Pictograms: Can they help patients recall medication safety instructions?

Louis Del Re , B.Sc
Dr. Régis Vaillancourt , Pharm D, B. Pharm,
Dr. Gilda Villarreal, PhD, MHA,
Dr. Annie Pouliot , PhD

A B S T R A C T

Objectives: The effectiveness of pictograms to enhance the recall of information through a review of the literature was evaluated. **Methodology:** A search was conducted using "Pictogram" AND "Recall" on PubMed, SCOPUS, and Web of Knowledge databases. Additional searches were conducted on the above-mentioned databases and on Google Scholar using various combinations of key words "pictorial", "picture", "aid", "memory" and "medication". The main inclusion criterion was recall measurement. **Results:** Nineteen articles were analyzed. Ten studies measured immediate/short-term recall; five compared immediate/short-term to long-term recall; and four measured only long-term recall. Eight measured cued recall of pictograms and eleven measured free recall. Three studies failed to support pictograms as means to enhance recall for all subjects regardless of demographic characteristics. Recall abilities of elderly participants were lower than young individuals. Literacy level, education level, prior knowledge, and cultural familiarity are factors that may influence pictogram recall. **Conclusion:** Pictograms enhance patients' recall of information. Professionals using pictograms in healthcare settings should consider 1) educating patients about pictograms; 2) providing patients with pictorial cues; 3) measuring free recall with "true" method; 4) assessing patient's reading, education level, and prior knowledge of pictograms; 5) using text and pictograms; 6) and having special considerations for the elderly.

K e y W o r d s :

Non-verbal Communication, Pictogram, Mental Recall, Visual Aids, Medication, Health Literacy, Health Communication, Review Literature

INTRODUCTION

Difficulties in comprehending medication information often lead to medication errors, misinterpretation of instructions and/or symptoms, and lesser self-care behavior (Bains & Egede, 2011; Wolf, Feinglass, Thompson, & Baker, 2010). Hence effective communication of medication information is key in assuring patients' understanding of their medication regimen and the safe and effective use of their medications. Effective communication of medication information is derived from factors stemming from both the patient and the healthcare provider. Patient factors such as knowledge, literacy, numeracy, cognitive skills, language barriers, beliefs on health, specific health conditions, and socio-economic factors (such as social connectedness, access to health care, age, education, immigration status and employment) influence health literacy and, consequently, communication with healthcare providers (Volandes & Paasche-Orlow, 2007). Factors external to the patient that influence health communication effectiveness are the provider's communication skills, complexity of health information, characteristics of the healthcare setting, system demands and expectations upon patients, as well as time pressures upon health care professionals that may limit the building of a relationship with the patient (Makoul, 2001).

Unfortunately, too many people do not have the necessary health literacy skills to make informed decisions about their health and do not adequately understand health information received from their healthcare provider (Canadian Council on Learning, 2008; Statistics, 2006). One solution identified to support health literacy is to reduce demands placed on individuals (US Department of Health and Human Services, 2008). Pictograms can be used to simplify the process; they are symbols and pictures often combined with simple text to support verbal and written information to help the transmission of health and medication information and support communication between healthcare providers and patients. It is assumed that humans have a cognitive preference for picture-based rather than text-based information (Peter S Houts, Doak, Doak, & Loscalzo, 2006b); however, research on the impact of using pictograms on comprehension and recall has yielded contradictory results. Indeed, some studies have reported no impact of using pictograms on improving health messages comprehension (Friedmann, 1988; Hardie, Gagnon, & Eckel, 1979; Sansgiry & Cady, 1995; Wogalter, Kalsher, & Racicot, 1992).

Recall is the process of retrieving individual words or picture elements from memory and is closely related to comprehension, which is the process of interpreting the meaning of words or pictures to understand their collective meaning (Peter S Houts, Doak, Doak, & Loscalzo, 2006a). Patients with complex medication regimes and with low health literacy levels may have difficulty recalling all verbal instruction from memory (Ley, 1982; Board on Population Health and Public Health Practice, 2013; The Institute of Medicine, 2004). Research shows that patients can only recall 29% to 72% of information they receive, with recall rates decreasing as the quantity of information increases (Sadoski & Paivio, 2000). The aim of the literature review is threefold. First to provide an overview of the literature on the impact of using pictograms to enhance recall of written information. Second to structure the information in such way that research contributions can easily be found and compared to each other. Thirdly to identify challenges and elements that need to be explored in order to further refine knowledge into this area of research.

MEASURING PICTOGRAM RECALL

There is no consensus on the best methodology to measure recall of pictograms. However, the literature shows some common elements in the methodology, which includes presentation of information (either study or training phase) followed by a recall test which may take place the same day (immediate/short-term recall) or later (long-term recall). A recall test may consist of free recall or cued recall. Free recall is repeating information from complete memory, whereas cued recall is repeating information from paired-associate cues such as pictures or pictograms (Peter S Houts et al., 2006b). Both types of tests can be used to measure immediate/short-term or long-term recall. To measure immediate or short-term recall, a distraction phase should occur between the presentation phase and the testing phase. This is to ensure the recall test is measuring memory storage, rather than working memory. Working memory is the ability to store new information, to retrieve previously stored information, and to hold information with awareness (Lesch, 2003a)particularly by the elderly. The studies analyzed in this review measured recall effectiveness of pictograms in different populations, which include young adults and the elderly, high literate and low literate subjects, highly educated and poorly educated subjects, and actual patients.

COGNITIVE THEORIES

The use of pictograms to enhance recall is supported by various psychology theories including Paivio's Dual Coding Theory (the pictorial superiority effect) and Wickens' Redundant Theory. Allan Paivio proposed the Dual Coding Theory in 1971 and has performed many studies to support it (Paivio, Rogers, & Smythe, 2013a). The theory states that information is processed by two coding systems: 1) a verbal system and 2) a nonverbal system. Activation of one system can trigger activation in the other system. Dual Coding Theory also suggests that pictures trigger activation of both coding systems much better than words, resulting in improved recall of information (Sadoski & Paivio, 2000). Recalling information better from pictures than words is known as the "pictorial superiority effect" (Paivio, Rogers, & Smythe, 2013b);

this theory was expanded by Nelson in 1976 (Nelson, Reed, & Walling, 1976). Nelson's experiments suggested that the meaning representations for simple pictures and their labels may be identical, and that the pictorial superiority effect is related to the qualitative superiority of the sensory codes for pictures (Lesch, 2003b; Nelson et al., 1976) particularly by the elderly. The evidence of dual coding provided by Paivio suggests that pictograms with associated text could provide optimal processing and improve recall of medication information.

Similar to Paivio's theory is Christopher Wickens' theory which is based around redundancy. His theory states that words associated with pictures present information in two ways simultaneously, hence redundant communication. Depending on the situation or subject's cognitive preferences, the spatial information depicted by pictures is more effective than the semantic information depicted by words or vice versa. Having both forms of communication (text and pictures) allows an individual to extract information from the presentation method most beneficial for them. Wickens states that redundant communication (pictures and text) enhances recall over text or pictures alone (Wickens, Hollands, Banbury, & Parasuraman, 2015).

