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Do Internet Search Engines Support Children's Search Query Construction: A Visual Analysis

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Abstract

From previous studies into children's internet search practice, we gained insight into the taught strategies, children's behaviour and common errors while searching. This paper analyses the visual structure of commonly-used internet search engines (ISE) to explore how their interface and interaction design may influence the search practices of children. Common features of ISEs are identified and the effects of typical children's query construction on the visual presentation of information are reported. We use our observations to provide guidelines for the design and development of ISEs for children.

1 Introduction

Children use internet search engines as their primary information source when searching for information at home and at school (Vanderschantz et al., 2014a). In this paper, we asses how the design of contemporary ISEs may influence the search practices of children. We firstly aim to identify and name common features of search pages and results pages of ISEs. We secondly show the effects of typical children's query construction strategies on the visual presentation of information in a search engine results page (SERP). The findings of our study will assist in providing visual guidelines for the design and development of ISEs for children.

The paper is structured as follows: related literature is discussed in Section 2. Our study setup is described in Section 3, and the results are presented in Section 4. We discuss our findings in Section 5 and develop design recommendations for ISEs.

2 Related Work

Our previous studies with children and teachers (Vanderschantz et al., 2014b; Vanderschantz) explored typical inquiry tasks in NZ classrooms. The children considered in our greater body of work, as well as in this paper, have between aged 9 to 12 years old. Beyond using query keywords, the children are taught to use *Query Qualifiers* (e.g., "facts" and "for kids") and *Query Refiners* (e.g., further topic words or natural language queries). In our studies, children have also been reported to use questions with and without ques-

Table 1: List of queries constructed for testing

ID	Search Query	Construction Consideration	Qualifier / Refiner
A1	Mount Everest	Capitalisation / Spelled out	Broad Initial Keyword
A2	mount everest	Spelled out	Broad Initial Keyword
A3	Mt Everest	Capitalisation / Abbreviation	Broad Initial Keyword
A4	mt everest	Abbreviation	Broad Initial Keyword
B1	Mount Everest facts	Capitalisation / Spelled out	Facts
B2	mount everest facts	Spelled out	Facts
B3	facts mount everest	Spelled out / phrase order	Facts
B4	Facts Mount Everest	Capitalisation / Spelled out / Phrase order	Facts
B5	mt everest facts	Abbreviation	Facts
B6	facts mt everest	Abbreviation / Phrase order	Facts
B7	facts about mount Everest	Natural language	Facts
B8	facts and mount everest	Search operator and / Phrase order	Facts
B9	mount everest and facts	Search operator and / Phrase order	Facts
C1	mount everest for kids	Spelled out	For Kids
C2	Mount Everest for kids	Spelled out / Capitalisation	For Kids
C3	mt everest for kids	Abbreviation	For Kids
C4	for kids mt everest	Abbreviation / Phrase order	For Kids
BC1	mount everest facts for kids	Natural Language	Facts / For Kids
BC2	mount everest kids facts	Phrase order	Facts / For Kids
BC3	facts about mount everest for kids	Natural language / Phrase order	Facts / For Kids
D1	mount everest height	Spelled out	Keyword Refiner
D2	mt everest height	Abbreviation	Keyword Refiner
D3	height mount everest	Phrase order / Spelled out	Keyword Refiner
D4	height mt everest	Phrase order / Abbreviation	Keyword Refiner
D5	mount everest and height	Search operator and	Keyword Refiner
D6	height and mount everest	Phrase order / Search operator and	Keyword Refiner
D7	mount everest size	Spelled out	Keyword Refiner
D8	size mount everest	Phrase order	Keyword Refiner
D9	mount everest and size	Search operator and	Keyword Refiner
D10	size and mount everest	Phrase order / Search operator and	Keyword Refiner
D11	mount everest + size	Phrase order / Search operator +	Keyword Refiner
D12	size of mount everest	Natural Language	Keyword Refiner
D13	height of mount everest	Natural Language	Keyword Refiner
E1	what is the height of mount everest	Natural language	Question Refiner
E2	what is the height of mount everest?	Punctuation	Question Refiner
E3	what is the size of mount everest	Natural language	Question Refiner
E4	what is the size of mount everest?	Punctuation	Question Refiner
E5	how big is mount everest	Natural language	Question Refiner
E6	how big is mount everest?	Punctuation	Question Refiner
E7	how high is mount everest	Natural language	Question Refiner
E8	how high is mount everest?	Punctuation Question	Refiner
E9	how tall is mount everest	Natural language	Question Refiner
E10	how tall is mount everest?	Punctuation	Question Refiner

tion marks, as well as full sentences with conjunctions.

The literature surrounding information search and retrieval by children and adults is varied and dates back to the early web, digital library, and information system implementations. Children's information search studies have included investigations of children searching for printed artefacts, e.g., (Moore, 1995), or using older ISEs, e.g., (Bilal, 2000). Recent investigations have included anonymous log data analysis of information search logs, e.g., (Duarte Torres et al., 2010) and qualitative and quantitative analysis of children's search habits in the home, e.g., (Druin et al., 2010), and our own studies investigating children's information search in an educational setting (Vanderschantz et al., 2014b).

van der Sluis and van Dijk (2010) provided a thorough review of the literature covering children's use of Information Retrieval (IR) systems. Norman (1983) discussed the concept of mental models for the mental pictures that users create as they interact with a system, which may or may not be correct depictions of the system's workings. Bilal (2001) observes that if adults struggle with mental models for IR systems then so do children, who have far less experience with these systems. A widely accepted IR problem for both children and adults is the lack of vocabulary or domain knowledge, which likely creates spelling issues and impedes understanding of the correct use of search interfaces (see, e.g., van der Sluis and van Dijk, 2010; Bilal, 2000, 2001; Kafai and Bates, 1997; Druin et al., 2010). We believe that children's potentially-flawed mental models of ISEs coupled with their well-known vocabulary problems could be further exacerbated by the visual design of both search pages and result lists during Internet search.

