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Iranian Journal of Language Teaching Research

Urmia University

Are scientists objective? An investigation of appraisal resources in English popular science articles

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ABSTRACT

With the increasingly growing technological advances and their consequences for societies, the public has the right to be engaged in the outcomes of science. On the one hand, the public are interested in acquiring information about the results of scientists' experiments. On the other hand, the scientists are willing to share their feelings about their discoveries with the public in order to achieve wider audience. These all have prompted popularizing of science within the last few decades. The current study aimed to explore the frequency of evaluative resources of Appraisal in English popular science articles (PSAs hereafter) in the field of Nutrition. A total of 40 English popularized articles published in four popular sources, *WebMD*, *Better Nutrition*, *Science Daily*, and *New York Times*, were analyzed in terms of three main categories and subcategories of Appraisal Theory. The results of the analysis revealed that authors used more Attitude resources followed by Graduation and Engagement resources. With regard to subcategories of three main categories, the authors of English PSAs included more cases of *appreciation*, *force*, and *heterogloss* resources. The findings indicated that the authors of PSAs tend to insert their feelings about their discoveries through employing Appraisal resources. The results might be used to embed Appraisal resources in EAP materials in order to equip the would-be scientists with a helpful tool to meet the expectations of another group of their intended audience, i.e. general public, in addition to fulfilling the requirements of their academic discourse community.

Keywords: Appraisal Theory; attitude; engagement; graduation; popularization

ARTICLE HISTORY

Received: 28 Apr. 2016 **Revised version received:** 26 June 2016

Accepted: 1 Dec. 2016 **Available online:** 1 Jan. 2017

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Introduction

Individuals are exposed to a bulk of knowledge about science and technology and no one can deny significance of being scientifically literate for citizens (Miller, 2004). Indeed, with the increasingly growing technological advances and their consequences for societies, science plays a more important role in improving human's life.

Scientists publish their scientific findings in the form of academic papers as "the main vehicle … to make new knowledge" (Russell, 2010, p. 54). These scientific products are understood and endorsed by the scientists, who are well-trained to read and write the professional products. At the same time, the public has the right to be engaged in the outcomes of science. It is actually the need for scientific, technical, and societal development (Ren & Zhai, 2010) that necessitates "translation of scientific issues into contexts that mean something to audiences" (Russell, 2010, p. 88) in order to make professional communication of science to the public a realistic goal.

Not only the public's interest and the need for recent scientific findings but also the scientists' willingness to share their feelings about their scientific experiences and ideas (Ben-Ari, 1999) and achieving wider audience (Ren & Zhai, 2010) have prompted popularizing of science within the last few decades. Informing public of the recent outcomes of scientific efforts would build trust in scientists as "sources of information" (Turney, 1996, p. 1087) and introduce science as "a social construct" shared by various groups with various interests (Hyland, 2010, p. 118). These all have recently given rise to the intensity of science communication on a global scale (Bucchi, 2013) and forced the scientists to make efforts to relate science to public's practical needs.

Professional and popular texts tend to represent science differently as the readers' and writers' worlds are different and the target audience lacks the relevant professional and semantic knowledge (Bowler, 2009). Scientists require numerous skills to have informed choices regarding both the content and mode of presenting information (Bowler, 2009). They should provide new ideas and techniques to those people who may lack the required technical knowledge. While research articles target experts in a field, popular science articles attempt to provide a user-friendly account of the scientific outcomes which is easily understood by the non-expert and lay audience. They serve different communicative purposes in which the authors employ a specific set of linguistic features (Martin, 1992). This is what necessitates scrutinizing the circulation of knowledge in a variety of settings (Calsamiglia & Ferrero, 2003). In both academic and PSAs, writers strive "to inform and persuade readers of the truth of their statements" (Harris, 1991, p. 289) achieved through evaluative language use (Martin & White, 2005), which can be explored through Appraisal theory. Appraisal theory tries to explore, describe, and explain how language is employed to evaluate (White, 2014) and allows for studying the interpersonal meanings (Lee, 2006) through unfolding the application of three main domains, including Attitude, Engagement, and Graduation.

With this in mind, the current study strived to see how the interaction between the author and reader was linguistically managed through employing evaluative resources of Appraisal in English popular science articles. On the other hand, as Lievrouw (1990) rightly mentioned, all scientific discoveries are not worth being popularized and only those relevant ones that establish a link between science and practical needs should be included in order to pave the way for enhancing the public's scientific literacy (Ren & Zhai, 2010). In this sense, nutrition as a sub-domain of medicine was selected as this field entails both concern for practice and factual/speculative knowledge and addresses an audience with a variety of needs and interests (Giannoni, 2008). Hence, the study aimed to see how frequently the Appraisal resources were used in English PSAs in the field of nutrition.

