Visualizing Toxicity and Harmful Chemicals Contained in Baby Products

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Abstract
Many of the personal care products we use daily unknowingly contain potential harmful chemicals. Consumers assume that since it's for sale or it hasn't caused a noticeable problem for them before that it must be safe. Although the information on chemicals is not a secret if you google each one, there is no easy way for people to see and compare products when the brands and ingredients are expansive. Using data from the California Department of Public Health, this project aims to visualize the toxicity of baby products currently on the market to help consumers make more informed decisions about what they buy. We found that rather than seeing all the products at once, consumers would rather rather have quick information upfront, such as which brands are typically toxic and which toxic chemicals are common. Our visualization uses interactive bar graphs and pie charts, together with anecdotes to help viewers understand products on the market better, including those that are less hazardous.

Author Keywords
Public Health, Consumer Information,

Introduction
In 2016, an article was published in Time following a $72 million lawsuit against Johnson & Johnston about our use of personal care products which have high possible health risks unbeknownst to most of us. At the moment, only Environmental Working Group and the Campaign for Safe Cosmetics are working to inform consumers about the potential dangers of toxic chemicals found in products. However, these groups only provide information in lists, limiting the ways that can make it easy for us to choose and compare product. Using data from the California Department of Public Health, this project aims to visualize the toxicity of baby products currently on the market to help consumers make more informed decisions about what they buy. We require a structured way of learning about what types of information people desire as well as a structured way of extracting and surfacing these types of information.

By creating visual and interactive charts, viewers can see the expansive database summarized, and they can easily highlight any parts of the data that they are interested in learning more about.

Related Work

Previously, a couple of organizations have tried to make information available about toxins in cosmetics available to the public. However, what these organizations share in common is an overwhelming presentation of information. Searching for products with toxins is much like searching in a library, with no way of understanding the overall makeup of products.

Environmental Working Group Skin Deep Database

The Environmental Working Group is an American non-profit organization that conducts research in toxic chemicals and drinking water pollutants, and advocates agricultural subsidies and corporate accountability. They have created the Skin Deep Cosmetic Database which lists brands, products, ingredients with toxicity information, and whether or not a company does animal testing ([Source](#)). However, the display of information leaves much to be desired. The system in place allows a user to put in a search term, such as a company or a product, and it lists related items. If you were to search for the company/brand Johnson & Johnson, it would only give you it's range for toxicity and lists of ingredients and products (See Figure 1). If you were to search for "baby care" you would be able to see scores of products that match the term, but you would be unable to filter them by score or whether or not they contain certain chemicals (See Figure 2). Although having a toxicity score is a great way to compare products with each other, this website does nothing to help you do that.

Figures 1-2. Screenshots of EWG Skin Deep Database.

Unlike the EWG Skin Deep Database, this project aims to give a quick rundown of baby care products so that it's easier to avoid products and brands with higher toxicity scores and certain ingredients. Instead of simply listing the vast number items, it would be better to graph and sort them in a way that is less overwhelming and have the main points easier to remember by the viewer.

Campaign for Safe Cosmetics
The Campaign for Safe Cosmetics is a coalition project from the Breast Cancer Prevention Partners. It aims to protect the health of consumers through their educational information, sustainability campaigns, and legislative advocacy for eliminating harmful chemicals in cosmetics and personal care products (Source). The website is much like a blog, with links to articles about recent harmful chemical findings in products. The search function allows you to search any keywords throughout their website, but is not helpful for specific products. Their primary information is organized in a get the facts section, where you can filter by the health hazard, product category, and affected population. However, it lists related articles, and only some articles are about chemicals in particular. The pages are all text heavy and the website is hard to navigate (See Figures 3-4). It is hard to get a clear idea of what contains what, when it mostly shows articles that you have to read through.

While the information in the articles is helpful, it is not as helpful if it is not directly connected to products and brands you'd actually see at the store. Although I might use their informations on

Figures 3-4. Screenshots of the Campaign for Safe Cosmetics website.

chemicals and why they are irritants, it would be easier to see more at once, rather than having to click through pages of articles that one isn't even sure if it's relevant to themselves or what they are looking to use.

Methods

The project began with a set of government data on cosmetics and chemicals. The data was cleaned up to show only related baby product data that could be used for comparison. Following this, five prototypes were created and tested with several participants. We had the participants examine the visualizations and provide us with feedback to narrow down the final visualizations and give us insights on how to make it interactive.