We are not alone in our assumption that the adult-oriented ISEs that children use do not suit their information-seeking needs. For example, van der Sluis and van Dijk (2010) report that children require complex knowledge about search and query construction to successfully use ISEs. A common response to the issue are specialised child-centred IR systems (e.g., Druin et al., 2003; Gossen et al., 2012; Lingnau et al., 2010). These systems are often research-based prototypes without ongoing professional support. Furthermore, many commercial child-specific ISEs have disappeared again. We found that no dedicated child-centred systems are used in NZ classrooms.

3 Study Method

We conducted a lab-based study in which a series of child-typical search queries was executed. We selected search engines that would be encountered by children in an educational setting: Google, Bing, and Yahoo!, and Google with Reading Level Filter set to basic. For simplicity, we refer to this setting as a separate, fourth search engine (Google-BRLF).[1] Because children-specific search engines are rarely used in NZ classrooms, these were not included in the study.

Query Construction We aimed to replicate the process of a typical inquiry task in NZ classrooms by choosing a common topic of investigation ("Mount Everest"). When developing appropriate test queries, we applied both query qualifiers and query refiners to our basic search concept (see Table 1). To study the factors that

[1]Google and the Google logo are registered trademarks of Google Inc., used with permission. Bing, used with permission from Microsoft. Yahoo! used with permission from Yahoo!. This declaration holds for all of the content of this paper including text and images used henceforth.

influence the presentation of search results and the impact this will have on childrens ability to use SERPs, we tested multiple variants of five queries A to E (testing capitalisation, abbreviation, keyword vs. natural language (sentences and questions), punctuation as well as search operators 'and and '+). The resulting 43 queries were thus constructed in a way that replicates typical search strategies of children in Years 5 to 8 of NZ schools (approximately aged 9 to 13 years old). We manually entered each of the queries into each of the four search engines and recorded screen-shots of the results as they appeared in the viewable browser area.

Web Browser Set-up We used a Google Chrome web browser on a 27inch iMac computer with a native resolution of 2560x1440 pixels. We ran the searches in Incognito mode of the web browser to reduce the influence of history or cache. No user style-sheets were activated. The viewable area of the browser was 1208 pixels by 1048 pixels. The horizontal position of 1208pixels from the top of the browser window will be referred to as the *fold*. Unless explicitly stated, pages were not scrolled and no screen-shots are recorded from data below-the-fold.

Evaluation Criteria We evaluated the potential impact of the information presentation and the visual features of ISEs on children's search. in particular, we identified graphic and typographic features and discuss their potential impact on childrens ability to read and find information when triaging and searching. We noted differences in search result list orderings, but did not speculate on possible implications of list ordering nor the inherent quality of the returned websites. Our intention was not to reverse engineer the algorithms used by these search engines but to provide insights into the presentation of information to children.

4 Results

Here we report the findings of our visual analysis of the differences in visual presentation and the differences of search result list order that resulted from our query constructions tests.

4.1 Conventions and Definitions

Throughout the rest of this paper, we will use the layout references labelled A to K as in Figures 1, 2 and 3. We identify two categories of visual presentation elements found on search results pages (SERPs) across the four ISEs. *Entry-level units* are the typical search engine results entries (e.g., A). These were found to be very similar across all four ISEs, consisting of title, URL, and descriptor. *Block-level units* are visually separated from other information using techniques such as borders and background colours; we identified pull-boxes (e.g., B, C) and sidebars (e.g., G). Note that we refer only to entries and visual presentations above the fold (see H).

4.2 Search Results Page

Here we discuss the layout and visual presentations of SERPs and outline in detail the use of the visual presentation elements we identified in Section 4.1.

4.2.1 SERP layout & presentation

All four search engines used similar overall SERP layout and we observed strong visual similarities. All ISEs used a left-aligned page layout with top left branding next to the search box (see Figure 1). All four ISEs required scrolling to review the entire SERP list. Google, Google-BRLF and Bing presented a two-column layout, while Yahoo! used a three-column layout.

The two-column layout appeared more visually open and suffered less from crowding. Open and uncrowded SERPs will assist with effective eye paths that will be more beneficial for children who easily become distracted by complex information presentation.

Text Presentation. Google, Google-BRLF and Bing used a white background colour for both the page and sidebars, while Yahoo! had set a light grey background colour for both. Colour is often cited as important for childrens motivation and pleasure, however, foremost in a text-based information seeking environment must be consideration of readability and legibility. The text and background colour contrasts are likely appropriate for readability and legibility for children using these search engines. All four ISEs use a similar number of characters per line to represent their results, a single line of text for titles, and two lines for descriptors. Keywords are displayed in bold in search result titles, URLs, and descriptions. Entry titles appear in blue (see D in Figure 1), URLs appear in green (E in Figure 1), and descriptors in grey (see F) in all four ISEs. Google and Google-BRLF use a slightly taller type height than Bing and Yahoo! for this title text. All ISEs use the same type size for URL and descriptor text (see Table 2 for details). We observe that Google's design creates clearer typographic hierarchy because the difference in text size between title and descriptor text is more prominent. These size differences will likely aid skimming and scanning by children because the larger text creates emphasis and is more visible.

