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Research article

Digital images of pediatric mental disorders do not accurately represent the conditions

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ABSTRACT

Objective: Digital images might contribute to stigma associated with mental disorders. The aim of this study was to investigate whether these images accurately represent pediatric mental disorders, as well as to explore specific image-related factors that influence perception.

Methods: Four hundred pictures were retrieved from three stock photograph websites ('Shutterstock', 'iStock' and 'Adobe') and 'Google Images' for mental disorders (ADHD, ASD, and depression) and somatic diseases (asthma, diabetes, and influenza) in childhood. Each picture was scored for gender, age, and emotional load. Data was compared against data from epidemiological studies. Ordinal regression was used to predict emotional load from image-related factors.

Results: There was a significant difference in gender representation of ADHD, ASD, depression, diabetes, and influenza. With respect to age, models were significantly younger in pictures of depression but older in pictures of influenza. Pictures of ASD, asthma and diabetes were mostly positive; however, images for ADHD, depression and influenza carried more negative connotations. For mental disorders, a more positive emotional load was associated with images of young and/or male models. iStock gave more positive images.

Conclusions: Digital images available in stock databases do not accurately represent pediatric mental and somatic disease. For mental disorders, image-related factors (including age, gender and emotional load) may influence societal perception.

1. Introduction

Online media are a network of web-based and informatics tools that aid the creation, sharing and dissemination of information between individuals and online communities (Hughes et al., 2017). The use of online media has expanded significantly since its inception (Kaplan and Haenlein, 2010). As of June 2019, Facebook and YouTube had approximately 2.4 billion and 1.9 billion active monthly users, respectively (Statista, 2018). It is estimated that people spend almost 2.5 h every day online (Molla, 2018). Activities range from the trivial (watching videos, online retail shopping), to self-expression on social media, to the access of online information with respect to personal or professional goals. Google, which has around 90% of the search engine market share worldwide, receives over 63,000 searches every second on any given day (Sullivan, 2016). Since the introduction of Google Images in 2001, about 250 million images are accessible to users.

It is therefore unsurprising that perceptions may be modified by online media, with exposure influencing our thinking (Lipsman et al., 2012). This is particularly true for health-related subjects. The internet is modern society's answer to health symptoms, its online resource for treatment, and the fundamental platform on which patients may form communities to share anxieties, personal experiences and access support (Baker et al., 2003; Diaz et al., 2002). When an individual uses online tools to investigate a medical condition, be it official information websites, personal blogs or public forums, they will likely be exposed to illustrative images (Chang et al., 1997). These often serve as exemplary representations of the disease. For example, a person using an inhaler may serve as a visual aid for asthma. These images will leave an imprint on the reader – perhaps more so than the text they accompany (Hinshaw

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and Stier, 2008). Indeed, advertising companies harness this phenomenon to influence their target market. This has been studied extensively in the field of smoking (Agaku and Ayo-Yusuf, 2014), alcohol consumption (Ross et al., 2014) and obesity (Goris et al., 2010). This influence may be actively used to effectively communicate disease-specific information to a lay audience (Dobos et al., 2015). However, it may also lead to a biased perception of medical conditions, such as obesity (Heuer et al., 2011).

Mental disorders are some of the most stigmatized conditions in our society (Gray, 2002; Stout et al., 2004). Whilst almost 20% of the population suffers from a form of mental disorder, many people still rely on the media for their perception of such conditions. This is particularly significant when individuals lack real-world experience of the disease. As a result, lay-people may have unconscious biases instilled from an early age. Indeed, a study by Poster et al. found that children were more likely to draw a mentally ill person as a being male (Poster et al., 1986). Conversely, there was a more positive attitude towards females (Kaushik et al., 2016). As the internet becomes the public's gold standard for information retrieval, this ‘collective subconscious archetyping’ will be increasingly influenced by online images.

The pictures used online to illustrate articles are often supplied by stock photography databases (Frosh, 2001). These provide royalty-free photos to websites, advertisers or health institutions, including hospitals and other health care providers (Goodstein et al., 2018). Website editors and designers will select images to display, without medical experience or the use of epidemiological data. Thus, the frequency of image-related characteristics (e.g. the ratio of boys versus girls) within the database will influence the frequency of these characteristics featured on websites. Subsequently, characteristics of the photo models (such as age and gender) may impact the image's emotional perception. As such the photographer's conceptual or aesthetic-based choices may influence the public's exposure to health related images and ultimately its perception of a disease, positively or negatively.

To test the above mentioned hypothesis, in this study we investigated the frequencies of the ‘gender’, ‘age’ and ‘emotional load’ in the stock photograph databases for six representative conditions in children: three mental disorders and three somatic diseases. The chosen mental disorders were attention deficit hyperactivity disorder (ADHD), autism spectrum disorder (ASD) and depression. The somatic diseases were asthma, diabetes and influenza. Additionally, we investigated how the diseases as entities themselves, the image source, and the age and gender of the model might predict the image's emotional load.