Literature Review

Science Popularization

Science and technology has shadowed human's daily lives in numerous ways (Sapp, 1995). This has led to the emergence of science communication and popularization but modern science communication and popularization has its root in twentieth century (Ren & Zhai, 2014). The growing advances in science and technology have brought about enormous changes in the way science, technology and society are related. On the other hand, new communication technologies, e.g. the Internet has given science communication and popularization much more prominence than ever (Ren & Zhai, 2010). In the twentieth century, broadcasts, newspapers, and journals came to play a key role in popularizing science and enhancing public's scientific literacy. Nevertheless, although print media have always been pioneers, the advent of digital communication tools has facilitated the transfer of information and provided remote locations with access which, in turn, resulted in broadening the scope of communication.

In this regard, science communication and popularization as "a social phenomenon" (Ren & Zhai, 2014, p. 2) is responsible for providing the public with the knowledge of communities which are the producers and owners of knowledge (Giannoni, 2008). It is a process which leads to the circulation of scientific ideas in the everyday discourse. Indeed, Ren and Zhai (2014) pointed out that public is the basis on which science popularization has emerged and grown. Moreover, scientists themselves feel enthusiastic to share their work in public terms (Ben-Ari, 1999). They try to provide the public with the implication and application of their research findings in the real-world context and express their personal feelings about their studies. On the other hand, Russell (2010) holds that lack of scientific information among public urges the scientific community to provide them with facts and theories through all existing media and opportunities. This urgent need led the rhetoric of science communication to leave their focus on understanding and turn their attention to engagement (Russell, 2010). However, science communication is not as simple as it might seem "as it requires a shift between two different types of discourse" (Giannoni, 2008, p. 213). PSAs entail recponstructing the scientific information discursively for non-academic audience.

As "a social phenomenon" (Ren & Zhai, 2010, p. 2), popularization of science has attracted enormous attention due to its determining role in enhancing the public's literacy and a large number of scholars have viewed it from different angles. Nwogu (1991) analyzed the discourse structure of the journalistic version of research articles through an expanded version of Swales' (1981) approach to the analysis of genres and identified a schematic structure projected by *pragmatic conditions* e.g. audience, purpose, and medium of discourse. To this end, a popular science magazine (*The New Scientist*), a general interest magazine (*Newsweek*), and a leading British newspaper (*The Times*) were selected. The analysis of the texts demonstrated that journalistic version of research articles mostly included these types of information: a brief statement which functions to provide some background to the problem, an indication of the main research problem followed by the limitations of previous efforts at resolving the problem, introducing the researchers who conducted the study and what they set out to achieve, reporting some of the positive results obtained, explaining some of the methods used in the collection of data, a description of the methods used in the experiments, some discussions and explanations of specific research outcomes, a statement of the main conclusion of the research report and its implications to the target audience.

Some years later, Miller (1998) compared the application of visual elements in academic and popular texts through systematic linguistic concepts of interpersonal, ideational, and textual metafunctions. The findings illustrated that visual elements in academic texts would play the informative and persuasive role as they provided the readers with immediate access to information

while they were mostly luxurious and sometimes explanatory in popular texts. In other words, visuals were not as much embedded as they were in academic ones.

In another study, trying to reveal the possible differences between popularized and academic articles, Varttala (1999) explored the application of hedging devices in a corpus of 15 academic research articles and 15 PSAs in the domain of medicine and found similar results to those of previous studies in which hedges were considered as a common feature of scientific texts. However, the findings of this study revealed that hedging devices were typically employed by science popularizers of medical research. He discussed that the use of hedges in popularized texts might be attributed to the authors' tendency to provide the readers with a clear picture of the presented information. Hedging may be also used to gear the scientific findings to the non-specialist readers' background.

Moreover, looking at popularization through a pedagogical lens, Parkinson and Adendroff (2004) reported a study in which the application of PSAs in teaching scientific literacy was examined. They used popularized science texts as reading material in a course of English for specific purposes, *Scientific Writing*, which aimed at including factual genres and writing practice. They argued that although PSAs cannot act as a model for scientific writing, they provide the students with access to science. The researchers found that merely using popularized texts as a model for the students would lead to their extreme focus on human participants and use of active voice. They would also cite the work of other scholars in non-academic style. Hence, it may endanger the students' academic writing while it is considered as a valuable source to be used in science classes since popular texts take advantage of simpler concepts.

In another study, Gallardo (2005) analyzed the type of supportive utterances for recommendations in 52 popularized medical texts published in two Argentinian newspapers both quantitatively and qualitatively and found a high proportion of supporting functions formed as a direct question of the specialist's voice. These questions aimed to make the readers embrace the communicative purpose. Indeed, the presence of justification as a subtype of acceptance function seems inevitable in medical texts as it allows ensuring that advice was accepted on the part of the audience.

Moreover, Giannoni (2008) tried to investigate the generic features of popularization in 40 editorials in medicine and applied linguistics and found such popularizing features as personalization, contingency, and humor. One striking feature of popularization was "appeals to the reader" (p. 225) in which the authors utilized numerous expressions to call for the reader's involvement in the discourse. The authors did this through including second-person pronoun or an imperative verb. In medicine, the authors' appeals to the reader were represented in the form of advice while it was in the form of requests in applied linguistics.