Text spacing is important for leading the eye around a document in an effective and efficient manner (Vanderschantz et al., 2014a). On-screen reading by children is affected by the text size, line-length, interlinear space (i.e., horizontal space between lines) and paragraph space (i.e., space between blocks of text) as well as margins and gutters (i.e., space outside and between blocks of text).

Table 2: Text presentation to assist skimming & scanning

	Google	Google-BRLF	Bing	Yahoo!
Title Colour	Blue	Blue	Blue	Blue
Text Size	15px	15px	13px	13px
Inter-linear Spacing	9px	9px	9px	6px
Inter-Entry Spacing	32px	32px	30px	37px
Underline	x	x	✓	✓
Margin	137px	137px	100px	21px

Text must be large enough for the child to distinguish and identify the shape of words and letters to conduct the complex act of reading and decoding with automaticity (Vanderschantz et al., 2010). Greater space between lines of text, blocks or paragraphs of text and surrounding text is known to improve childrens ability to find the next line of text when reading running text (Burt, 1959). Yahoo! provided the most generous space between SERP list entries, followed by Google and Google-BRLF and then Bing.Google, Google-BRLF and Bing had greater interlinear space between title and URL than Yahoo!. The spacing between lines of text will help with the readability of individual lines and will improve the skimmability and scannability of SERP entries. Both Bing and Yahoo! use underlined text for the titles of each entry. Underlined text further decreases the interlinear spacing and lines of text become harder to distinguish, and reading on from one line to the next is made harder. This difficulty to easily distinguish lines of text will likely result in slower reading for children. Scanning for the ti-

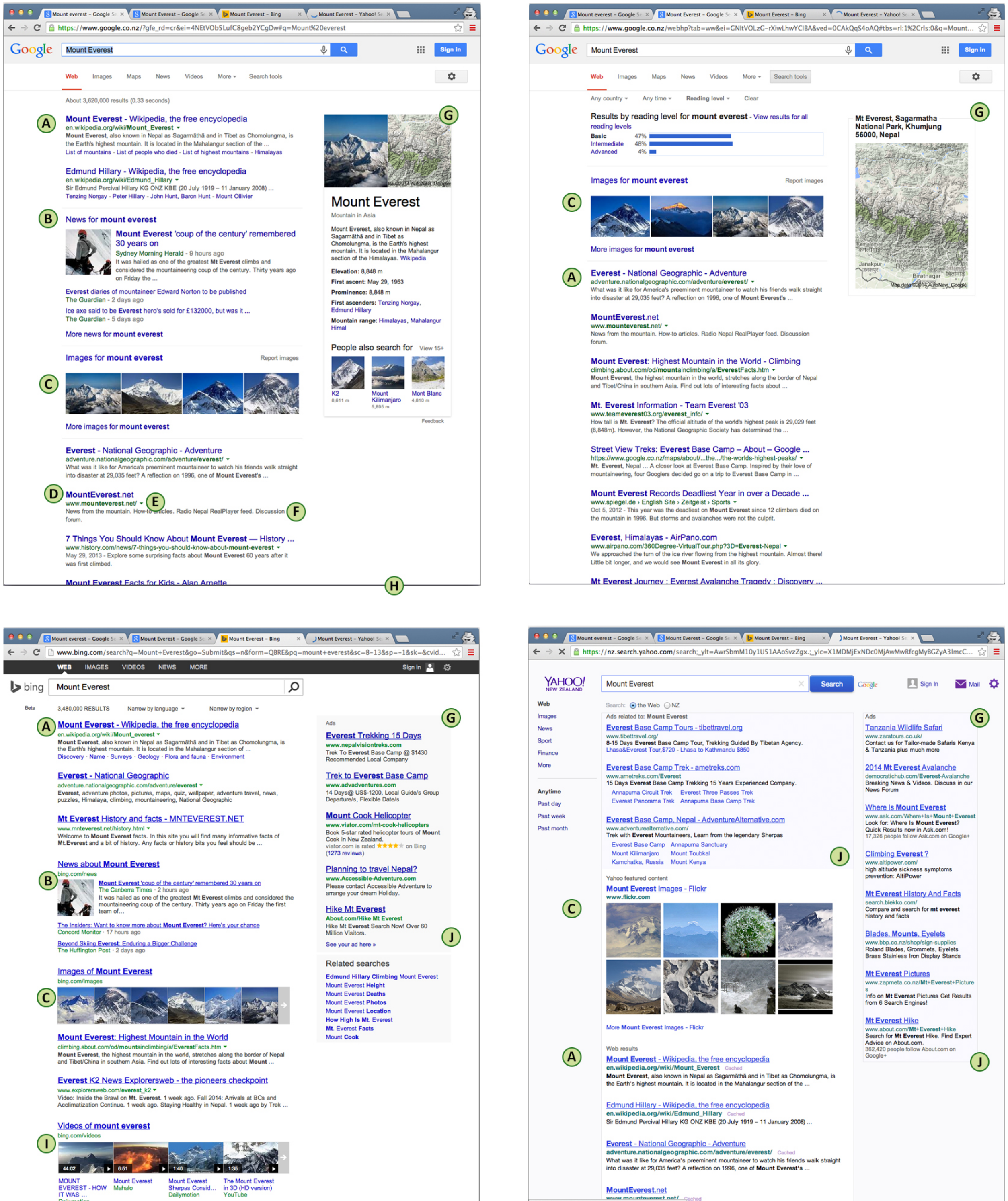

Figure 1: Google (top L), Google-BRLF (top R), Bing (bottom L), Yahoo! (bottom R)

tles of entries will also be less efficient for younger users.