2. Material and methods

The study design is illustrated in Figure 1.

2.1. Approval of the study

This study did not include the use of patients as test subjects, human material or personal data. Thus, no approval of an Ethical Committee was required.

2.2. Picture selection

To collect the images, we chose three stock photograph websites out of the top ten of stock photography websites (according to www.consumersadvocates.org): ‘Shutterstock’, ‘iStock’ and ‘Adobe’. Search terms used were deliberately broad to mimic the search string of a non-medically trained person (journalist or website editor). These were: ‘adhd child’, ‘autism child’, ‘asthma child’, ‘diabetes child’, ‘depression child’ and ‘influenza child’. Results were screened using two criteria: a single child in the picture, and a clear relationship to the search term. The first one implies that pictures of two or more children were excluded, as it would not have been possible to isolate the effect of each of the photo models separately. The second criterion implies that pictures that were found using a certain search term but did not depict a child with the disease/disorder, were also excluded. Images were excluded if they involved a model previously identified in the search, or if they were a drawing. The search was halted when a total of 100 pictures were identified per disease as it has been shown that most web users do not screen beyond this number (iProspect, 2006).

As ‘Google’ is the most popular search engine for the general public, we also included pictures retrieved from ‘Google Images’. Using the browser ‘Google Chrome’, the same search phrases and inclusion criteria were used. The incognito mode was employed to reset the settings for each search.

2.3. Scoring the pictures

All pictures were analyzed and scored by two individuals (JB, JT) for the following topics: gender of the child used in the picture, age of the child used in the picture and ‘emotional load’ (the feeling that the observer experiences when looking at the image). For gender, the image

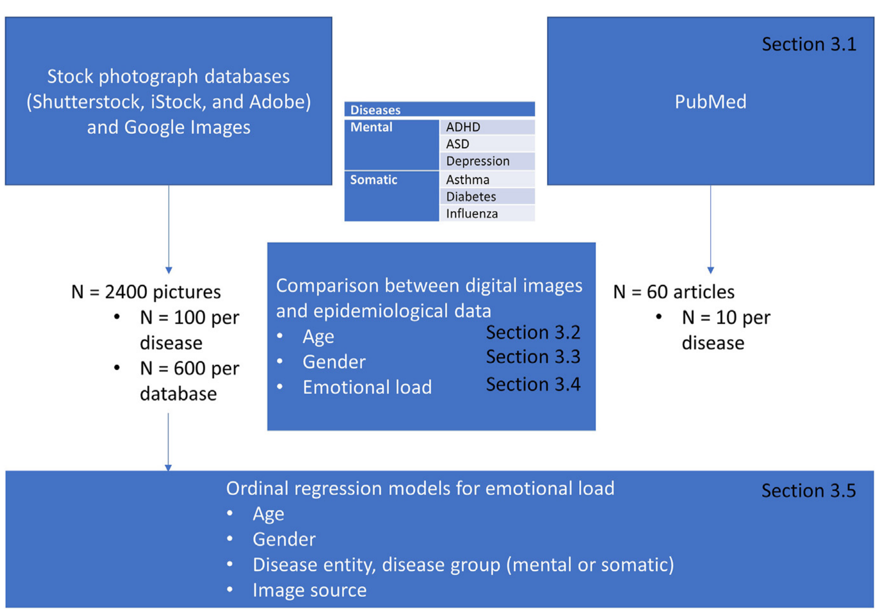


Figure 1. Study design.

could be scored 'male', 'female' or 'unclear'. For age, four categories were defined: infant (0–1 years), toddler (2–5 years), child (6–12 years) or adolescent (13–18 years). To score the emotional load of the picture, the images were classified as 'positive', 'negative' or 'neutral'. If there was discordance between the two observers a consensus was first sought, before a third party independently reviewed the image for final scoring.

2.4. Epidemiological data collection

Pubmed was used to search for studies that reported on gender ratios and/or age distributions of the six chosen diseases. The Mesh terms used for the disorders were Attention Deficit Hyperactive Disorder, Autism Spectrum Disease, Asthma, Depression, Type 1 Diabetes Mellitus and Influenza. Additional Mesh terms connected with Boolean operators (AND/OR) or additional limits were: Child, Adolescent, Age, Gender, Pediatrics, Characteristics, Prevalence and Epidemiology. The articles were screened based on the title and abstract. Only articles from the last ten years were included. Studies had to have been peer reviewed and contain a sample size of $n > 1000$. 10 articles were used to obtain gender ratios and age categories for each disease.