MEHTODOLOGY

A narrative review of the literature, informed by Baumeister and Leary, was conducted. This type of review is useful where the aggregation of data is difficult because of the diversity in the field of research (Baumeister & Leary, 1997). A search was performed between September and June 2014 in the databases PubMed (Medline), SCOPUS, and Web of Knowledge and used keywords "pictogram" and "recall" to begin the search process. Due to the small body of medical literature concerning pictograms in healthcare, further searches were conducted on the databases mentioned adding combinations of keywords: "pictorial", "pictures", "aid", "visual aid" or "symbol", "recall", "memory", "medication", "health literacy", and "training". Although these terms are conceptually different, they are often used interchangeably because of the lack of familiarity in the medical literature. We also searched reference lists of included studies and review manuscripts. The relevant literature was selected and presented in this review.

The main inclusion criterion was that the study measured recall of graphic information. Presentation of information via pictures, or a combination of pictures with verbal or written information, followed by a recall test, confirmed that recall was measured. All studies up until September 2014 were included; all relevant articles found were analyzed regardless of publication date. Only English studies were included. Negative findings were also included. The review will discuss studies on pictogram recall in terms of immediate, short-term, long-term, cued and free recall.

Each article included in this literature review was summarized into a broad table, which included three main sections: 1) the article title, year published, and authors' names, 2) study design and methodology, and 3) results. Population characteristics including the sample size (n) and age (range or mean) were collected. In addition, other important characteristics such as education level, reading level, and cultural background were collected if provided in the study. Second, common themes in the study design were identified. The study designs had different variations of the following phases: 1) a presentation phase, 2) a distractor phase (not all studies included a distractor phase) and 3) a recall phase or test. Third, the specifics of each phase were examined, and two key differences between the studies were identified: 1) the length between the presentation phase and recall phase and 2) the type of recall test – cued or free. These two key differences determined the organization of the results section and provided a foundation for the discussion points.

For this article, we considered pictograms as a combination of signs, icons and pictures to represent a story or data set. Where a sign is a visual representation without resembling, an icon represents a specific thing by resembling simply. Finally a picture visually represents a specific thing by resembling specifically (Zender & Cassedy, 2014).

RESULTS

The "pictogram" and "recall" search on PubMed found seven studies, SCOPUS found nineteen, and Web of Knowledge found twenty-nine. From the fifty-four studies found, only three studies were selected. The search of "visual aid" and recall on PubMed found 681 manuscripts. A literature review found in the initial search, plus two additional ones were used to provide background knowledge and references to other relevant studies (Dowse & Ehlers, 1998; Peter S Houts et al., 2006b; Katz, Kripalani, & Weiss, 2006). From the database searches and the studies found through literature reviews, a total of nineteen studies were selected and are presented in this review. It should be noted that not all studies could be accessed.

Ten studies presented measured only immediate/short-term recall, five studies analyzed measured immediate/short-term recall and compared it to long-term recall, and four studies measured long-term recall. Tables 2 to 4 summarize the methodology and findings of the studies included in this review. Due to the heterogeneity in the studies, the findings are presented in a narrative manner.

IMMEDIATE/SHORT-TERM RECALL

Cued Recall

From the immediate/short term studies analyzed, only two studies measured cued recall of pictograms (Carpenter & Olson, 2012a; P S Houts et al., 1998). Subjects who received verbal instructions and a pictogram were able to recall significantly more information when cued with the pictogram than subjects who were required to perform free recall from verbal instructions alone (P S Houts et al., 1998). When attempting to recall foreign words, providing pictures as cues did not improve recall compared to providing English translations as cues. However, warning the subjects presented with picture not to be overconfident resulted in pictures being superior to the English translations as cues for foreign words (Carpenter & Olson, 2012b).

Free Recall

In the majority of immediate/short-term studies, pictograms enhanced subjects recall of information from complete memory. Moreover, free recall was enhanced for subjects when presented with a pictorial aid during the presentation phase compared to subjects who did not receive a pictorial aid (Carpenter & Olson, 2012b; Cherry, Dokey, Reese, & Brigman, 2003a; Kakkilaya et al., 2011; Mayer & Gallini, 1989a; Morrell, Park, & Poon, 1990; Sojourner & Wogalter, 1998; Stewart & Stewart, 2001). However, the benefit of pictures in recalling information is not consistent in all age groups, as pictures with text reduced older subjects' recall abilities (Morrell et al., 1990). In one study, when subjects were presented with pictures and text, subjects freely recalled more information pertaining to the pictures than information within the text (Patel & Others, 1989a). Only one study had negative results in all subjects for using pictorial aids to enhance recall, as no significant difference was found in recall rates between subjects presented with text, text with symbols, or symbols only (King, 2012).

SHORT-TERM RECALL COMPARED TO LONG-TERM RECALL

Cued Recall

Two studies measured immediate or short-term cued recall and compared it to long-term cued recall. Subjects were able to recall a significant amount of information immediately, retain the information over a long period of time, and recall the majority of the information again (P S Houts, Witmer, Egeth, Loscalzo, & Zabora, 2001; Lesch, 2003a). Four weeks after the training phase, subjects were able to recall more information from simple pictograms

Study	Population characteristics N	Other	Method/Intervention	Recall test	Recall rate (% or score correct answer)
Carpenter et al, 2012	254	Undergraduate students	- Subjects in one of four condition groups Group 1: Swahili + picture (cued Swahili word) Group 2: Swahili + picture (free English word) Group 3: Swahili + English word (cued Swahili word) Group 4: Swahili + English (free English word) Presentation Phase: Subjects taught new Swahili word by seeing it paired with its English translation or a picture. Each item presented on computer screen for 6 seconds with one-second interval between. Order was randomized, full list presented twice Recall Phase: subjects were to recall Swahili word from picture or English translation (cued recall- unlimited time), or subjects were to recall English word from memory (free recall- 5 min) by typing answer on computer screen- type of recall test was dependent on condition assigned to subject.	Free and cued recall	Cued Recall of Swahili Word (groups 1 & 3): - No statistical significance Free Recall of English Word: (groups 2 & 4): - Group 2: ~ 51% recall - Group 4: ~ 41% recall * Results show no benefit of pictures for cued recall of foreign words from pictures *Positive results- Increased free recall of English word from picture
King et al, 2012	161	Reading Level: 6th grade or <	Fictional information used to create medication leaflet. Three different formats of the leaflet were made: (1) text only (2) text with symbols, and (3) symbols only. Subjects were given 1 minute to study the leaflet that was randomly assigned to them. Recall test: Subjects completed an 8 item administered questionnaire based on the eight instructions contained in the leaflet	Free recall	(1) text only = 6.54 (2) text with symbols = 6.65 (3) symbols only= 6.36 * Results do not support the use of pictograms
Cherry et al, 2003	96	Young and older adults	Presentation Phase: Subjects were presented with information in one of three different formats: (1) sentence only, (2) sentence with matching pictures, and (3) incomplete sentences with matching pictures. Distractor Phase: 2 minute subtraction test Recall Test: Subjects instructed to answer questions based on symbols and associated text presented. Two types of scoring were used: 1) Strict score and 2) Lenient score. Demographic Questionnaire: given to subjects.	Free recall	* Results support use of pictograms *Young adults recall more information, elaborate sentences were recalled more for lenient scoring in older adults:
Stewart et al, 2001	39	University students	-Subjects were put into 13 groups of 3 -Each subject received package containing 15 shared words, 15 shared pictures, 5 unshared words and 5 unshared pictures. Study Phase 1: Subjects were instructed to study each word or picture for 5 seconds. Recall Test: Subjects given 10 minutes to write down any recalled information with their three-person group. This was repeated twice.	Free recall	Shared words: Recall Test 1: 7.77/15 Recall Test 2: 13/15 Shared pictures: Recall Test 1: 11.15/15 Recall Test 2: 13.92/15 Unshared words: Recall Test 1: 1.54/15 Recall Test 2: 7.31/15 Unshared pictures: Recall Test 1: 5.54/15 Recall Test 2: 10.77/15 * Positive - Shared information was recalled more than unshared information, but unshared pictures were recalled more than unshared words. *Subjects indicated pictures were more easily recalled in the questionnaire
Houts et al, 1998	21	Reading Level = grade 8.7	Presentation/Training Phase: Subjects verbally presented with two sets of instructions on cancer symptom management: Sore mouth 50 instructions; fever 38 instructions. -Pictograms were presented with one set of instructions (cross-over design) Patients were distracted with an 8 min music video and then asked to verbally communicate information recalled.	Cued and free recall	Verbal instructions with pictograms = 84% Verbal instructions alone: 14.2% * Positive- all subjects had higher recall with pictograms
Sojourner et al, 1998	216	Undergrads, Adults, Elders	-Six differently formatted fictitious drug information sheets were created for the same medication instructions. -Sheet contained eight instructions about directions and warnings -Subjects were given medication bottle and 1 of 6 associated drug information sheets (information sheet randomly assigned) Study phase: Subjects given 60 seconds to study sheet and medication bottle Distractor phase: Demographic questionnaire Recall Phase: Subjects wrote down all information relevant to their medication	Free recall	Text alone Mean recall = 9.1 Text + pictorials: Mean recall =7.9 Incomplete pictorials 1: Mean recall = 7 Incomplete pictorials 2: Mean recall = 7.8 Pictorials alone: Mean recall = 4.0 No instructions Mean recall = 0 *Undergraduates had statistically significant higher scores on recall than adults and elderly (ANOVA). *Text and pictorials scored the highest (ANOVA).