Document spacing, such as margin and gutter spacing is also important for encouraging eye flow and navigation of a document. Margins are the spaces to the top, bottom, and sides of a page, while gutters are the vertical spaces between blocks of text or image information. When spacing is too small, the border between text and its bordering object becomes complex increases reading difficulties. Google had the most generous margin and gutters with Bing providing similar document spacing. Yahoo! was slightly more crowded due to it's left column being used for navigation.

Due to the generous text size of title and interlinear space along with the comfortable space between search entries and the lack of title underline, Google and Google BRLF is likely more scannable for children.

4.2.2 Block-level units

We here describe the location and presentation of the five types of pull-boxes (advertisements, news, images, videos and info-blocks) and the sidebars in the right-hand columns (see Table 3). Page elements that were placed within the run of the results page were identified and named pull-boxes. Often, pull-boxes are encapsulated by a filled or bordered box or used a horizontal rule to separate this content visually from the list entries on the SERP.

Table 3: Block-level units used by ISEs

	Google	Google-BRLF	Bing	Yahoo!
Ad-blocks	x	x	✓	✓
News-blocks	✓	x	x	x
Image-blocks	✓	✓	✓	✓
Video-blocks	✓	✓	✓	x
Info-blocks	✓	✓	x	x
Sidebars	✓	✓	✓	✓

Ad-blocks. When discussing advertising on web pages, one teacher in our interviews in (Vanderschantz) explicitly reported: websites cluttered with advertisements hinder [children] when finding information. This obscuring of useful information, through the inclusion of advertising links, is therefore likely detrimental to successful information search by children. Children are often still learning to skim and scan results pages to identify information of relevance to their search. Advertisements are prominent and often displayed in both Yahoo! and Bing. Google and Google-BRLF did not show advertisements for any of the queries that were tested for this study. For the queries performed, Bing and Yahoo! both showed ad-blocks in Postion 1 of the search result list (see J in Figure 1). Yahoo! returned three ad-blocks in Postion 1 for every search conducted for our study, while Bing only sometimes displayed advertisements. Bing used a light-green background-colour with a grey right-hand border with the title ads in the top right corner. Yahoo! used a light-grey background-colour and the title advertisements related to:. Both Bing and Yahoo! also used the sidebar to show advertisements.

To force advertisements to appear in Google we ran a search query which was not included as a part of the search set detailed in Table 1 for this experiment. We searched for "travel mount everest" and were able to return two advertisements in both Google and Google-BRLF, labelled J in Figure 2. Advertisements in Google appeared in pull-boxes in Position 1. Each sponsored link was marked with a small yellow graphic next to the URL. Pull-boxes for advertisements in Google are separated from the SERP list by a thin grey horizontal rule. When advertisements

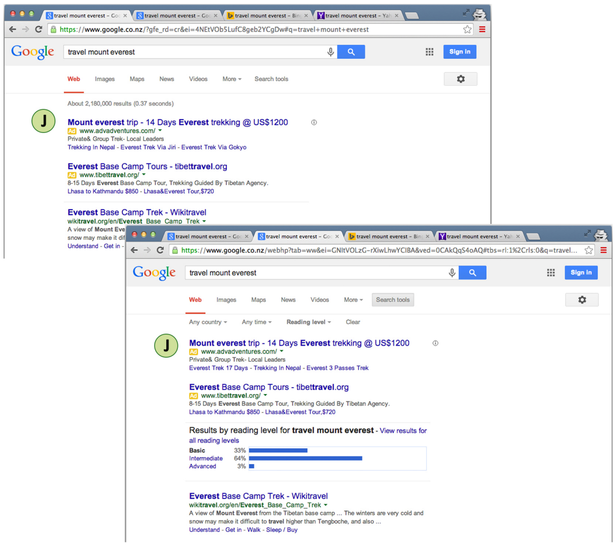

Figure 2: Ad-blocks in Google (T) and Google-BRLF (B)

are present in Google-BRLF, they appear above the reading level filter.

News-blocks. Google was the only ISE that included news-blocks (see B in Figure 1) as clearly marked boxes, while Bing was the only other search engine to include news-blocks (not visually separated from other results list links). Pull-boxes for news items did not appear in Google-BRLF or Yahoo! for any of the searches that we ran.

News-blocks were visually identical to Googles pull-boxes used for images (see C in Figure 1). Google news-blocks were encased in a grey top and bottom border without a coloured background. Google news-blocks often displayed news results at Position 3 or 4. Typically news-blocks contained either a single news item with an accompanying image or 3 news items with only the first news item containing an accompanying image. News-blocks contained a title

Table 4: Visual design of image-blocks.