In addition, Hyland (2010) analyzed a corpus of texts of two different genres, research papers and popular science articles to identify how writers transfer their expertise and interact with the readers of different degrees of expertise. He concluded that journalistic version of research articles is written in a way that allows non-specialist readers to access the research findings. He stated that in popular science, *proximity* results from providing non-specialist audience with accessible research findings.

More recently, Riesch (2014) also referred to the beneficial application of humor in public discourse about science and scientific communication as it bears useful learning effects on informal science education as well as wider social functions. Furthermore, Estrada and Davis (2015) referred to the significant role of images in communicating scientific outcomes. They revealed that visual elements were usually used as an appendix rather than as an inseparable part of the popularized texts. Moreover, they understood that visual communication did not target a specific group of audiences.

They drew this conclusion that taking advantage of both theoretical and practical concerns of the discipline of design would be beneficial in improving the quality of science communication.

Appraisal Theory

Appraisal Theory is related to previous works on evaluation (Martin & White, 2005). It fundamentally relates to the concept of evaluation that Hunston and Thompson (2000, p.5) defined as "a broad cover term for the expression of the writer's attitude or stance towards, viewpoint on, or feelings about entities or propositions that he or she is talking about." Appraisal Theory allows for a "comprehensive study of evaluation that represents the construct as more than the contribution of one or more specific grammatical resources, or even as the sum of a range of grammatical parts" (Hood, 2004, p.49).

Appraisal Theory encompasses three main categories: Attitude, Engagement, and Graduation. Martin and White (2005) define them as follows:

> ATTITUDE is concerned with our feelings, including emotional reactions, judgments of behavior and evaluation of things. ENGAGEMENT deals with sourcing attitudes and the play of voice around opinions in discourse. GRADUATION attends to grading phenomena whereby feelings are amplified and categories blurred (p. 35).

Attitude is a "system of meanings" for expressing feelings and entails three semantic areas, traditionally referred to as emotions, ethics, and aesthetics and includes three main categories: 1) *affect* includes "resources for constructing emotional reactions" (Martin & White, 2005, p. 35), and "emotional response e.g. *like*, *fear*" (White, 1998, p.75), 2) *judgment* is concerned with "attitudes towards behavior, which we admire or criticize, praise or condemn" (Martin & White, 2005, p.42) and includes "evaluation of human behaviors e.g. *corruptly*, *skillfully*" (White, 1998, p. 75), and 3) *appreciation* entails "evaluation of semiotic and natural phenomena" (Martin & White, 2005, p.43) and "evaluation of entities e.g. *beautiful*, *striking*" (White, 1998, p. 75).

The second main category of Appraisal Theory is Engagement which encompasses "negotiating heteroglossic diversity (*perhaps, it seems, he says, I declare, however, obviously, etc.)*" (White, 1998, p. 75) and provides "resources for negotiating various convergent, alternative and counter socio-semiotic realities or positions activated and referenced by every utterance" (p. 78). Generally speaking, *monogloss* utterances leave no space for other viewpoints while *heterogloss* ones embrace alternative voices (Martin & White, 2005).

The third main category, Graduation, focuses on resources "for scaling interpersonal force for sharpening/blurring the focus of valeur relationships (*very, really, sort 'v, somewhat*)" (White, 1998, p. 75) and covers lexicogrammatical resources which are used to strengthen or soften one's *judgment* and *appreciation*. According to Martin and White (2005), it is divided into two categories: *force* and *focus*. *Force* entails "grading according to intensity or amount" and *focus* encompasses "grading according to prototypicality and the preciseness by which category boundaries are drawn" (p. 137).

Since its establishment, Appraisal Theory has been taken as the point of departure for analyzing various genres of discourse. The written discourse of key learning areas was examined in secondary education (English, history, science, mathematics, and geography) and the discourse of workplace (the science industry, media, and administration) (Coffin, 1997). Taking the Appraisal Theory as the point of departure, Coffin found that students' use of Appraisal resources would enhance their grades. Indeed, the students should be enabled to examine the value *judgments* and how they are embedded in the text in order to promote their grades.

Page (2003) analyzed childbirth narratives in terms of Appraisal resources which revealed the variation of storytelling styles across male and female participants. Women's narratives were more personalized and carried higher extent of interpersonal involvement than those of their male counterparts. In addition, men and women used different numbers of *judgment* resources. The number of *appreciation* and *affect* resources was not the same in male and female participants' narratives either. In spite of the variation caused by the participants' gender, Page asserted that cultural context plays a pivotal role and should be considered to explore the possible relationship between gender and linguistics forms more deeply.

Moreover, Hyland and Tse (2005) explored the frequency, form, and function of the use of evaluative "*that*" in 465 abstracts as a contributing structure to thematization of attitudinal meanings and found high frequency of this structure. They concluded that making use of evaluative "that" in abstracts allows the writers to manage their discourse and to explicitly present the evaluations of their material. Tutin (2010) also analyzed various text types, research articles, theses, and coursebooks in the fields of humanities and social sciences considering the evaluative objectives. The findings revealed the writers' higher tendency toward not using very subjective evaluation in scientific writing.