Cleaning up the Data

Initially, the chemicals in cosmetics data from the California Department of Public Health came with a wide variety of categories adding up to 94,862 entries. To narrow this down, I decided to focus on the Baby Products category because babies are more susceptible to chemicals. It also could be alarming to viewers and prompting them to question their own products. However, the California Department of Public Health data did not come with a score that could be used to compare it to other products. Usually, it is the FDA that assigns scores. So, I cross referenced the products listed here with the EWG's scoring information (which includes various sources to contribute to its accuracy) to have some way to quantify the toxicity of products more than the list of chemicals contained.

Exploratory Data Analysis

At this point, there could be several metrics used to compare the data. In total, we had 17 brands, 5 baby product sub-categories, 9 known toxic chemicals, and toxicity scores ranging from 1 - 10 to filter the data. I created 5 different visualizations on Tableau for how this data could

be presented and showed them to viewers for initial feedback to help narrow down the final visualizations.

Average Toxicity Score by Brand
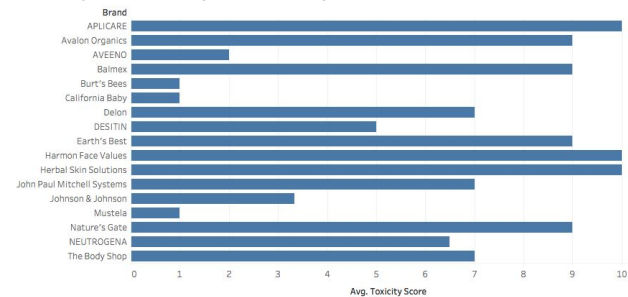
Figure 5. Visualization of each brand's toxicity average.

The first visualization aims to see which brands have products with a high average of toxicity. From looking at the data, most brands tended to use the same ingredients, thereby having similar toxicity scores between products. A whisker plot wouldn't be as necessary in this case, since we don't really have outliers in the data. A bar graph should suffice enough to give clear suggestions. According to EWG, products are low hazard if they have a toxicity score at or less than 3. Brands that fall under this rating include Aveeno, Burt's Bees, and California Baby.

How Often Toxic Chemicals Appeared as Ingredients

Another way of possibly informing viewers which products are toxic is by letting them know which chemicals are common. From this graph, I found that by far, Titanium dioxide was used most often in baby products (See Figure 6). However,
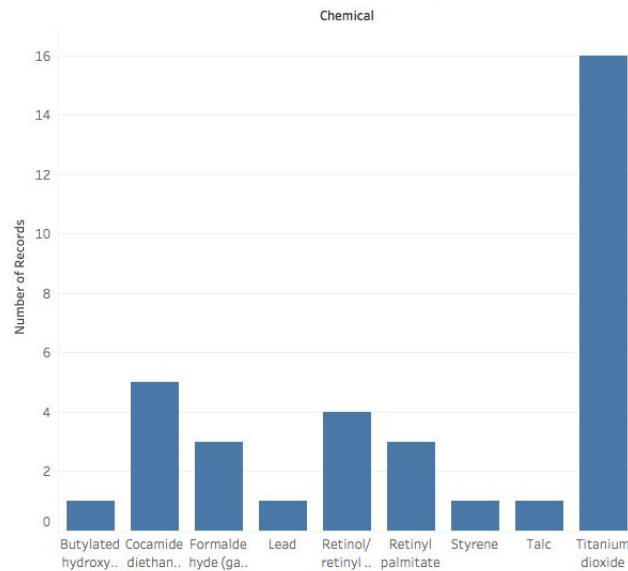
Figure 6. Visualization of each chemicals appearance.

Figure 7. Visualization of the average product toxicity score when each chemical is present.

titanium dioxide has a typically low toxicity (~2), and this graph could potentially be gravely misleading. One of the more dangerous chemicals found, lead, hardly appeared in the data, but it is still worth noting that it could be included in products.