	Google	Google-BRLF	Bing	Yahoo!
List Position	3 or 4	2 to 4	4	2
Boarder	✓	✓	x	x
Background	x	x	x	x

'News for ...' and each news item entry also included its own title. Google further included a title at the bottom of the news-blocks that read 'More news for ...'.

New-blocks in Bing (see B in Figure 1, bottom left) are not visually separated from content using boxes in the same way that ad-blocks are. However, Bing does increase the space between news-blocks and typical SERP entries by approximately 2 pixels. News-blocks used by Bing, therefore, have 34 pixels of white space before a news-block. It is arguable that news-blocks serve a greater informational purpose than ad-blocks. We do not argue that these news-blocks are unnecessary for the searches that produced them. Similar to ad-blocks, news-blocks may obscure informational SERP links and may be detrimental to the successful information search by children.

Image-blocks and Video-blocks. Image-blocks were included in SERPs by all four ISEs. Google (including Google-BRLF) and Bing presented 4 and 6 images, respectively, in a carousel strip, while Yahoo! presented 8 images in a grid (see Table 4). Google encapsulated image-blocks (see I in Figure 1) with a top and bottom border to visually demarcate these from the run of typical entries. Bing added additional space before and after an image-block to visually separate this from typical entries.

Pull-boxes used for videos (see I in Figure 1) were only noted in Bing and Google (and Google-BRLF). Bing clearly marked a video with a pull-

Table 5: Visual design of video-blocks

	Google	Google-BRLF	Bing	Yahoo!
List Position	6	2	4	-
Boarder	x	x	x	-
Background	x	x	x	-

box containing multiple videos in a strip similar to how Bing displays image-blocks. Google, however, simply included single videos, with a video still as a clickable icon to the left of an Entry. No additional space, background colour or horizontal rule was discernible for pull-boxes used for video-blocks by Google (see Table 5). Image-blocks and video-blocks that are clearly separated from entries are likely to assist with skimming due to their visual differentiation, which creates separation from the skimmable text.

Info-blocks. Google and Google-BRLF were the only ISEs to incorporate a unique pull-box which we have called info-blocks (see K in Figure 3). Info-blocks were noted only when a specific question or recognizable fact was searched for. These info-blocks returned the answer to the question being searched within the SERP and supplied a link to the source website as well as images where relevant.

Sidebars. We observed that the rightmost column in each search engine was used for additional information or additional navigation (see G in Figure 1). These sidebars were used differently by each ISE. Sidebars are potentially very relevant for a child when they contain useful information, for a similar purpose to that seen in the use of info-blocks by Google or as a tool to raise related searches above the fold. All four ISEs bordered their sidebars using solid black or grey lines. Clear demarcation of information areas and generous space between text and visual content will aid childrens reading through

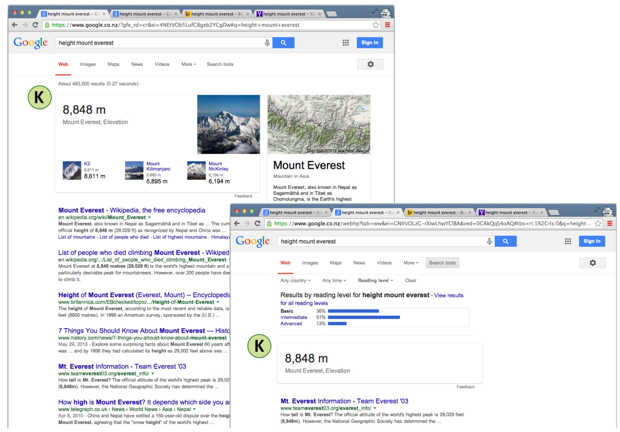

Figure 3: Info-boxes in Google (L) and Google-BRLF (R)

Table 6: Visual design of sidebars

	Google	Google-BRLF	Bing	Yahoo!
Usage	Image & Text	Image & Text	Ads & Rel.Search	Ads
Boarder	✓	✓	x	✓
Background	x	x	✓	✓

minimising features that impact the types of eye movements required for reading.

Google and Google-BRLF used sidebars to list information related to a search. This search-related-information always included an image. Google most often displayed a heading above which was often one or two images. Below the heading was a short list of factual information. The provenance of some of the information is clear and can be tracked by way of the link text provided, while some of the information requires interpretation to track its provenance. When Google-BRLF is used the sidebar, it was only found to include an image, often a map with an informative heading below this as noted with Google sidebars. Images are known to draw the eye as shown by heat-map and eye tracking studies (Beymer et al., 2007; Buscher et al., 2009). Use of images in the sidebar will likely attract the eye of a young user and therefore, increase the likelihood of attention to this area. Google often incorporated images and factual information in the sidebar, which may provide a helpful tool to children.

Yahoo! and Bing both included advertisements in the top-most portion of the sidebar. Yahoo! typically displayed six to eight advertisements while Bing most often displayed three advertisements. Google did not display advertisements in a sidebar for any of the searches that we conducted. Bing included a lower section to its sidebar that was visually separated from the advertisements by a thin white horizontal rule. This lower sidebar contained related-searches. Bings inclusion of related-searches in an above-the-fold and visible location in the sidebar will also assist users with query reformulation. While we did not observe images associated with advertisements in our study, should images be subconsciously associated with advertisements in a sidebar this would have an adverse impact on childrens ability to find information. Eye tracking studies have also shown the existence of the banner-blindness and ad-blindness phenomena, or according to Hervet et al. (2011) more correctly ad-avoidance. Sidebars that do not include images may prove to have a very low magnetism for children and may, therefore, result in scarce eyeflow to this area.