In addition, Babaii (2011) examined a corpus of book reviews published in prestigious physics journal in terms of Appraisal framework and revealed the application of personal comments, mockery, sarcasm, and unhedged and blunt criticism. The findings of her study called the hard science claims for objectivity into question as some physics scientists hardly ignored the weaknesses of specialized books.

The existing gap and research questions

Academic RAs and PSAs present different views of science (Myers, 1990) and serve different communicative purposes (Martin, 1992). As the review of related literature on the application of Appraisal framework revealed, Appraisal resources have been explored mostly in academic genres and subgenres including abstracts, RAs, theses, books, and book reviews (Babaii, 2011; Coffin, 1997; Hyland & Tse, 2005; Page, 2003; Tutin, 2010). As regards popularization of science, most studies have touched upon various tools to enhance the quality of popularization process (Estrada & Davis, 2015; Miller, 1998; Riesch, 2014) and its pedagogical implications (Parkinson & Adendroff, 2004). Few studies have focused on analyzing popular texts (Gallardo, 2005; Giannoni, 2008; Nwogu, 1991) and unfolding the similarities and differences between ARAs and PSAs (Varttala, 1999; Hyland, 2010).

The huge bulk of research on Appraisal resources and science popularization notwithstanding, an obvious gap seems to be left considering the frequency of evaluative resources of Appraisal framework in PSAs to see how knowledge circulates in a different setting (Calsamiglia & Ferrero, 2003). The current study tried to fill in the gap proposing the following question:

- How frequently are Appraisal resources used in popular science articles in the field of Nutrition?

The above major research question was divided into three minor research questions:

- How frequently are Attitude (*appreciation, judgment, affect*) resources used in popular science articles in the field of Nutrition?

- How frequently are Engagement (*monogloss, heterogloss*) resources used in popular science articles in the field of Nutrition?
- How frequently are Graduation (*force, focus*) resources used in popular science articles in the field of Nutrition?

Method

Corpus

First, four associate professors (three national and one international) with research experience of more than 10 years and currently active in the field of Nutrition and five PHD students of Nutrition (three national and two international ones) with research experience of more than three years were asked to write the list of well-known English popular sources, including magazines and newspapers, in which experts write articles for non-expert readers. The common popular sources were selected and included in a new list. The new list was given to 2 associate professors and 5 PhD students to be reviewed and ranked. The first four highly ranked sources were chosen. The ultimate selected English popular science sources were *WebMD*, *Better Nutrition*, *New York Times*, and *Science Daily*.

WebMD provides valuable health information. It has created an organization that is believed to fulfill the need for health information on the Internet. It won 2013 Award of Excellence, American Society of Healthcare Publication Editors (ASHPE) Awards, and Web Health Awards. The WebMD Medical Team works with a team of over 100 nationwide doctors and health experts to ensure the accuracy and novelty of the content. It is accredited by Urac, as the American Accreditation Healthcare Commission (www.urac.org) which ensures and promotes the quality of health information on the Internet.

Better Nutrition has been published for 70 years as a leading magazine for health conscious customers. It has reached nearly one million readers monthly and provides authoritative and well-researched information on food, nutrition, dietary concerns, etc.

New York Times is an American daily newspaper which is published in New York City since September 18, 1851 and has won 117 Pulitzer prizes. It has the second-largest circulation and was ranked 39th in the world by circulation.

Science Daily has started as one of the Internet's most popular science news web sites in 1995 and generates nearly 20 million page views a month. It is best known for reporting the top science news stories from the world's leading universities and research organizations. The news stories are edited to ensure high quality and relevance. It enjoys high ranking with popular search engines such as Google and Yahoo, and media metrics firms rank it among the Internet's top 500 to 1000 web sites.

Ten articles published from 2010 till 2015 were selected from the archive of each popular science source. The sample consisted of 40 articles comprising a total of 17983 words (The list of articles included in the sample is presented in Appendix A). All popular sources were written by English native speakers. The researchers chose one article of each author in order to control for the possible influence of style.

Procedure and data analysis

First, each article was analyzed in order to code the cases of Appraisal resources. In accord with Systemic Functional Linguistics (SFL), the clauses were used as the unit of analysis (Babaii, 2011). The whole text of popular science articles was analyzed. Then, half of the data (20 articles) was randomly selected to be coded by the second and third coders and inter-coder reliability was estimated (r= 0.91). The coders were MA graduates of applied linguistics who have done their theses on Appraisal Theory. Then, the frequencies were determined for all categories (Attitude, Engagement, and Graduation) and subcategories (*affect, appreciation, judgment; monogloss, heterogloss; force, focus*) of Appraisal resources. The frequency and percentage values were determined. Afterwards, the raw frequencies were normalized to 1000 words in order to make the popular science articles of various lengths comparable (Biber, Conrad, & Reppen, 1998). For normalizing, each raw frequency was divided by the number of words in that corpus and multiplied by the basis chosen for norming (in this case 1000) (Nur Aktas & Cortes, 2008).