TABLE 1.
Immediate/short Term Recall Studies[1]

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Study	Population characteristics N	Other	Method/Intervention	Recall test	Recall rate (% or score correct answer)
Mayer et al, 1990	96	College students	-Subjects completed questionnaire to determine prior knowledge on breaking systems and to classify them into two groups: low prior knowledge and high prior knowledge learners. Study Phase: Subjects randomly assigned to 1 of 4 booklets and given 8 minutes to read. Contained 750 words and 95 idea units on how 4 different breaking systems operate. Distractor phase: None Recall Phase: 3 different recall tests: - Free Recall: 10 min to write down everything they remembered - Problem Solving Recall: 12.5 minutes to answer 5 questions - Verbatim Retention: 3 min to identify exact phrase used in the booklet from a pair of phrases	Free recall	No illustrations: Free recall: 15% Verbatim recall: 24% Diagram with text: Free recall: 17% Verbatim recall: 26% Steps illustrations: Free recall: 21% Verbatim recall: 26% Diagram + steps illustrations: Free recall: 35% Verbatim recall: 43% *In the group of higher prior knowledge learners, no benefit of pictograms was found
Morrell et al, 1990	64	18-22 y.o. (young group) 59-89 y.o. (old group)	-Ten medicine bottles with hypothetical information on label were presented to subject by the investigator ("physician") Subjects received verbal instructions about eight of the ten medicine bottles (random ordering for each subject) in one of two formats: (1) verbal instructions or (2) verbal and pictures. Study Phase: Subjects were given unlimited time to study label and add to perform a subtraction exercise (distraction) before being asked to recall information about the medicine.	Free recall	Verbal instructions: Old group= 45% Young group = 70% Verbal and pictures: Old group= 37% Young group= 86% *Positive results for young subjects, negative results for older subjects
Patel et al, 1990	40	Mothers living in Kenya	Presentation Phase: subjects were presented with instructions on preparing medication for diarrheal dehydration either using (1) 5 pictograms with a brief text, plus original ORT (oral rehydration text) or (2) 5 pictures and brief text as previous group plus revised ORT. Subjects were then instructed to read the instructions aloud and immediately after they were verbally asked to recall any information they could remember.	Free recall	All recalled information was from the pictures and not the text. Mothers recalled procedures for the preparation as in the pictures, but not those presented in the written instructions (original text being more difficult than revised text).
Kakkilaya 2011	89	28 weeks pregnant low income	Randomized study: Prenatal counselling, fetus viability at 23 weeks: counselling with/without visual aids. Distractor phase: none Surveyed for survival chances, disabilities, short/long term problems, resusitation	Free recall	Before/after survival rate difference 1.6±2 (no visual aid) 2.74 ±2.74 (visual aid) p 0.04 NICU longer stay 85 vs 100 (p 0.03) Disabilities recall 2.3 ±1.5 vs 3.2 ±1.1, p 0.005

1 For the purposes of this review, long term is defined as more than one day
2 USP = Standard pharmaceutical pictograms developed by the United States Pharmacopeia

TABLE 1. CONT.

compared to complex pictograms (P S Houts et al., 2001). Explanations of symbols with verbal labels played a key role in enhancing recall. Eight weeks after explanation of symbols with a text label, subjects were able to retain and recall a significant amount of information (King, 2012). Using pictogram elements to create a storyboard concept as a visual cue to aid verbal communication, also showed significant retention and recall of information after three days (Sorfleet, Vaillancourt, Groves, & Dawson, 2009).

Study	Population characteristics N	Other	Method/Intervention	Recall test	Recall rate (% or score correct answer)
Houts et al, 2001	50	Reading level: < 5th grade	-193 pictograms representing actions listed for six problems: fever, sore mouth, nausea, depression, fatigue and how to control spread of HIV/AIDS. - The 193 pictograms included a total 236 actions. -Pictograms ranked by panel of six judges into 1) Simple, 2) Intermediate and Complex categories. 40 ranked as simple, 32 ranked as intermediate and complex and 121 complexity was not agreed upon. Subjects were unaware of the pictogram complexity rankings. Training Phase: Subjects individually taught meaning of 29 standardized parts ("conventions") that would remain consistent in all pictograms. Then the instructor explained meaning of pictograms to each subject. After each problem section, immediate recall was tested. Immediate Recall Test: Each subject asked to verbally describe meaning of each convention and all actions in pictograms. Long Term Recall: 4 weeks later, same recall test was conducted. Pictograms appeared in same order initially taught. Probing questions may have been used by the instructor.	Cued	Immediate recall mean=85% Long term 4 week recall mean = 71% Simple Pictogram mean recall= 87% at 4 weeks Complex Pictogram mean recall= 71% at 4 weeks. -Positive results, people with low literacy are able to retain a significant amount of information over time from pictograms. -Simple equals better recall
Thompson et al, 2010	100	Literacy Can read English Education < High school no prior know-ledge on testing info	Six single page pamphlets containing information on methotrexate was created. -3 pamphlets were pictorial and text base and 3 were prose-based. Study Phase: 1 of 6 pamphlets was randomly selected and given to the subjects. Subject was instructed by interviewer to study the pamphlet for 5 min. Distractor Phase: None Recall Test (immediate): two different types of recall tests conducted: 1) subjects verbally recall as much information as they could remember and 2) answer 20 multiple-choice questions. Recall test (Long-term): Same two tests conducted 7 days later.	Free	Pictorial and text: Immediate recall 1 = 20.45% 7 days recall 1 = 11.65% Immediate recall 2 = 48.15% 7 days recall 2 = 45.55% Text only: Immediate recall 1 = 20.45% 7 days recall 1 = 11.35% Immediate recall 2 = 49.6% 7 days recall 2 = 44.45% *No statistically significant results in recall (in both tests) immediately and at 7 day follow up *Negative results- No benefit of pictorial/text based info over prose based.
Lesch et al, 2003	92	Education 52% high school 38% college 10% grad degrees	-31 warning symbols were tested and trained -10 warning symbols were tested without training - All symbols contained 1 of 3 associated texts (refer to condition method). -Participants were assigned to one of the three conditions Pre-test: Warning symbols shown on computer screen twice: once with correct text and once with incorrect text. Subjects were to indicate "yes" if the correct text was shown or "no" if incorrect text was shown by pressing a labeled key. Training Phase: subjects were shown symbol with its correct associated text label on computer screen. Subjects were to indicate by pressing the "3" key when they were done reading the text to move onto the next symbol. Distractor Phase: Demographic Questionnaire completed by subjects Immediate Recall Test: Subjects were to match symbols with associated text on computer screen. Medium-Term Recall Test: One week later, same test as pre-test Long-Term Recall test: 6-8 weeks later, same test as pre-test.	Cued	Recall Improvement - Old Adults - Pre-test = 37% - Immediate Recall = 68% - Medium-Term Recall = 65% - Long Term Recall= 58% Recall Improvements – young adults - Pre-test= 52% - Immediate Recall= 88% - Medium Term Recall= 83% - Long Term recall= 74% * All Three conditions had similar results *Positive results, supports three theories *Recall of info is maintained over long periods of time
Sorfleet et al, 2009	525	9-61 years old	Storyboard developed to depict medication information using pictograms tested during medical mission to Gabon, Africa. Training Phase: Medication dispensed to subject and researcher using standard script and storyboard to explain how to take medication Immediate Recall Test: At 1st Interview subjects comprehension was tested - explain through oral retelling and answer questions related to storyboard and medication information. Long-Term Recall Test: Same comprehension test given 3 days later.	Cued	Initial interview = 81.5% recall Follow-up = 80.9% recall
Zeng-Treitler et al 2008	13	Not healthcare professionals		Free	