Related Searches. Related searches features of ISEs were investigated because in previous studies the children (Vanderschantz et al., 2014b) and teachers (Vanderschantz) had discussed difficulties the children encounter when reformulating searches when a search query failed to return the desired results. To review the use of Related Searches we did need to scroll the browser to allow assessment of information that was below-the-fold. This mere fact that related searches are demoted to presentation below-the-fold and some distance from the search box may prove detrimental to childrens ability to associate this as a tool for reformulating search queries.

Bing clearly displayed related-searches in the sidebar (above-the-fold), while both Yahoo! and Google placed related-searches at the bottom of the search result list (below-the-fold). Bing also gave secondary related-searches in the lower part of the search result list in a similar manner to Yahoo! and Google. Google-BRLF did not display related-searches for any of our search queries. Related searches were present for all searches in Bing and Google, but not for Yahoo!. For example, we noted that for the query *mt everest*; related-searches were present, however for *mt everest for kids*; no related-searches were given by Yahoo!. When related-searches are not present in a Yahoo! SERP, advertisements are placed in the same space. Related-searches that are above-the-fold will be more readily available to a user, and thus, when these are used in the sidebar they are likely more accessible to children. However, when advertisements are placed in the position that a related-searches have appeared previously (such as noted by Yahoo!) confusion for a child may occur. All four ISEs present the related searches as blue link text and use the words related searches in a title for this page unit.

4.3 Query Construction Effects

Here we consider the influence of query construction on the visual display of the SERP. We observed that minor changes in query construction

Table 7: keyword vs. NL sentences (D3 vs. D13)

	Google (D3)	Google (D13)	Google-BRLF (D3)	Google-BRLF (D13)	Bing (D3)	Bing (D13)	Yahoo! (D3)	Yahoo! (D13)
Entries	x	x	x	x	x	x	x	x
Ad-blocks	-	-	-	-	x	x	x	x
News-blocks	-	-	-	-	x	-	-	-
Image-blocks	-	-	-	-	-	-	-	-
Video-blocks	-	-	x	-	-	-	-	-
Info-blocks	✓	✓	✓	✓	-	-	-	-
Sidebar	✓	✓	-	-	✓	✓	x	x

Table 8: keyword vs. NL questions (D3 vs. E2)

	Google (D3)	Google (E2)	Google-BRLF (D3)	Google-BRLF (E2)	Bing (D3)	Bing (E2)	Yahoo! (D3)	Yahoo! (E2)
Entries	x	x	x	x	x	x	x	x
Ad-blocks	-	-	-	-	x	x	x	x
News-blocks	-	-	-	-	x	-	-	-
Image-blocks	-	-	-	-	-	-	-	-
Video-blocks	-	-	x	-	-	-	-	-
Info-blocks	✓	✓	✓	✓	-	-	-	-
Sidebar	✓	✓	-	-	x	x	x	x

can have significant effects on both result list as well as SERP presentation. Here we present selected results and comparisons to show the effects of different queries. We do not interpret the quality of the search results returned, nor do we interpret the relevance of the results returned to the query submitted.

Keyword vs. Natural Language Queries We consider both natural language (NL) queries and sentences. All four ISEs showed differences in very early entries in the SERP list (often Position 1 or 2) when comparing a keyword search to natural language search. Table 7 shows the comparison between the keyword query *height mount everest* (D3) and the natural language sentence *height of mount everest* (D13). We use the following conventions for comparison Tables 7 to 12: $-$ refers to an element not present in the SERP, X refers to an element present but visually different to the element used in the compared query, and a ✓ indicates the feature was present and visually similar in both queries. Note that in our comparison tables, we always compare different queries for the same search engine, e.g., Google-D3 to Google-D13.

Table 8 lists the differences for the keyword query *height mount everest* (D3) compared to the NL question *what is the height of mount everest* (E2). We observe that in Bing, news-blocks were only displayed for keyword searches, not NL searches. In Yahoo! video-blocks were only used for keyword searches, not NL searches. For our examples D3, D13 and E2, Bing and Yahoo! presented more advertisements for NL searches compared to keyword search. Deeper investigation reveals that when NLS and NLQ were used, Bing and Yahoo! both presented the user more advertisements. As many less confident searchers, like children, often use NL queries, it is of concern that these result in increased advertising. Google and Google-BRLF resulted in the fewest differences when NLQ are compared to keyword queries and do not produce advertisements for these queries.

NL Sentence vs. NL Question Using NL sentences vs NL questions had some impact on the results lists, with the first difference occurring at Position 6 or 7 across all ISEs. Also, NLQ resulted in fewer advertisements than NLS for both Bing and Yahoo!. in Bing only NLS triggered news-blocks or video-blocks. Table 9 lists the differences we identified for the NLS *height of mount everest* (D13), which we compare to the NLQ *what is the height of mount everest* (E2).