Results

The current study aimed to explore the frequency of Appraisal resources in English PSAs published in four English newspapers and magazines in the field of Nutrition which concerned coding Attitude (*affect, appreciation, judgment*), Engagement (*monogloss and heterogloss*), and Graduation (*force and focus*) resources. Table 1 displays the frequency counts that indicate how appraisal resources were distributed in English popular science articles.

Table 1
Frequencies of Appraisal Resources in English Popular Science Articles

Appraisal Resources	Total Frequency	Normalized Frequency
Attitude	950	528.276
Affect	30	16.682
Appreciation	893	498.580
Judgment	27	15.014
Engagement	251	139.576
Monogloss	79	43.930
Heterogloss	172	95.645
Graduation	354	196.852
Force	351	195.184
Focus	3	1.668
Total	1555	864.705

The results of the analysis of English PSAs in terms of Appraisal resources revealed that authors used more Attitude resources. Out of 1555 identified Appraisal resources, 950 (%61.10) were Attitude resources in comparison with 251 (%16.15) engagement resources and 354 (%22.75) graduation resources.

Among attitude markers, the authors of English PSAs made the most use of Appreciation resources (893 (%94)). Some examples are presented below.

(1) ……to give you *super-human* nutrition, it seems that ……..

(2) ……to reduce your family's exposure to *harmful* pesticides and *unknown* antibiotics

(Better Nutrition, 2013)

(3) The whole fruit, though *delicious*, is less *familiar* to most people than juices and supplements.

(4) ……both of which bring with them *harmful* side effects.

(Better Nutrition, 2012)

(5) ……that breakfast is the most *important* meal of the day.

(6) …….. the slightly *unsatisfying* takeaway from the new science would seem to be that …….

(New York Times, 2014)

(7) ……that estimates of salt intake were based on self-reports, which are not always *reliable*.

(New York Times, 2015)

(8) ……. These can be *challenging* and I had a few ……

(9) ……..muffins have *great* texture because of the ……..

(New York Times, 2013)

(10) .....that calorie restriction can be *beneficial* to muscles, improving muscle …

(Science Daily, 2015)

In all these examples, the authors used resources to construct the values of things and provided an evaluation of the natural phenomena and entities. The *appreciation* resources were employed to express the authors' positive or negative feelings towards products (Example: 3, 5, 6, 9, 12), processes (Example: 1, 4, 10), and entities (Example: 2, 7, 8) (White, 1998).

Following *appreciation* resources, the authors of English PSAs included more cases of *affect* resources (30 (%3.15)).

(11) ……it seems that you're likely to be *disappointed.*

(12) ……..and if you're *concerned* with replenishing and protecting the earth and diminishing harm…….

(Better Nutrition, 2013)

(13) ……I was *pleased* with, including some delicious, moist ……

(New York Times, 2013)

(14) It's important for *sufferers* of these maladies …

(Better Nutrition, 2014)

(15) …to eat to celebrate with friends or because you're *feeling blue*.

(WebMD, 2014)

In these examples, the *affect* resources were realized in the form of "mental processes of reaction" (Example: 13, 14) and "attributive relationals of Affect" (Examples: 11, 12, 15) to reflect how the authors assigned positive and negative feelings to individuals (White, 1998, p. 75).

The least frequently used category of Attitude resources in English PSAs articles was *judgment* (27 (%2.85)).

(16) *Scientists, like mothers*, have long suspected that midnight snacking is inadvisable.

(New York Times, 2015)

(17) If you often eat for emotional reasons instead of because you're physically hungry, *that can be a problem*.

(WebMD, 2014)

(18) My parents undoubtedly think they are doing the best for their children by having them bring lunch from home instead of eating the lunches served in school. *But recent studies prove them wrong*.

(New York Times, 2014)

In Example 16, the author made an analogy between scientists and mothers and implicitly referred to scientists' concerns for the health of children as the mothers. In Example 17, the author somehow blamed what some people do, i.e. eating due to some emotional reasons rather than hunger. In Example 18, the parents' beliefs were called into question and challenged the scientific evidence which disconfirmed them.

Considering the Graduation category, the authors of English PSAs included more *force* resources (351 (%98.65)) than *focus* resources (3 (%0.85)) in their communication of scientific facts about nutrition.

(19) ……that organic produce isn't necessarily more nutritious than conventional fruits and veggies-……..

(20) The Stanford study noted significantly lower levels of such bugs in organically raised stocks.

(Better Nutrition, 2013)

(21) … who is *very* pleased with the results.

(Science Daily, 2014)

(22) Teff is higher in calcium than any other grain, and ……

(New York Times 7, 2013)

(23) ……had better vitamin C retention than those ……

(WebMD 3, 2012)

In the abovementioned examples, the authors employed *force* resources (e.g. *more, -er, very, significantly* in English sample) to strengthen or soften their appreciation (White, 1998) to imply the intensity of that characteristic they attributed to processes, products, and entities.

