decide for each trial, whether or not the same information was displayed on both the label and the specification sheet, indicating whether or not there was an error by pressing a Yes/No response key. The participants were allowed to take as long as they wished to reach their decisions but, in practice, each block of label-checking trials took approximately 30 minutes to complete, with a 60-minute interval between blocks during which the unrelated cognitive tests were completed.

The participants were debriefed at the end of the study.

3.1 Results

3.1.1 Overall label-checking accuracy

A related *t*-test indicated that there was no significant difference in overall percentage accuracy scores between Block 1(mean = 93%, *SD* = 0.06) and Block 2 (mean = 91%, *SD* = 0.06), $t(15) = 1.05$, $p = .312$.

Since no differences in accuracy were found between blocks, the data were collapsed across blocks for all subsequent analyses.

The overall mean response time across both blocks was 21s (*SD* = 6), with a mean number of fixations per trial of 5.64 (*SD* = 1.26).

3.1.2 Detecting label errors on non-congruent trials

The mean rate of error detection was 92% (*SD* = 8).

Response times were, on average, eight seconds faster on trials where the participants failed to detect a non-congruent field (mean = 14s, *SD* = 9) than when they detected it successfully (mean = 22s, *SD* = 5), $t(11) = 3.00$, $p = .012$, $d = 0.87$. The degrees of freedom are reduced since four participants made no errors and, thus, were not included in this analysis (or the next).

A greater number of fixations occurred on non-congruent trials when a non-congruent field was detected (mean = 5.32, *SD* = 1.35) than when it went undetected (mean = 3.78, *SD* = 1.95). This difference in look-frequency was found to be significant, $t(11) = 2.31$, $p = .042$, $d = 0.67$.

3.1.3 Number of intervening fixations as a measure of strategic label-checking performance

Qualitative study of the eye movement recordings indicated that the participants took different approaches to label-checking. Some exhibited a highly systematic checking strategy, taking a serial approach to the task. These individuals tended to check one field of information at a time on the label against its entry on the corresponding specification sheet, making more frequent passes between the two sources of information. Another group of participants showed evidence of picking up information from several fields of information on the label in a single visual pass and checking these against the specification sheet in the same visual pass. A further group of participants exhibited no discernible pattern to their label-checking, appearing to be very haphazard in their approach.

In order to quantify the extent to which performance was systematic, the mean number of fixations that intervened between a participant looking at an “erroneous” field of information on a label and checking the corresponding field of the specification sheet was calculated for each checker.

To determine whether the number of intervening fixations was related to accuracy, checkers whose performance was in the highest quartile for detecting label errors (all of whom had a 100% accuracy rate) were compared with those in the lowest (and, therefore, least accurate) quartile (mean = 81%, *SD* = 6). An unrelated *t*-test indicated that the accuracy of performance of these two groups differed significantly, $t(3.00) = 5.85$, $p = .010$, $d = 1.73$

(Levene's test for equality of variances was significant so a reduced number of degrees of freedom are reported). The eye movement data revealed that the four most accurate performers (mean = 3.46, *SD* = 1.18) made significantly fewer intervening fixations (between the error on the label and the corresponding entry on the specification sheet) compared with the four worst performers (mean = 7.13, *SD* = 2.13), $t(6) = 3.02$, $p = .023$, $d = 1.45$.

3.1.4 Relationships between variables for best and worst performers

There was a significant negative correlation between the number of intervening fixations made on non-congruent trials (i.e., where an error existed on the label) and error detection accuracy, $r(8) = -.758$, $p = .029$. Number of intervening fixations did not correlate significantly with years of experience in label-checking, $r(8) = -.299$, $p = .471$.

4.1 Discussion

Following interviews and observations undertaken at a large fresh produce packaging facility, a laboratory-based study of label-checking behavior was undertaken. The label-checking task was administered to quality control staff employed at that facility and involved close simulations of the processes and materials in use there. Experienced label-checkers were found to vary in the accuracy with which they detected label errors. However, these individual differences were not found to be related to the number of years of experience accrued in quality control checking labels. Instead, accuracy was found to be associated with the extent to which label-checkers adopted a systematic approach to the task, checking one field of label information at a time against its corresponding entry on the product specification sheet.

On non-congruent trials, where the participants failed to detect the presence of a label error, response times were found to be significantly faster, suggesting that the participants might be exiting the visual inspection process before they had determined whether all the fields of information were correct. Observation of the eye movement patterns on the non-congruent trials revealed different approaches. Some participants were found to adopt a systematic approach, determining whether information on the labels matched that on the specification sheet one field at a time. Others were found to chunk information (Miller, 1956), encoding and retaining several items of information from the label in short-term memory before checking them all in the same visual pass against the specification sheet. Yet others failed to exhibit any discernible pattern in their label-checking behavior.

To support these qualitative distinctions in the approach taken to label-checking, an index was devised to quantify the extent to which label-checking behavior was systematic. The number of fixations that intervened between a participant’s fixating on a field of information that contained an error on the label and fixating on its corresponding entry on the specification sheet. This index served to reflect how directly information appearing on the product label was compared with its corresponding entry on the specification sheet. The label-checkers who were most accurate in detecting label errors were found to have made fewer intervening fixations between checking the non-congruent field on the label and its counterpart on the specification sheet. A reduced number of intervening fixations would be consistent with a more systematic approach to label-checking task, in which participants checked one field of information at a time in serial fashion in order to determine whether or not the entries were correct. The use of a more systematic approach to label-checking was not found to be related to the number of years of experience accumulated as a label-checker; rather, it would seem to indicate an individual difference in strategy preference.