Average Toxicity Score when Chemical is Present
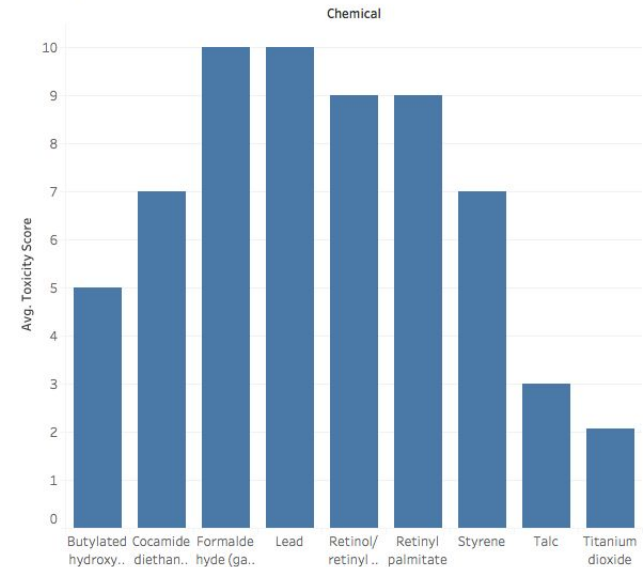The last visualization brought up an important point. It is not necessarily the frequency of the chemical that matters, but how potent or hazardous it is. A comparison of the chemical and the average toxicity score of a product when it is present could better explain which products are more hazardous (See Figure 7). It is important to

note that toxicity varies between products, despite them containing the same chemicals. This is because the chemicals can be more harmful in higher quantities than others.

Average Toxicity Score by Product Subcategory
Another piece of interest could be the baby product subcategory (shampoo, skin care, wash/soap, diaper rash treatment, other). Could there be some subcategory of products that are better to avoid because they're usually inherently toxic in any case? The visualization in Figure 8 aims to provide some answers by comparing the average toxicity between this subcategory.
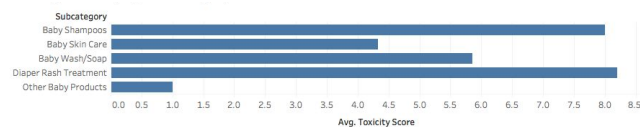
Figure 8. Visualization of average toxicity scores per baby product subcategory.

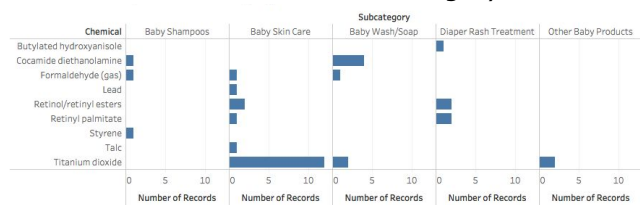Unfortunately, the toxicity was quite high for all categories, except for other, which isn't as telling as hoped.

Chemicals in Each Product Subcategory

Figure 9. Visualization of the chemicals present in each baby product subcategory.

Another way of seeing the information could be instead to see the chemicals present in each category. This one however, also has the problem Figure 6 had, where the prevalence of titanium dioxide can be seen as bad. Unfortunately, this visualization as well as the following one were seen as too convoluted and confusing to follow by viewers.

Average Toxicity Score of Chemicals in Each Product Subcategory
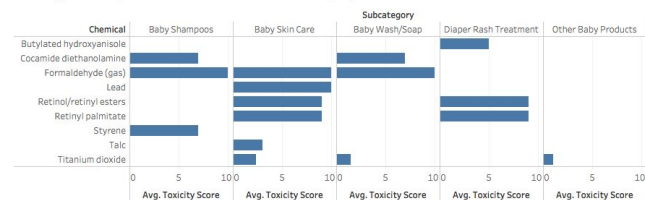
Figure 10. Visualization of the chemical toxicity values present in each baby product subcategory.

Similar to the last visualization, this one compares the chemicals in each baby product category by their average toxicities and whether or not they appear. Again, it tended to confuse viewers, and like figure 8, led people to believe the only "safe" category was "other".

Average Toxicity of Chemicals Present in Baby Skin Care Products
The final exploratory visualization aims to demystify the prior two visualizations by focusing solely on one subcategory (See Figure 11). In this way, viewers can get insights relative to the category and focus on which chemicals that would typically be present are least hazardous. It's not so much that certain categories of products should be avoided, but rather that people choose the safer products within those categories. To do that, you have to narrow down the chemicals to look for and avoid.

Figure 11. Visualization of the average product toxicity score when each chemical is present in baby skin care products.

Addressing feedback
The most successful visualizations among viewers were Figure 5 and Figure 7. In these visualizations, viewers understood what was being shared, and there is room for expansion. Therefore, interactive versions of this information appear in the Final Project. For the last visualization, I decided to come up with one that combines the simplicity of Figure 11, while being informative for each category. Given some way for viewers to zoom in on categories, while having

an idea of their prominence in the overall group, can also maintain expectations for each category.