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TABLE 2.
Immediate Short and Long Term Recall Studies[1]

Two studies measured free recall immediately and compared it to long-term recall. In one study, the pictorial enhanced pamphlet did not provide recall benefits over the text-based pamphlet immediately or seven days after the study phase (Thompson, Goldszmidt, Schwartz, & Bashook, 2010a). In a well-designed pilot study with 13 volunteers, Zeng-Treiteler found a statistically significant difference in recalled information of medical discharge instructions when the text was accompanied by pictograms (Zeng-Treitler, Kim, & Hunter, 2008).

LONG-TERM RECALL

Cued Recall

Subjects who received pictogram-enhanced medication labels outlining targeted information were able to recall significantly more information when presented with the pictogram than subjects who had to freely recall verbal and text information four to eight weeks after presentation phase (Wilby et al., 2011a). Cued recall was enhanced in people with less and higher level of schooling (Paulus, Vaillancourt, & Villarreal, 2015) as well as with people of low literacy level (Dowse & Ehlers, 2001) over a two to three week period.

TABLE 3.
Long Term Recall Studies[1]

Study	Population characteristics		Method/Intervention	Recall test	Recall rate (% or score correct answer)
	N	Other			
Wilby et al, 2011	72	HIV Positive Patients Initiating or changing ARV medications *ARV= Antiretroviral Therapy	Randomized control study Training Phase: 5 pharmacists provided verbal counseling on AVR medication. Treatment group also received a pictogram-enhanced label on their medication. Recall Test: Conducted at next follow up appointment. Patients were to verbally recall targeted information about their medication.	Cued & Free at 4-8 weeks	2 % of targeted information correctly recalled (control) 88% of targeted information correctly recalled (intervention)
Dowse et al, 2000	46	South African (Xhosa ethnic group) Literacy 57% poor reading & comprehension level. Education No schooling (19.6%) 1-4 years (26.1%) 5-7 years (55.3%)	-46 pictograms used (23 locally modified pictograms and 23 USP[2] pictograms) -subjects were educated on pictograms' purpose and application -demographic data collected, literacy level assessed First Interview: subjects shown each pictogram, one at a time, in random order, then asked to explain their interpretation of each pictogram. Training Phase: Pictogram meanings explained. ANSI criterion of ≥85%, before and after training (follow-up)	Cued Recall at 3 weeks	Local pictograms: Initial = 30% Follow-up = 87% USP pictograms: Initial = 8.7% Follow-up = 48%
Delph et al, 1996	205	English speaking	Study Phase: Patients in the Emergency Department received instructions pertaining to wound care in one of two formats (text + cartoons or text only) before they were released to outpatient care. Recall test: Patients were contacted by telephone and asked to answer four questions pertaining to wound care.	Free recall at 3 days	Intervention = 46% Text only = 6% <high school education: average 0% correct answers recalled
Moll et al, 1977	50	Gout patients	Study Phase: Subjects given booklet containing information on gout in one of two formats. Cartoon and text format contained 89 cartoons. Recall test: A questionnaire was answered at the next follow up-appointment	Free recall	Booklet with text and cartoons = 65.5 % Text only = 67% No difference between the groups.

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Two studies used free recall to measure the effects of pictograms use to enhance long-term memory. Three days after presentation phase, subjects were able to freely recall instructions from text with cartoons much more effectively then from text alone (Delp & Jones, 1996a). However in a similar study, there were no benefits for subjects who received dually coded information (text and cartoons) over patients who received text only (Moll, Wright, Jeffrey, Goode, & Humberstone, 1977a).

DISCUSSION

CUED RECALL VERSUS FREE RECALL

Before discussing cued and free recall, it should be noted that free recall can be measured from both text and non-text information, whereas cued recall always requires a pictorial aid (with exception to Carpenter's study when recalling foreign words). Providing pictorial cues to recall information has shown to produce optimal rates of recall (Carpenter & Olson, 2012b; P S Houts et al., 1998, 2001; Lesch, 2003a; Sorfleet et al., 2009; Wilby et al., 2011b). The discrepancy between subjects' recall scores was the greatest when comparing cued recall from pictures to free recall of text or verbal instructions. All studies that provided the same pictorial cue in the recall test that was provided in the presentation phase showed beneficial results. Even when subjects were asked to perform free recall, subjects that received a pictorial aid in the presentation phase showed higher rates of recall in the testing phase than subjects who were freely recalling information from text or verbal instructions alone (Beiser & Stewart, 2005; Carpenter & Olson, 2012b; Cherry, Dokey, Reese, & Brigman, 2003b; Delp & Jones, 1996b; Mayer & Gallini, 1989b; Morrell et al., 1990; Patel & Others, 1989b; Sojourner & Wogalter, 1998). However, not all studies that measured free recall of pictograms or pictures showed beneficial results (King, 2012; Moll, Wright, Jeffrey, Goode, & Humberstone, 1977b; Thompson, Goldszmidt, Schwartz, & Bashook, 2010b).

Although studies support the use of pictograms by health-care professionals to increase patients' recall of information, three studies did not verify this conclusion regardless of their demographic characteristics (King, 2012; Moll, 1986; Thompson et al., 2010b). A common factor between all three of these studies is the design of the presentation phase. Subjects were required to study the information by themselves instead of having an instructor educate them. Misinterpretation or an unclear understanding of pictograms during the study phase may reduce the subject's ability to recall information. A training phase ensures that subjects understand the content before recall is tested.