Having found evidence indicating that a more systematic approach is likely to yield a greater error detection accuracy, there remains the question as to what it is about checking information serially that confers benefits upon the label-checker. There is likely to be an increased cognitive load (Sweller, 1988) attached to non-structured visual search, in which the checker's eyes tend to "wander about" in search of a relevant item of information. Similarly, committing more than one item of information from the label to memory before checking for accuracy on the specification sheet will increase the memory demands during checking. A serial, one-item-at-a-time approach was found to be most effective in detecting label errors. In highlighting the benefits conferred on checking by systematic search, this finding is consistent with previous research on visual inspection in other real-world tasks (e.g., Koenig, Gramopadhye & Melloy, 2003).

5.1 Conclusions

Professional label-checkers varied in their levels of accuracy in detecting a single difference between the information presented on two sources. Generally, a high level of accuracy was found on the simulated label-checking task. Even so, there was more variation between participants than would be deemed ideal by the packaging facility's management and their supermarket customers, given that a single failure to detect a label error could cost the packaging company tens of thousands of pounds in fines, wastage, and re-fulfilment of the order. On average, response times were faster when participants failed to detect a difference than when they succeeded, suggesting early exiting from the label-check. The results seem to corroborate the interview reports of operatives by highlighting the varying approaches taken to label-checking and the absence of a standard, "trained" method of carrying out quality control checks.

In uncovering individual differences in label-checking behavior and the relationship of these differences to label error detection, it would seem that label-checking should be performed in a systematic, serial manner in order to maximize accuracy. Two means of achieving this present themselves. Firstly, label-checkers could be trained to use a systematic checking strategy, a method used previously in other types of visual inspection task (e.g., Koenig, Liebhold & Gramopadhye, 1998; Nickles, Sacrez & Gramopadhye, 1998). Secondly, behavior could be explicitly guided during search (e.g., Chabukswar, Gramopadhye, Melloy & Grimes, 2003). Preliminary, successful attempts to do the latter through the computer-controlled, serial release of information relating to the search have been reported by Smith-Spark et al. (2015, 2016).

Whilst the current study is important in identifying differences between label-checkers in their accuracy and approach to the task, several limitations should be noted. The label-checking task was a simulation presented on a computer screen rather than requiring interactions with physical media (as would be required in the pack-house) and a higher frequency of errors were present than would be found under real-world conditions. To simulate their true rate of occurrence would have led to a very long experiment so a compromise was necessary to maintain the goodwill of the participants. Secondly, the appearance of errors was limited to a maximum of one per label, whereas in the pack-house multiple errors could conceivably occur on a single label. Thirdly, the number of fields of information presented was limited to seven per trial. In the pack-house, experienced staff would typically check a variety of product labels containing differing numbers of fields. Fourthly, the label-checking task differed from the day-to-day demands of the operatives in that label checks followed immediately after another within each block without breaks. Under typical working conditions, label-checking would be interspersed amongst a range of other duties and responsibilities. Depending upon the timing of the completion of production runs, several label checks might need to be performed one after another but, even at the packaging facility’s busiest, not to the number presented with an experimental block. Fifthly, the question remains as to whether label-checkers would use a particular label-checking strategy consistently over a whole shift; perhaps with fatigue or at busy periods a suboptimal approach might be adopted instead. Given that label-checking is one duty to be performed amongst other responsibilities, there might be less slippage in strategy use than if label-checkers were focused solely on checking labels over the course of a long shift. This is an interesting question but, given the average 9.5-hour duration of shifts, very difficult to explore in a laboratory setting. Finally, it should be recognised that the conclusions drawn from this study are based on a relatively small sample and should, therefore, be treated with corresponding caution. Set against the limitation of a small sample size, however, is the considerable benefit gained from testing professional label-checkers (of whom numbers are limited and the opportunity to test them even more so) on a simulated laboratory task generally complimented by the participants for its verisimilitude.

The current study has provided insights into the performance of quality controllers in detecting errors on fresh produce labels. In particular, strategy use has been found to be more important to label-checking accuracy than the number of years of professional experience accumulated by an individual; this should be taken into account in personnel selection and training. Based on the current data, a label checker is as likely to be an accurate quality control checker of labels when starting as they are after years in the role. Although data were obtained from a relatively small sample, it would seem highly beneficial to product packaging companies to ensure that regular reminders about, and reinforcement of, the optimal method of label-checking are given to operatives. The insights gained from the current study on label-checking accuracy might apply equally to other domains of manufacturing, healthcare, and safety where label error detection is of vital importance to quality assurance.

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Figure 1

The pack-house floor.

Figure 2

An example of a fresh produce label. Like all the stimuli used in the study, this label contains seven bits of information (product name, country of origin, grower, quantity, best before date, barcode, and a promotional ribbon/label).

Figure 3

An example of a specification sheet used in the study. "BB" denotes the best before date.

PRODUCT	COUNTRY	GROWER	QUANTITY	BB	BARCODE	Promotion Ribbon / Label
BABY COURGETTES	EGYPT	GREEN EGYPT	200g	24-Oct	0118 4648	
BABY COURGETTES	SPAIN	AGRO ORGANICS	200g	25-Oct	0118 4648	
GLOBE ARTICHOKE	FRANCE	SICAGRI	250g	25-Oct	0043 4648	
COURGETTES	MOROCCO	BIO TROPIC	300g	25-Oct	0109 1922	
GLOBE ARTICHOKE	KENT, UK	MARK BATCHELOR	250g	25-Oct	0043 7141