On the other hand, in the following examples, the authors used focus resources (e.g. …*, of a sort* in English sample) for "sharpening/blurring the focus of valeur relationships" (White, 1998, p. 75).

(24) The largest mass-poultry-producing facilities are still farms of a sort.

(Better Nutrition 6, 2012)

With regard to Engagement category, English PSAs encompassed more *heterogloss* (205 (%72.18)) than *monogloss* (79 (%27.22)).

(25) Now, *researchers at Chang Gung University* in Taiwan have found that …

(Science daily, 2015)

(26) *A doctoral thesis from the Sahlgrenska Academy* shows that a diet consisting …

(Science Daily, 2013)

(27) *One of the best ways* to get more antioxidants is to eat a wide variety of fruits and vegetables.

(WebMD 6, 2014)

(28) *Newer research* shows that pomegranate can help alleviate common symptoms of menopause, such as hot flashes.

(Better Nutrition 7, 2010)

In the abovementioned examples, the authors of English PSAs referred to the previously conducted research (Example: 25, 26, 28) and provided resources to leave space for alternative positions (Example: 27) to present the readers with new pieces of scientific findings and to persuade the readers to accept their ideas (Martin & White, 2005; White, 1998).

Nevertheless, in the following examples, the authors referred to some scientific facts (Example: 29, 32) or findings (Example: 30, 31) without referring to other voices or quoting or reporting an external voice (Martin & White, 2005; White, 1998).

(29) It (Millet) is *a good source of manganese, phosphorous, magnesium and tryptophan, as well as B vitamins, calcium, potassium and zinc*.

(New York Times 7, 2013)

(30) When fresh fruits and vegetables are stored correctly and eaten in a short period *they have more vitamin C*.

(WebMD 3, 2012)

(31) And for overall health, *antioxidants protect against environmental damage and ravages of aging*.

(32) *The pomegranate's bright red seeds, or arils, are little juice sacs with crunchy inner seeds that are rich in fiber*.

(Better Nutrition 7, 2010)

Discussion and Conclusion

The study tried to explore the frequency of Appraisal resources in English PSAs in the field of Nutrition. The results demonstrated that the authors of PSAs had higher preference to use Attitude resources and inserted their feelings in the texts (Martin & White, 2005). Among Attitude

subcategories, *appreciation* resources were the most frequently used ones by which the authors tried to "construct the values of things" (White, 1998, p. 36) and presented their evaluation of products, processes and entities. With regard to two other subcategories of Attitude resources, the authors of English popular science articles tended to employ more *affect* resources followed by *judgment* resources.

The higher application of Attitude markers than that of the other two main categories of Appraisal resources in English popular science sample might be justified by the function of these resources, i.e. "to express the attitude of the author rather than certainty or commitment to the truth-value" (Abdollahzade, 2011, p. 290). The authors of PSAs aimed to present the scientific findings as appealing to the readers and involve them in the discourse (Giannoni, 2008) and strive both to inform and persuade readers to embrace the latest scientific facts about nutrition and nutritional value of foods. Indeed, popularized articles set the scene for scientists to express their feelings about their works and discoveries and in order to keep the reader motivated to read through the popular science article, the authors should be equipped with such resources and present technical information in an entertaining way (Ben-Ari, 1999). They should show both sides of the scientific literature, i.e. informing and entertaining (Bowler, 2009).

In PSAs, authors insert their "passion for a subject" (Ben-Ari, 1999, p. 822). A successful popular science article is characterized by entertaining and stimulating and simultaneously making technical information accessible and comprehensible to the non-scholarly audience (Hyland, 2010; Sapp, 1995). It is required to praise or condemn something in order to unfold its potential merits and flaws for the readers. Since the authors take advantage of PSAs to make an impression on the public's attitude (Bowler, 2009), they should adapt the scholarly articles so that the "readers marvel at" the findings and presented information (Fahnestock, 1998, p. 335). To sum up, it seems to be a must for the authors of PSAs to explicitly put forth evaluation of the scientific findings in the field of nutrition.

The second most frequently used category of Appraisal resources was Graduation resources and English popular Science articles included more *force* resources than those of *focus* subcategory. The authors tried to calibrate their appreciation and judgment (White, 1998) and express either an increase or a decrease of the extent of a specific characteristic in a product, process, and entity. Indeed, through using some lexicogrammatical resources for grading the judgment or appreciation, the scientists try to achieve proximity and provide the non-scholarly audience with new discoveries through recovering "the voice of the scientist which is absent in professional papers" (Hyland, 2010, p. 126). In popular science articles, the authors tend to present scientific findings and persuade the audience to accept their value rather than to convince the readers of their validity (Miller, 1998). Hence, the preciseness of the boundaries seems not to be prioritized (White, 1998). To influence the public (Bowler, 2009), the authors of popular science articles should highlight the intensity or amount of an attribute (White, 1998) htrough taking advantage of *force* resources.