King's et al study analyzed in the immediate/short-term recall section produced negative results for pictures with text presentation format. All formats (text alone, text with symbols and symbols alone) produced similar rates of recall (King, 2012). There are three factors that may explain the results of pictograms not enhancing recall of information. First, free recall was not measured in its "traditional" or "true" way; a multiple-choice questionnaire was given to subjects rather than having subjects recite information to measure their free recall abilities. Second, over simplicity of language in text may have been easily understood by subjects, despite their low reading level of 6th grade or less. If language was more complex, there may have been a greater discrepancy of recall scores between presentation formats. Last, subjects may have been drawing on information from working memory rather than memory storage as there was no distraction phase. Immediate or short-term recall study designs should include a distraction phase after the presentation phase to ensure information has been stored in memory (King, 2012). Similarly, Moll's et al study found non-significant differences in recall rates between text only to cartoons with text pamphlets (Moll et al., 1977b). Two factors that may account for these findings include free recall being measured with a questionnaire, as well as the previous knowledge of the subjects. When completing the recall test, subjects may have been drawing on their previous knowledge to answer questions rather than recalling the information depicted in the pamphlets.

The discrepancy in results may be due to several additional factors. Age, literacy level, education level, prior validation of the pictogram used, prior knowledge and cultural preferences may all influence the understanding and recall of information.

AGE

Age has an influence on overall recall abilities as well as the effectiveness of pictograms for improving recall. In the studies comparing young and old age groups, mixed results were observed. All studies produced positive results supporting the use of pictograms to aid in recall for the young age group (Cherry et al., 2003b; Lesch, 2003a; Morrell et al., 1990; Sojourner & Wogalter, 1998). However, results were inconsistent for the elder population. In regards to elderly subjects, three studies suggested pictograms enhanced recall of medication instructions (Cherry et al., 2003b; Lesch, 2003a; Sojourner & Wogalter, 1998) while one suggested pictograms did not enhance recall in the elderly (Morrell et al., 1990). In the three studies that demonstrated pictorial advantage, a maximum of two sources (pictures and text) of information was presented to the subjects, unlike the study that failed to demonstrate pictorial advantage, where subjects could receive up to three sources (pictures, text, and verbal explanation) of information. This negative result may be explained by the increase cognitive processing required to decode information from text, verbal instructions and pictures simultaneously (Morrell et al., 1990). However, the reason behind the negative result needs to be discerned. Studies show that older people have greater difficulty linking the elements of pictograms to the meaning they are trying to portray (Albert, Wolfe, & Lafleche, 1990; Moore, 2003). Therefore, we can speculate that an unclear understanding of the information presented in pictograms may explain why recalling information from pictograms may be more difficult for older people than younger people.

LITERACY LEVEL, EDUCATION LEVEL, PRIOR VALIDATION OF PICTOGRAM USED, PRIOR KNOWLEDGE AND CULTURAL PREFERENCES

Pictograms significantly increase the recall of information in the low literate and poorly educated populations (P S Houts et al., 1998, 2001; Patel & Others, 1989b; Thompson et al., 2010b). Subjects of higher literacy and education levels may be able to understand and process text more efficiently than subjects who have difficulty reading. This may explain the reason why subjects of lower education and reading level benefit from pictograms more than subjects of higher education and reading level. This benefit is clearly depicted in one study that compared subjects with less than high school education to subjects with high school education or beyond. The discrepancy in recall between text-based and text with pictures was greater for subjects of lower education than subjects of higher education. Lower educated subjects recalled no information from text-based instructions (Delp & Jones, 1996b). Low-prior knowledge subjects will benefit from picture with text much more than high-prior knowledge subjects (Mayer & Gallini, 1989b). Healthcare professionals often communicate to low-prior knowledge patients, which require patients to process new information. However, two studies involving subjects of low reading or education levels do not support the use of pictograms in healthcare (King, 2012; Thompson et al., 2010b). Possible reasons for these negative findings have been partly explained above. Pictogram comprehension was not assessed in these two studies. Furthermore, only three studies mentioned the use of validated pictograms prior to testing recall (Dowse & Ehlers, 2001; P S Houts et al., 2001; Sorfleet et al., 2009). According to Montagne, studies on the impact of pictogram have produced mixed results so far because many of these studies have incorporated pictograms that were never tested for comprehension. It is important to assess comprehension prior to recall as recall of information and comprehension are interrelated. One of the few studies that ensured comprehension before assessing long term recall is by Paulus et al who found that even after comprehension was ascertained, schooling level and country of origin influenced pictogram recall (Paulus et al., 2015).

Education or training on the meaning of pictograms has shown to enhance the recall of information, especially for subjects with low

education and literacy levels (Dowse & Ehlers, 2001; Paulus et al., 2015). Prior to training, the interpretation of pictograms was fairly low in these populations. After educating subjects on the meaning of the pictograms, they were able to retain the information over a two to three week period. Both of these studies demonstrated how important patient education and training is to enhance the recall of health or medication related instructions. Both studies also displayed the cultural preferences that need to be considered. In Dowse's study, subjects were able to recall information from locally modified pictograms more often than the information depicted by the standard United States Pharmacopeia pictograms (Dowse & Ehlers, 2001). Sorfleet's study also reinforced the importance of education and cultural sensitivity. Using a culturally sensitive storyboard concept to aid in verbal communication allowed subjects to understand, retain, and then recall the information three days later (Sorfleet et al., 2009).

DUAL CODING, PICTORIAL SUPERIORITY EFFECT AND REDUNDANT THEORIES

The analysis of all studies in this review suggests that pictures alone are not always ideal for communicating information. The results of studies presented herein were inconsistent in their support for the pictorial superiority effect. When comparing recall using pictures alone to other presentation methods, pictures alone scored lower than text or pictures with text. This suggests pictures alone are not sufficient for subjects to retain information (Sojourner & Wogalter, 1998). However, in some instances pictures alone were recalled more often than text alone (Carpenter & Olson, 2012b; Stewart & Stewart, n.d.). In a study conducted by Patel et al, it was observed that subjects recalled information depicted in the pictures rather than the information provided in the text (Patel & Others, 1989b). From the mixed results observed using pictures alone, it can be concluded that the pictorial superiority effect is not present in all situations. However, the pictorial superiority effect demonstrated dominance when pictures were used in conjunction with verbal communication (P S Houts et al., 1998, 2001; Morrell et al., 1990; Sorfleet et al., 2009; Wilby et al., 2011b).

Pictures with text enhance recall rates most effectively, supporting Paivio's Dual Coding Theory and Wickens' Redundant Theory (Cherry et al., 2003b; Lesch, 2003a; Mayer & Gallini, 1989b; Morrell et al., 1990; Sojourner & Wogalter, 1998) particularly by the elderly. Having information presented in two different forms exposes the subject to the same information twice and allows them to extract the information from the format most preferable and beneficial for them. Although the Dual Coding Theory suggests pictures activate both verbal and nonverbal cognitive systems better than text, combining both formats shows optimal activation of both cognitive systems.