Results
There are 3 final visualizations included in the project. The user is given the choice to visualize the data either by brand, product category, or chemical. The default is by brand. The visualizations were created using altered templates on Blocks.org [4][5].

Visualization A

Figure 12. Screenshot of website featuring the first visualization, while the column corresponding to Burt's Bees' toxicity score is selected.

The first visualization allows users to see the toxicity averages of each brand of baby products in the database, and highlight the ones they are interested in. The first page introduces the metric

of toxicity, what values are considered safe, and where the information originates from. This allows an easy introduction to the data and how to interpret it.

Visualization B
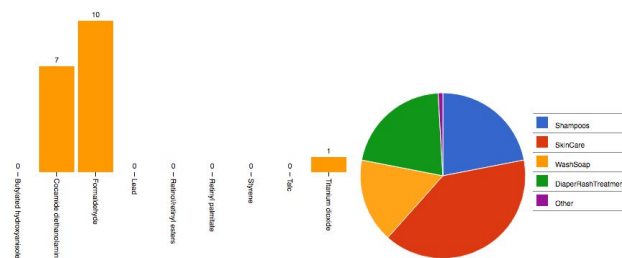
Figure 12. Screenshot of website featuring the second visualization, while the portion corresponding to Wash/Soap products is selected.

The second visualization allows users to select a portion of products by subcategory, and view the average toxicities and chemicals found in that subcategory. Users liked this one the most, and were able to create visualizations instantly, although many did not readily understand what they were telling.

Visualization C
The third visualization is similar to the first in that it allows the viewer to highlight and compare, but this time among chemicals found in products. At the end of the page, the reader can read additional information about selected chemicals. This visualization aims to help the user understand why certain chemicals are toxic, how, and to what extent.
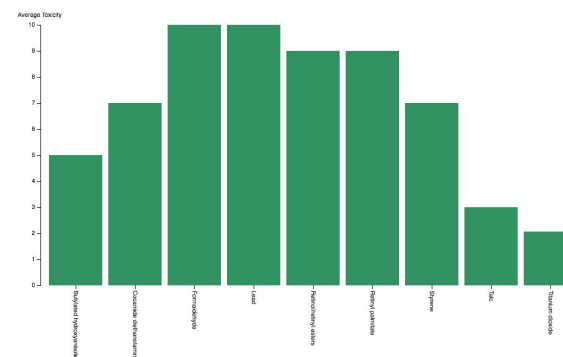

Figure 12. Screenshot of website featuring the third visualization. No part of the graph is currently selected.

Discussion
The audience gave relatively similar feedback and reactions to each of the visualizations. The first visualization was straightforward to those who read the prompts, but not to those who looked at the graph on its own. From this, it would be useful to have a line indicating the threshold for

anything too hazardous. Several tried clicking the bar graphs upon hovering. The second visualization was more complicated for users, however, they easily were able to create new visualizations and then many gave shocked responses to the ones created. Especially, when seeing how many chemicals are present in skin care products, for example. The third visualization, similar to the first one, was then easier to navigate by users.

Users learned that only a few brands have average toxicity levels that are not hazardous. Additionally, all walked away learning that things they use everyday, such as shampoo, possibly have some of the chemicals mentioned in this study.

Challenges and Limitations
Since the data came from the California Department of Public Health, the data only reflects information that has been reported to them. They have a disclaimer that all products containing carcinogens or developmental or reproductive toxicants may not be included, due to companies failing to report. Additionally, during the process of cleaning up the data, some did not have a toxicity rating, so I attempted to find one based on an ingredient used. If I was unable to find an accurate score from the EWG, I removed it from the data, which resulted in a smaller pool of products to compare with each other.

Future Work
There are several directions the current system could expand. If staying on the topic of baby products, users mentioned that it would be useful if lists of good products could pop up when certain categories, such as brands, are selected. It could be possible to create a photomap, for example, of safer baby products. Safer products can be larger and at the forefront.

Additionally, it could be useful to expand to other personal care products, such as make-up. The ingredients mentioned in this data are not specific to baby products only, and this would require simply adding more entries to the data. However, splitting it up into categories would be helpful to keep from creating information overload.

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4. Using d3-tip to add tooltips to a d3 bar chart. http://bl.ocks.org/Caged/6476579

5. Dashboard. http://bl.ocks.org/NPashaP/96447623ef4d342 ee09b