The least frequently used category of Appraisal resources included in English PSAs articles was Engagement resources. The authors of English popular science articles included more *heterogloss* than *monogloss* resources. It seems that the authors of English PSAs follow the academic research article authors by citing other scientists and referring to previously conducted studies to convince their readers to accept their recommendations (Gallardo, 2005). Moreover, in popular science sources, science enjoys a wide range of voices (Russell, 2010). The authors seem to prefer to report the findings of authorized experts (Parkinson & Adendorff, 2004) and draw on their comments in order to persuade their audience to appreciate what they tried to convey. In Parkinson and Adendorff's (2004) terms, popularized texts address the general public and provide new discoveries without making science look either 'authoritative' or 'difficult' but appealing.

To sum up, it seems that Appraisal resources provide the scientist with helpful tools to fulfill their desire to share their discoveries with the general public (Ben-Ari, 1999). Indeed, these resources seem to enable the scientists to keep a reader's interest in following the scientific news and findings more enthusiastically. Hence, the results of this study would enrich both theoretical literature and practical decision-makings for popularizing science through employing Appraisal resources. As Russell (2010) pointed out, successful popularization entails obeying the media rules rather than the institutionalized norms of the scientific community and we might consider Appraisal resources as one of those rules. As a result of applying such keys to succeed in communicating and popularizing science, scientists would come up with more desired communication outcomes and thereby, reach higher extent of public credibility (Zhang, 2015).

In addition, to ensure that the general public grasps the significance of the presented findings, the authors of PSAs should adjust new information and take advantage of persuasive devices (Fahnestock, 1986). To this end, the authors try to attach something to "a recognized value for an audience" (Fahnestock, 1986, p. 334) and pinpoint numerous attributes in order to make the scientific findings more accessible and comprehensible and lead the readers to 'marvel at' presented information.

The findings also showed that making use of Appraisal resources, similar to the application of visual elements (Estrada & Davis, 2015; Miller, 1998; Riesch, 2014) contributes to the process of accommodating scientific findings for the intended audience of PSAs articles and establishing a link between the scientists' new discoveries and the audience's intrinsic values (Fahnestock, 1998).

On the other hand, these findings can be transferred to pedagogical grounds through including Appraisal resources in L2 writing courses, in general, and in EAP writing courses, in particular. In this regard, the EAP writing instructors can provide their students with ample opportunities to learn and practice the application of Appraisal resources in both academic and PSAs in order to enable them to address different groups of their audience successfully and efficiently. Indeed, EAP writing courses should set the scene for the would-b scientists acquire the required skills for addressing the readers and make appropriate decisions about the content and mode of presenting their findings (Bowler, 2009). As Sapp (1995) maintained, effective popularization of science requires highly specific communication skills in order to enable the writers to make a balance "between technical accuracy and easy comprehension" (p. 28). Altogether, injecting Appraisal resources into their popular science written products seems to enhance the quality and efficiency of the interaction between the writers and the readers.

The findings of the current study seem to provide good cues for the EAP writing instructors and materials developers in order to incorporate the appraisal resources in the educational resources in order to make them more up-to-date and more in accord with the recent changes of popular science communities resulting from the modern technological advances (Rashidi, Rahimi, & Alimorad, 2014). Moreover, several consciousness-raising tasks can be designed to be completed in EAP classes in order to equip the science students with the required resources for establishing a successful relationship with the intended readers of their scientific written products. In addition, getting familiar with the practices of the experts in a field of study and the way they transfer their new findings to non-scholarly audience would raise the EAP students' awareness to make both structurally and pragmatically appropriate choices for fulfilling the intended goals underlying popular science genres (Hyland & Tse, 2005). In this way, they would be able to produce texts which result in their audience's successful retrieval of presented information (Hyland, 2010). Besides, this may help EAP students in reading comprehension and identifying evaluative resources of popular science texts.

The results of the study carry some pedagogical implications for EAP courses held in local context as an EFL setting as well. Being able to both comprehend and produce scientific texts of different professional levels at international scale seems to be a requirement for the future scientists (Shaw & Vassileva, 2009). This would move the EAP students in an EFL setting beyond presenting simple accounts of scientific discoveries toward accommodating the scientific professional accounts and gearing them to their audience's professional level (Dafouz-Milne, 2008). This would be possible through having a good command of relevant features of English (as a second or foreign language) which requires active researchers and creative instructors to design an appropriate set of techniques and methods (Bozorgian & Fallahpour, 2015) for reinforcing the structural and pragmatic accuracy in PSAs written by novice scientists for the public.

Despite all the merits of including popular science articles in the EAP classes, though, EAP instructors are recommended to be cautious in employing popular science sources. Parkinson and Adendorff (2004) warned against mere reliance on PSAs as it might lead students to confuse and misconceive the requirements of academic genres. Indeed, the instructors should be professional and experienced enough to transfer the differences between academic and popular science conventions precisely, so that the students are socialized in their scientific community and make appropriate choices in addressing various groups of audience. One such exercise would be translating academic research articles into PSAs and vice versa in order to gain a deeper and richer knowledge of both genres. These all seem to help scientists, science students, science instructors, and EAP instructors to approach a revolutionary trend in science that strives to make knowledge accessible to the public (Paul, 2004).