After analyzing the factors that influence recall and evaluating the cognitive theories in the context of pictogram recall, it can be concluded that the most effective means of communication to enhance understanding and recall is using pictures with associated text and verbal instructions. With the advent of newer technologies, including videos accessible through the web and other computer technologies, more options have been explored with good results. One of these is called Project Red, a computer-aided visual and verbal aid to medical information recall (in this case, hospital discharge information). This innovation relies heavily on computer-generated visuals and also incorporates interactive behaviour with a computer-generated avatar who issues information orally and who then tests the patients on their comprehension and recall of the information. This program also showed a lower rate of returning to the hospital within 30 days of discharge for patients taking part in the program (Berkowitz et al., 2013). This relates directly to our first conclusion below, that is, "Training is key".

CONCLUSION FOR PRACTICE:

Based on the results and analysis of the studies in this literature review, six considerations have been proposed to all healthcare professionals when communicating to their patients via pictograms or any pictorial aid.

1. TRAINING IS KEY.

Ensuring patients understand the meaning of pictograms will enhance their recall abilities. Understanding is essential to recall. Although comprehension is rarely assessed when training with pictograms, healthcare professionals should ensure patients understand the medication instructions. Training of pictograms has shown to be superior over self-study in terms of recalling information. All healthcare professionals should provide verbal instructions when using pictograms with or without text to effectively increase recall rates. Do not overestimate the strengths of using pictures; patients need to understand the pictures to recall the information depicted by them.

2. PROVIDE PATIENTS WITH PICTORIAL CUES WHENEVER POSSIBLE.

Cued recall is superior to free recall. If healthcare professionals can provide "take home" pictograms for patients, the likelihood of them recalling the information away from the healthcare setting is greater. Pictorials aids may be useful in any healthcare provider-patient communication situation. For example, pharmacists could provide patients with pictograms for prescription medication instructions.

3. MEASURE FREE RECALL WITH "TRUE" METHOD.

When assessing the effectiveness of pictograms, measure free recalls using the "true" method. That is, have patients recite information depicted in pictograms from complete memory rather than providing them with questionnaires or multiple-choice tests to answer.

4. TRY TO ASSESS PATIENT'S READING LEVEL, EDUCATION LEVEL AND PRIOR KNOWLEDGE BEFORE USING PICTOGRAMS.

Healthcare professionals should attempt to evaluate their patient's background, and support their medical instructions with pictograms when necessary. Healthcare professionals should never assume high literacy, education or prior knowledge. Patients with low literacy, poor education or low prior knowledge have the potential to benefit the most from pictograms. Perhaps the most effective way to increase understanding and recall in these populations is to educate patients with pictograms and only with their particular medication regimen.

5. DO NOT REPLACE TEXT WITH PICTURES, USE THEM TOGETHER.

Pictures with text provide optimal recall rates. Healthcare professionals should combine both formats to allow patients to extract information from the format most suitable for them.

6. HAVE SPECIAL CONSIDERATIONS FOR THE ELDERLY.

Regardless of the presentation format, elderly patients are not able to retain and recall as much information as younger patients. Healthcare professionals should be aware of this when communicating with older patients, especially when using pictograms. Due to the increased cognitive effort required to decode a pictogram, healthcare professionals should spend extra time ensuring older patients understand the information depicted in the pictograms.

FUTURE RESEARCH

After analyzing the literature in this review, the following suggestions are made for future research on pictogram recall:

1. COMPARE GROUPS OF DIFFERENT LITERACY LEVELS.

In some studies, the entire sample consisted of low literate subjects but was not compared to a group of higher literacy. Future researchers should recruit participants, assess their reading level and segregate them into comparison groups. This will allow researchers to observe the discrepancy of pictogram recall between different literacy groups.

2. FOCUS ON CHILDREN.

No studies analyzed in this review assessed pictogram recall in children. Young children are in a critical cognitive development stage with low literacy levels. Assessing pictogram effectiveness of recall on children should be an area of focus. Despite the presence of parents, it is still important for children to be informed and remember information related to their health and clinical symptoms.

3. PROVIDE SPECIAL TRAINING PROGRAMS FOR THE ELDERLY

As observed in studies by Morrell et al, Sojourner et al, Cherry et al, and Lesch et al; elderly subjects have reduced recall abilities. In Morrell's study, pictograms have reversed the pictorial superiority effect all together in the elder population. Research should focus on specific interventions or training of pictograms for the elderly, so they may benefit as much as the younger population.

4. STUDY DESIGNS SHOULD INCLUDE MORE INFORMATION AND MEASURE RECALL OVER LONGER PERIODS OF TIME

Medication regimes can be extremely complex. Most studies analyzed in this review required subjects to recall a low quantity of information compared to quantity of information required in some medication routines. Future research should focus on communicating larger quantities of information as well as measuring subjects recall abilities over longer periods of time.

5. ASSESS COMPREHENSION WHEN STUDYING RECALL.

As recall and comprehension are closely related, it is essential to assess comprehension when measuring recall.

CONCLUSION

Most manuscripts described in this review support the dual coding (text and pictograms), pictorial superiority effect, and redundant theories with respect to pictogram recall. We suggest healthcare professionals should consider using pictograms with text in their daily routines when communicating information to patients. Additionally, when providing the pictograms and text, an instructor should explain the significance of the pictograms and ensure comprehension by asking questions. In order to maximize the potential recall benefits of pictograms, healthcare professionals should pay special attention to patients' age, literacy, health literacy, and familiarity with treatment regimen, as well as ensure comprehension of information when using pictograms in a healthcare setting. Targeted direction toward the impact on patient care from the view of the patient will help implement the appropriate tools in the right patient setting for improved outcomes.

REFERENCES

Albert, M. S., Wolfe, J., & Lafleche, G. (1990). Differences in abstraction ability with age. *Psychology and Aging*, *5*(1), 94–100. http://doi.org/10.1037//0882-7974.5.1.94

Bains, S. S., & Egede, L. E. (2011). Associations between health literacy, diabetes knowledge, self-care behaviors, and glycemic control in a low income population with type 2 diabetes. *Diabetes Technology & Therapeutics*, *13*(3), 335–341. http://doi.org/10.1089/dia.2010.0160

Baumeister, R. F., & Leary, M. R. (1997). Writing narrative literature reviews. *Review of General Psychology*, *1*(3), 311–320. http://doi.org/10.1037/1089-2680.1.3.311

Beiser, M., & Stewart, M. (2005, March 1). Reducing health disparities: A priority for Canada (Preface). *Can J Public Health*. http://doi.org/10.17269/cjph.96.1496

Berkowitz, R. E., Fang, Z., Helfand, B. K. I., Jones, R. N., Schreiber, R., & Paasche-Orlow, M. K. (2013). Project ReEngineered Discharge (RED) lowers hospital readmissions of patients discharged from a skilled nursing facility. *Journal of the American Medical Directors Association*, *14*(10), 736–40. http://doi.org/10.1016/j.jamda.2013.03.004

Canadian Council on Learning. (2008). *Health Literacy in Canada: A Healthy Understanding 2008*. Ottawa.