Punctuation and Capitalisation. Using question marks, commas, or full-stops showed no visual differences nor did it impact the number of search results returned by Google, Bing or Yahoo!. Using a question mark in Google-BRLF resulted in different entries at about Po-

Table 9: NL sentences vs. questions (D13 vs. E2)

	Google (D13)	Google (E2)	Google-BRLF (D13)	Google-BRLF (E2)	Bing (D13)	Bing (E2)	Yahoo! (D13)	Yahoo! (E2)
Entries	x	x	x	x	x	x	x	x
Ad-blocks	-	-	-	-	x	x	✓	✓
News-blocks	-	-	-	-	x	-	-	-
Image-blocks	-	-	-	-	-	-	-	-
Video-blocks	-	-	✓	✓	x	-	-	-
Info-blocks	✓	✓	✓	✓	-	-	-	-
Sidebar	✓	✓	-	-	x	x	x	x

Table 10: Phrase orderings (B2 vs. B3)

	Google (B2)	Google (B3)	Google-BRLF (B2)	Google-BRLF (B3)	Bing (B2)	Bing (B3)	Yahoo! (B2)	Yahoo! (B3)
Entries	x	x	x	x	x	x	x	x
Ad-blocks	-	-	-	-	✓	✓	x	x
News-blocks	-	-	✓	✓	✓	✓	-	-
Image-blocks	✓	✓	✓	✓	-	-	-	-
Video-blocks	-	-	-	x	-	-	-	-
Info-blocks	x	x	x	x	-	-	-	-
Sidebar	✓	✓	-	-	✓	✓	x	x

sition 7 (queries E1 to E10). Similarly, we found no effects from capitalisation. These results suggest that the use of punctuation or capitalisation will have little bearing on the results returned by search engines and therefore use of these query construction techniques should not hinder childrens ability to find websites to visit from the returned SERP lists.

Phrase Ordering. This refers to the permutation of keywords within the query (e.g., see queries B1 and B3). We observed an effects on the SERP lists of all four ISEs, typically at early positions such as Entry 2 or 3. The number of advertisements changed in Yahoo! but not in Bing (no advertisements in Google and Google-BRLF). The effect of an example phrase re-ordering is shown in Table 10, which compares queries *mount everest facts* (B2) to query *facts mount everest* (B3).

Abbreviations. Table 11 lists the differences when comparing queries with and without abbreviations in broad searches such as *mount everest* (A2) and *mt everest* (A4). Different to the full query (e.g., A2), Google and Google-BRLF did not show any news items for the queries using abbreviations (e.g. A4). This resulted in an increased number of full entries visible above-the-fold. Bing removed news-blocks and video-blocks when an abbreviation was used resulting in more full entries above-the-fold compared to non-abbreviations. Yahoo! produced only differences in the content of the advertising with little perceivable difference in the number of full entries above-the-fold for the abbreviation than for the full spelling.

Table 11: Abbreviations (A2 vs. A4)

	Google (A2)	Google (A4)	Google-BRLF (A2)	Google-BRLF (A4)	Bing (A2)	Bing (A4)	Yahoo! (A2)	Yahoo! (A4)
Entries	x	x	x	x	x	x	x	x
Ad-blocks	-	-	-	-	-	-	x	x
News-blocks	x	-	-	-	-	-	-	-
Image-blocks	✓	✓	✓	✓	x	-	x	-
Video-blocks	-	-	-	-	-	-	-	-
Info-blocks	✓	✓	-	-	-	-	-	-
Sidebar	✓	✓	✓	✓	✓	✓	x	x

Search Operators. Although Boolean search operators such as AND, + and − were not specifically taught to children in great detail, teachers use these in model searches (Vanderschantz). We explored the effect of query operators on searches, see queries D5, D6, D9, D10 and D11. Google and Google-BRLF were not affected by the use of query operators. Bing and Yahoo! displayed more advertising when an operator was used. The content of the sidebars utilized by Bing were different when using query operators, and no news-block was present when a query operator was used.

Query Qualifiers The children in the schools that we studied are taught to use search quali-

Table 12: Query qualifiers (A2 vs. B2)

	Google (A2)	Google (B2)	Google-BRLF (A2)	Google-BRLF (B2)	Bing (A2)	Bing (B2)	Yahoo! (A2)	Yahoo! (B2)
Entries	x	x	x	x	x	x	x	x
Ad-blocks	-	-	-	-	-	x	x	x
News-blocks	x	-	-	-	x	-	-	-
Image-blocks	✓	✓	✓	✓	x	-	x	-
Video-blocks	✓	✓	-	-	x	-	-	-
Info-blocks	✓	✓	-	-	-	-	-	-
Sidebar	✓	✓	x	-	x	x	x	x

fiers such as "facts" and "for kids". Adding these phrases to a query is intended to result in websites whose language or structure are appropriate for, or designed for, children. We explored the effect of query qualifiers on searches to understand their effect. Table 12 lists the differences that between using a broad query with a qualifier 'mount everest facts' (B2) vs the same query without qualifier 'mount everest' (A2). The use of a query qualifier produced noticeable effects in the entry list with changes to the first entry for Google, Google-BRLF and Bing. The addition of qualifiers resulted in both Google and Bing removing news-blocks from their SERP lists. Google further dropped sidebars from the SERP. Bing and Yahoo! dropped image-blocks and Bing also dropped video-blocks. The addition of a query qualifier resulted in more searche results in Google-BRLF being returned that were classified as Basic.

5 Discussion

Query construction influenced SERP list order and the presence or absence of block-level-items (such as news-blocks, ad-blocks, and image-blocks) in all search engines tested as well as the inclusion of pull-boxes and sidebars in Google and Google-BLRF.