Although the current study would contribute to the existing literature on both Appraisal theory and popularization of science, it had some limitations which may lead to relevant future studies. The study tried to explore the frequency of Appraisal resources in PSAs articles in the field of Nutrition. Several studies can be conducted considering the use of various linguistic and pragmatic features taking a sample of articles in other fields of study, e.g. Biology, Physical Education, etc. In addition, a chronological study of popular science articles can be conducted to see if time would influence the use and frequency of Appraisal resources in popular genre. Besides, the current study addressed the frequency of Appraisal resources in written popular genres. Further studies can touch upon the oral mode of this genre, e.g. presentations of scientific findings by the scientists for the non-scholarly audience on TV or radio. Furthermore, the study can be replicated with a larger sample of popular science articles taking into account the authors' gender to see if male and female scientists employ the same number and similar types of Appraisal resources in communicating scientific ideas to the general public. Moreover, popular science articles written in English by non-native speakers of English, e.g. Iranian authors can be compared to those written by native speakers of English to see if they employ Appraisal resources differently at the international scale. Taking a more pedagogical approach, the Appraisal resources can be taught to a group of students in EAP classes in order to investigate its possible influence on their understanding and perception of the audience they address in their future job. Their writing ability to address the general public can be tested after presenting these resources.

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Appendix A

List of Popular Science Articles in the Sample

a) WebMD Popular Science Articles (All articles retrieved from www.webmd.com)

Benorach, R. (2013, December). Super-foods for new moms.

Derrer, D. T. (2014, September). Food allergies and your skin.

Dotinga, R. (2013, December). Could a supplement prevent weight gain?

Jacobson, M. T. (2012, April). How to maximize nutrition in vegetables.

Jaret, P. (2012, May). Healthy aging: Living long and well.

Manning, J. (2014, July). Emotional eating: What helps.

Nguyen, A. (2014, February). Juicing for health and weight loss.

Patural, A. (2014, July). What should I eat before working out?

Uscher, J. (2014, October). What are the best foods for your skin and the best ways to get the vitamins and other nutrients your skin needs?

Wait, M. (2014, May). Watching your children's nutrition and growth.

b) Better Nutrition Popular Science Articles (All articles retrieved from www.betternutrition.com)

Bowden, J., & Bessinger, J. (2014, August). Just beet it.

Bril, J. B. (2011, February). Heal your heart with food.

Feiring, A. (2015, November). Wine not?

James, K. (2015, December). Beyond Paleo.

Singh Khalsa, K. P. (2015, December). Tea Rx.

Smith, M. D. (2014, October). Medicinal food: Garlic and ginger.

Strausfogel, Sh. (2015, November). Potent pomegranate.

Turner, L. (2012, March). Hot tea.

Tweed, V. (2010, December). Pomegranate: Nutritional jewel.

Zevnik, N. (2012, September). Chicken and the egg.

c) Science Daily Popular Science Articles (All articles retrieved from https://www.sciencedaily.com)

American College of Allergy, Asthma and Immunology (ACAAI). (2012, November). An egg a day to keep allergies away?

American Heart Association. (2010, June). Coffee or tea: Enjoy both in moderation for benefits, Dutch study suggests.

American Physiological Society (APS). (2015, April). Caloric restriction: A fountain of youth for aging muscles?

Cornell University. (2011, August). Weight loss without the hunger: Eat a lighter lunch, scientists say.

George Washington University Milken Institute School of Public Health. (2016, April). Fast food may expose consumers to harmful chemicals called phthalates.

Plataforma SINC. (2013, September). Experts confirm that fruit and vegetable consumption reduces risk of mortality.

The JAMA Network Journals. (2015, March). An apple a day won't keep the doctor away but maybe the pharmacist.

University of Gothenburg. (2013, October). Dietary intervention reduces stomach problems for diabetes patients.

University of Southern Denmark. (2014, December). Fat cells reprogrammed to increase fat burning.

University of California - Davis. (2015, April). Just two weeks of drinking sugary drinks boost risk factors for heart disease, study suggests.

d) New York Times Popular Science Articles (All articles retrieved from www.nytimes.com)

A.D.A.M. (2013, April). Cooking utensils and nutrition.

Bakalar, N. (2014, December). Mediterranean diet is good for your DNA.

Ballentine, S. (2011, August). Meal plan.

Bittman, M. (2015, March). Feeding kids well.

Brody, J. E. (2014, December). Why cafeteria food is the best.

Carroll, A. (2015, April). Simple rules for healthy eating.

O'Connor, A. (2014, December). Questioning the idea of good carbs, bad carbs.

North, A. (November, 2014). Should you pack your child's lunch?

Parker-Pope, T. (2013, June). Small grains, big nutrition.

Reynolds, G. (2015, January). A 12-hour window for a healthy weight.