Carpenter, S. K., & Olson, K. M. (2012a). Are pictures good for learning new vocabulary in a foreign language? Only if you think they are not. *Journal of Experimental Psychology. Learning, Memory, and Cognition*, *38*(1), 92–101. http://doi.org/10.1037/a0024828

Carpenter, S. K., & Olson, K. M. (2012b). Are pictures good for learning new vocabulary in a foreign language? Only if you think they are not. *Journal of Experimental Psychology. Learning, Memory, and Cognition*, *38*(1), 92–101. http://doi.org/10.1037/a0024828

Cherry, K. E., Dokey, D. K., Reese, C. M., & Brigman, S. (2003a). Pictorial illustrations enhance memory for sentences in younger and older adults. *Experimental Aging Research*, *29*(3), 353–70. http://doi.org/10.1080/03610730303720

Cherry, K. E., Dokey, D. K., Reese, C. M., & Brigman, S. (2003b). Pictorial illustrations enhance memory for sentences in younger and older adults. *Experimental Aging Research*, *29*(3), 353–70. http://doi.org/10.1080/03610730303720

Delp, C., & Jones, J. (1996a). Communicating Information to Patients: The Use of Cartoon Illustrations to Improve Comprehension of Instructions. *Academic Emergency Medicine*, *3*(3), 264–270. http://doi.org/10.1111/j.1553-2712.1996.tb03431.x

Delp, C., & Jones, J. (1996b). Communicating Information to Patients: The Use of Cartoon Illustrations to Improve Comprehension of Instructions. *Academic Emergency Medicine*, *3*(3), 264–270. http://doi.org/10.1111/j.1553-2712.1996.tb03431.x

Dowse, R., & Ehlers, M. S. (1998). Pictograms in pharmacy. *International Journal of Pharmacy Practice*, *6*(2), 109–118. http://doi.org/10.1111/j.2042-7174.1998.tb00924.x

Dowse, R., & Ehlers, M. S. (2001). The evaluation of pharmaceutical pictograms in a low-literate South African population. *Patient Education and Counseling*, *45*(2), 87–99.

Friedmann, K. (1988). The Effect of Adding Symbols to Written Warning Labels on User Behavior and Recall. *Hum. Factors*, *30*(4), 507–515. Retrieved from http://dl.acm.org/citation.cfm?id=49570.49580

Hardie, N. R., Gagnon, J. P., & Eckel, F. M. (1979). Feasibility of symbolic directions on prescription labels. *Drug Intelligence & Clinical Pharmacy*, *13*(10), 588–595.

Houts, P. S., Bachrach, R., Witmer, J. T., Tringali, C. A., Bucher, J. A., & Localio, R. A. (1998). Using pictographs to enhance recall of spoken medical instructions. *Patient Education and Counseling*, *35*(2), 83–8. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10026551

Houts, P. S., Doak, C. C., Doak, L. G., & Loscalzo, M. J. (2006a). The role of pictures in improving health communication: a review of research on attention, comprehension, recall, and adherence. *Patient Education and Counseling*, *61*(2), 173–190. http://doi.org/10.1016/j.pec.2005.05.004

Houts, P. S., Doak, C. C., Doak, L. G., & Loscalzo, M. J. (2006b). The role of pictures in improving health communication: a review of research on attention, comprehension, recall, and adherence. *Patient Education and Counseling*, *61*(2), 173–90. http://doi.org/10.1016/j.pec.2005.05.004

Houts, P. S., Witmer, J. T., Egeth, H. E., Loscalzo, M. J., & Zabora, J. R. (2001). Using pictographs to enhance recall of spoken medical instructions {II}. *Patient Education and Counseling*, *43*(3), 231–242.

Kakkilaya, V., Groome, L. J., Platt, D., Kurepa, D., Pramanik, A., Caldito, G., … Davis, T. C. (2011). Use of a visual aid to improve counseling at the threshold of viability. *Pediatrics*, *128*(6), e1511–9. http://doi.org/10.1542/peds.2011-0597

Katz, M. G., Kripalani, S., & Weiss, B. D. (2006). Use of pictorial aids in medication instructions: a review of the literature. *American Journal of Health-System Pharmacy: {AJHP}: Official Journal of the American Society of Health-System Pharmacists*, *63*(23), 2391–2397. http://doi.org/10.2146/ajhp060162

King, S. R. (2012). The Influence of Symbols on the Short-Term Recall of Pharmacy-Generated Prescription Medication Information in a Low Health Literate Sample, *17*(sup3), 280 – 293. Retrieved from http://resolver.scholarsportal.info/resolve/10810730/v17isup3/280_tiosotialhls.xml

Lesch, M. F. (2003a). Comprehension and memory for warning symbols: Age-related differences and impact of training. *Journal of Safety Research*, *34*(5), 495–505. http://doi.org/10.1016/j.jsr.2003.05.003

Lesch, M. F. (2003b). Comprehension and memory for warning symbols: Age-related differences and impact of training. *Journal of Safety Research*, *34*(5), 495–505. http://doi.org/10.1016/j.jsr.2003.05.003

Ley, P. (1982). Satisfaction, compliance and communication. *British Journal of Clinical Psychology*, *21*(4), 241–254. http://doi.org/10.1111/j.2044-8260.1982.tb00562.x

Makoul, G. (2001). Essential Elements of Communication in Medical Encounters. *Academic Medicine*, *76*(4), 390–393. http://doi.org/10.1097/00001888-200104000-00021

Mayer, R. E., & Gallini, J. K. (1989a). When Is an Illustration Worth Ten Thousand Words?. *Journal of Educational Psychology*, *82*(4), 715–26. Retrieved from http://eric.ed.gov/?id=EJ440468

Mayer, R. E., & Gallini, J. K. (1989b). When Is an Illustration Worth Ten Thousand Words?. *Journal of Educational Psychology*, *82*(4), 715–26.

Moll, J. M. (1986). Doctor-patient communication in rheumatology: studies of visual and verbal perception using educational booklets and other graphic material. *Annals of the Rheumatic Diseases*. Retrieved from http://ard.bmj.com/content/45/3/198.short

Moll, J. M., Wright, V., Jeffrey, M. R., Goode, J. D., & Humberstone, P. M. (1977a). The cartoon in doctor-patient communication. Further study of the Arthritis and Rheumatism Council handbook on gout. *Annals of the Rheumatic Diseases*, *36*(3), 225–231. http://doi.org/10.1136/ard.36.3.225

Moll, J. M., Wright, V., Jeffrey, M. R., Goode, J. D., & Humberstone, P. M. (1977b). The cartoon in doctor-patient communication. Further study of the Arthritis and Rheumatism Council handbook on gout. *Annals of the Rheumatic Diseases*, *36*(3), 225–231. http://doi.org/10.1136/ard.36.3.225

Montagne, M. (2013). Pharmaceutical pictograms: a model for development and testing for comprehension and utility. *Research in Social & Administrative Pharmacy : RSAP*, *9*(5), 609–20. http://doi.org/10.1016/j.sapharm.2013.04.003

Moore, T. (2003). Impairment in abstraction and set shifting in aged Rhesus monkeys. *Neurobiology of Aging*, *24*(1), 125–134. http://doi.org/10.1016/S0197-4580(02)00054-4

Morrell, R. W., Park, D. C., & Poon, L. W. (1990). Effects of labeling techniques on memory and comprehension of prescription information in young and old adults. *Journal of Gerontology*, *45*(4), P166–172.

Nelson, D. L., Reed, V. S., & Walling, J. R. (1976). Pictorial superiority effect. *Journal of Experimental Psychology: Human Learning and Memory*, *2*(5), 523.

Paivio, A., Rogers, T. B., & Smythe, P. C. (2013a). Why are pictures easier to recall than words? *Psychonomic Science*, *11*(4), 137–138. http://doi.org/10.3758/BF03331011

Paivio, A., Rogers, T. B., & Smythe, P. C. (2013b). Why are pictures easier to recall than words? *Psychonomic Science*, *11*(4), 137–138. http://doi.org/10.3758/BF03331011

Patel, V. L., & Others, A. (1989a). Comprehending Instructions for Using Pharmaceutical Products in Rural Kenya. *Instructional Science*, *19*(1), 71–84. Retrieved from http://eric.ed.gov/?id=EJ413734

Patel, V. L., & Others, A. (1989b). Comprehending Instructions for Using Pharmaceutical Products in Rural Kenya. *Instructional Science*, *19*(1), 71–84.