There are no closely-related studies with which to compare to our results. However, our research relates to the area of *Visual Aesthetics* (Tractinsky, 2013). Norman (2005) and Leder et al. (2004) discussed how aesthetically pleasing design positively influences both emotional and cognitive processes. Thüring and Mahlke (2007) and De Angeli et al. (2006) provided empirical evidence that aesthetically-considered design of interactive technology can increase users pleasure and engagement. Furthermore, Moshagen et al. (2009); Moshagen and Thielsch (2010) showed that visual aesthetics may improve performance and thereby compensate for usability problems (Moshagen et al., 2009, p. 1317). We view the development of the research area of visual aesthetics as motivation for further development of our research.

In Section 4.2 we identified a number of visual conventions used by these search engines. Little empirical evidence is presently available regarding the effects of these visual features for web searchers or digital information users, and no evidence is reported in the literature regarding childrens use of these visual features of search engines. We would like to see future studies on ergonomics, HCI, and IR that assess the effectiveness of these visual features for children and adults.

In previous studies (see Vanderschantz et al., 2014b; **?**), both children and teachers reported on skimming and scanning behaviour being a necessary feature of children's information behaviour. While eye movement studies to evaluate commercial websites now seem commonplace, we found no empirical studies based on SERPs. Eye movement studies (Beymer et al., 2007; Buscher et al., 2009; Hervet et al., 2011; Kim et al., 2015; Pan et al., 2004) of web pages (differing from web search engines) often show the eye is drawn to visual stimuli such as images and logos. Thus, a future investigation with children could be beneficial to gauge the effect (benefit or distraction) of SERP features such as image-blocks, news-blocks, and video-blocks. We observed that the use of pull-boxes resulted in a decreased number of search result entries visible above-the-fold. Should the number of entries above-the-fold be a contributor to ease of skimming, scanning and information triage by children during search, then the use of these pull-boxes requires further investigation.

In our study reported here, we did not attempted to evaluate the quality of the returned SERP lists nor the effect on quality of results returned by any of the query construction techniques we tested. Naturally, an investigation of the impact of query variation and ISE design on quality of results returned could prove useful to both teachers and information searchers.

In previous studies (see Vanderschantz et al., 2014b; Vanderschantz), children and teachers reported the use of Google-BRLF. Additionally, studies by Bilal (2013) begin to report the effectiveness of the Google-BRLF. At the time of writing this reading level filter feature has been removed from Google and no replacement has been incorporated. We have not identified a similar tool in Bing, Yahoo! or Google to date. Should a similar feature be integrated into a future search engine the use of these features by children requires investigation.

While acknowledging the research insight that is independent of commercial considerations, the rate of technology advancement must be considered during the reporting of such a study. A number of visual design changes have occurred in both Bing and Yahoo! resulting in all four ISEs now having visually open and minimalist SERP designs with a focus on clarity of information presentation. When repeating some of searches at the time of writing (e.g., A4, B2, C3, E1), fewer advertisements are shown and less space is used for advertisement blocks by Bing and Yahoo!. All search engines still display images and videos in pull-boxes, yet in slightly different visual styles. Google is still the only ISE to incorporate pull-boxes for information.

These modifications by the respective manufacturers are further evidence of the rapid change and supports the continual and progressive research into what is required to assist children and adults in searching for information. We believe these design changes by the ISEs do not compromise our findings regarding what is necessary in an ISE for children and how query structure effects SERP presentation, though, is it necessary for the record to acknowledge these advancements by all manufacturers.

6 Summary & Conclusion

In previous studies, we identified typical query construction strategies that are promoted by teachers and used by children in NZ classrooms, see (Vanderschantz et al., 2014b; Vanderschantz). In this paper, we report on the results of a lab-based study that explored the visual presentation of internet search results in ISEs and its implications for children's search.

Visual design and presentation of SERP result link entries was found to be fairly consistent across search engines. We identified visual enhancements to SERP list presentation and observed differences in SERP list orderings. We reported details of the differences created by alternative query structures and phrasing of similar queries. We draw the following conclusions from our study observations:

1. Some query construction techniques may assist with returning result pages that are visually advantageous for children. For example,

- Using abbreviations resulted in more entries above the fold due to fewer news-blocks and less advertising. Abbreviations also appeared produce a larger number of basic results in Google-BRLF compared to the full spelling.

- Use of query qualifiers such as facts and for kids seemed to have overall positive effects on keyword searches by reducing advertising and news-blocks (leading to more results above-the-fold).

2. Design could better support children's information search through the following principles.

- Explicit support for query reformulation would benefit children. Emphasis of alternative query constructions in the form of related searches could be positioned high on the page and clearly for the user to encourage identification of this potentially useful query reformulation tool.

- Non-result-list content needs to be visually different from typical results list links to assist with skimming and scanning. Pull-boxes and sidebars that contain information related to the search query can serve the needs of young searchers by providing useful resources to compliment the websites presented in the search lists.

- Clear visual differentiation of advertising entries compared is required to assist young readers in identifying sponsored links compared to search results. Advertising was used less with natural language queries suggesting these might prove a successful search technique when looking to avoid entries that detract from the search at hand.

- Designers are recommended to visually differentiate sidebars, pull-boxes, and advertising through use of borders, background colour differences, typographic differences and increased white space around these features.

Our work reported here finally identifies the need for further investigations into how the identified interface elements affect childrens information search and how the presentation differences created by alternative query formulations impacts childrens ability to find information.

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