Paulus, G., Vaillancourt, R., & Villarreal, G. (2015). Differential comprehension and mid-term recall of pictograms depicting medication instructions by individuals stratified by schooling level: a cohort study. *Submitted for Publication*.

Roundtable on Health Literacy; Board on Population Health and Public Health Practice; Institute of Medicine. Health Literacy: Improving Health, Health Systems, and Health Policy Around the World: Workshop Summary. (2013). In *National Academies Press* (Vol. Jul 10). Washington: National Academies Press. http://doi.org/10.1080/10810730.2011.604392

Sadoski, M., & Paivio, A. (2000). *Imagery and text: A dual coding theory of reading and writing.*

Sansgiry, S. S., & Cady, P. S. (1995). The Effect of Label Content and Placement on Consumers' Understanding of {OTC} Product Label Information. *Journal of Pharmaceutical Marketing & Management*, *9*(3), 55–68. http://doi.org/10.3109/J058v09n03_05

Sojourner, R. J., & Wogalter, M. S. (1998). The influence of pictorials on the comprehension and recall of pharmaceutical safety and warning information. *International Journal of Cognitive Ergonomics*.

Sorfleet, C., Vaillancourt, R., Groves, S., & Dawson, J. (2009). Design, development and evaluation of pictographic instructions for medications used during humanitarian missions. *Canadian Pharmacists Journal/Revue Des Pharmaciens Du Canada*, *142*(2), 82–88. Retrieved from http://cph.sagepub.com/content/142/2/82.short

Statistics, N. C. for E. (2006). The Health Literacy of America's Adults: Results from the 2003 National Assessment of Adult Literacy. Retrieved from http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2006483

Stewart, D. D., & Stewart, C. B. (2001). Group recall: The picture-superiority effect with shared and unshared information. *Group Dynamics: Theory, Research, and Practice,* 5(1), 48.

Stewart, D. D., & Stewart, C. B. (2001). Group recall: The picture-superiority effect with shared and unshared information. *Group Dynamics: Theory, Research, and Practice*, *5*(1), 48.

The Institute of Medicine, U. (2004). Health Literacy: A Prescription to End Confusion - PubMed - NCBI. Retrieved March 18, 2015, from http://www.ncbi.nlm.nih.gov/pubmed/25009856

Thompson, A. E., Goldszmidt, M. A., Schwartz, A. J., & Bashook, P. G. (2010a). A randomized trial of pictorial versus prose-based medication information pamphlets. *Patient Education and Counseling*, *78*(3), 389–93. http://doi.org/10.1016/j.pec.2010.01.010

Thompson, A. E., Goldszmidt, M. A., Schwartz, A. J., & Bashook, P. G. (2010b). A randomized trial of pictorial versus prose-based medication information pamphlets. *Patient Education and Counseling*, *78*(3), 389–93. http://doi.org/10.1016/j.pec.2010.01.010

US Department of Health and Human Services. (2008). *Quick Guide to Health Literacy*.

Volandes, A. E., & Paasche-Orlow, M. K. (2007). Health literacy, health inequality and a just healthcare system. *The American Journal of Bioethics : AJOB*, *7*(11), 5–10. http://doi.org/10.1080/15265160701638520

Wickens, C. D., Hollands, J. G., Banbury, S., & Parasuraman, R. (2015). *Engineering psychology and human performance (2nd ed.).* (Psychology Press, Ed.).

Wilby, K., Marra, C. A., da Silva, J. H., Grubisic, M., Harvard, S., & Lynd, L. D. (2011a). Randomized controlled trial evaluating pictogram augmentation of HIV medication information. *The Annals of Pharmacotherapy*, *45*(11), 1378–83. http://doi.org/10.1345/aph.1Q091

Wilby, K., Marra, C. A., da Silva, J. H., Grubisic, M., Harvard, S., & Lynd, L. D. (2011b). Randomized controlled trial evaluating pictogram augmentation of HIV medication information. *The Annals of Pharmacotherapy*, *45*(11), 1378–83. http://doi.org/10.1345/aph.1Q091

Wogalter, M. S., Kalsher, M. J., & Racicot, B. M. (1992). The Influence of Location and Pictorials on Behavioral Compliance to Warnings. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *36*(13), 1029–1033. http://doi.org/10.1177/154193129203601324

Wolf, M. S., Feinglass, J., Thompson, J., & Baker, D. W. (2010). In search of "low health literacy": threshold vs. gradient effect of literacy on health status and mortality. *Social Science & Medicine (1982)*, *70*(9), 1335–1341. http://doi.org/10.1016/j.socscimed.2009.12.013

Zender, M., & Cassedy, A. (2014). (Mis)understanding: Icon Comprehension in Different Cultural Contexts. *Visible Language*, *48*(1), 69. Retrieved from https://www.questia.com/library/journal/1P3-3382869221/mis-understanding-icon-comprehension-in-different

Zeng-Treitler, Q., Kim, H., & Hunter, M. (2008). Improving Patient Comprehension and Recall of Discharge Instructions by Supplementing Free Texts with Pictographs. *{AMIA} Annual Symposium Proceedings*, *2008*, 849–853. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2656019/

Authors

Louis Del Re graduated from the University of Ottawa in 2014, with an Honours Bachelor Degree in Health Sciences and Minor in Business Administration. During his final year of university, Louis became intrigued by the research conducted at the Children's Hospital of Eastern Ontario (CHEO) Research Institute (Pharmacy Department), regarding patient education and communication. His research experience at CHEO and interdisciplinary education in health, science and business, sparked an interest in the business world of medical communication. Louis kick started his career in May of 2014, joining the client services team at FCB Health (Toronto), a pharmaceutical advertising agency.

Dr. Régis Vaillancourt is a Clinical Investigator at the CHEO Research Institute, and the director of the Pharmacy department at CHEO. He is a specialist in the field of pharmacy and has been extensively recognized through numerous awards and appointments, such as being named the Canadian Pharmacist of the Year (2004) and being awarded the Order of Military Merit by former Governor General Adrienne Clarkson. Dr. Vaillancourt has been published extensively in different areas of pharmacy practice, with a focus on health literacy. His degrees/designations include: OMM, CD, B.Pharm, Pharm D, FCSHP.

Gilda Villarreal, PhD, MHA, combines a Masters in Health Care Administration (Ottawa University) with PhD in Biomedical Sciences (Faculty of Medicine, Universidad Nacional Autónoma de México). Her post-doctoral fellowship was done at the National Institutes of Health, in Bethesda, Maryland under the supervision of Dr. Sharon Wahl. Gilda's interests are in knowledge translation and research metrics. She currently works at the Ottawa Hospital Research Institute.

Annie Pouliot earned a Master's degree in community health & epidemiology focusing on health in developing countries and a PhD in population health with a focus on health discourse, power relationships in health promotion and communication. In her capacity as a research manager she supports the development of research initiatives within the department of pharmacy, provides guidance to pharmacist conducting research. Present research interests include pediatric health literacy, medication literacy, health education and communication, qualitative evidence mapping and rapid review methodologies.