2.5. Statistical analysis

Data is represented as percentages, means with standard deviation or median with interquartile range, where appropriate. The Shapiro-Wilk test was used to evaluate data normality. For each disease, significant differences in gender, age and emotional load between sources were examined using the one-way ANOVA or Kruskal-Wallis test. Disease groups were split when a significant difference was found between sources. Possible discrepancies between pictures and articles were compared using a two-tailed two-proportions z-test (for gender) or by the independent samples t-test (for age). Univariate and multivariate ordinal regressions were performed to predict emotional load (negative, neutral or positive) with the following fixed effects: disease entity, disease group (mental or somatic), image source, the gender and age of the photo model. A p-value less than 0.05 was considered statistically significant. All statistical analyses have been performed using SPSS software (SPSS Inc. Chicago, IL, USA, version 25).

3. Results

3.1. Picture and article selection

The three stock databases selected for image retrieval were 'Shutterstock', 'iStock' and 'Adobe'. Additionally, pictures gathered from 'Google Images' were used. A total of 2400 pictures were included from the four different search engines. Ten articles containing epidemiological data were selected per disease (Tables A.1 and A.2).

3.2. Scoring the pictures

Interrater agreement was assessed on 2400 pairs of observations, revealing an almost perfect agreement for both age (Kappa = 0.99) and emotional load (Kappa = 0.99).

3.3. Gender

There was no significant difference in results between databases with respect to ADHD, ASD, Asthma, Depression and Influenza. Thus, the gender ratio was comparable in all these datasets (Table 1). The only significant difference in gender ratio was the 'Google Image' search for diabetes. For this reason, this data was analyzed separately. Per disease, a summative gender proportion calculated from the ten studies identified was compared against the summative gender proportion we obtained from the database images (Table 2).

The two tailed two proportions z-tests revealed significant differences in the gender ratios for ADHD, ASD, depression, diabetes (excluding the 'Google' images) and influenza image representation

Table 1. Gender from the collected pictures compared to articles.

			Pictures				Total proportion	Articles	P-value[a]
			Google	Istock	Shutterstock	Adobe		Total proportion	
Mental	ADHD	Male (n)	80	76	65	70	72.75	62.55	<0.001*
		Female (n)	20	24	35	30	27.25	37.45	
		Unclear (n)	0	0	0	0			
	ASD	Male (n)	75	70	76	74	75.06	81.76	0.001*
		Female (n)	25	29	24	25	24.94	18.42	
		Unclear (n)	0	1	0	1			
	Depression	Male (n)	43	41	40	42	43.57	34.18	0.001*
		Female (n)	52	56	59	48	56.43	65.82	
		Unclear (n)	5	3	1	10			
Somatic	Asthma	Male (n)	53	48	58	57	55.53	58.43	0.250
		Female (n)	44	49	37	43	44.47	41.57	
		Unclear (n)	3	3	5	0			
	Diabetes	Male (n)	*43*				46.24	51.08	0.350
		Female (n)	*50*				53.76	48.92	
		Unclear (n)	*7*						
		Male (n)		64	56	46	57.44	51.08	0.031*
		Female (n)		35	39	49	42.56	48.92	
		Unclear (n)		1	5	5			
	Influenza	Male (n)	36	36	35	34	36.15	52.30	<0.001*
		Female (n)	60	63	61	65	63.85	47.70	
		Unclear (n)	4	1	4	1			

ADHD, Attention Deficit Hyperactivity Disorder; ASD, Autism Spectrum Disorder.
*P < 0.05 was considered significant.
[a] Two-tailed two proportions z test.

when compared to the articles (Table 1). For influenza, the ratio was inversely correlated between image databases and studies (36.2% male in the images versus 52.3% in the studies, $p < 0.001$). A male predominance was seen in the gender ratios (both images and studies) for ADHD (72.8% and 62.6% male in images and studies, respectively), ASD (75.1% and 81.8% male) and asthma (55.5% and 58.43% male). There was more female than male representation in images related to depression (56.4%% female) and influenza (63.9% female). This was also true for 'Google Images' diabetes pictures (53.8% female). In contrast, our literature review indicated a larger proportion of male diabetics (51.1%). There was not, however, a statistically significant difference between these two ratios.

3.4. Age

We found significant differences between databases for the ages of models representing ADHD, ASD, depression and diabetes. Groups were split and analyzed separately (Table 3). For each disease, the mean age was calculated based on ten observational studies (Table 4). The pictures were categorized by age of the model: baby (age 0–1 years), toddler (2–5 years), child (6–12 years) and adolescent (13–18 years). The number of pictures for each disease was multiplied by the mean of the age range of the life stage, thus obtaining a mean age for the pictures of each corresponding disease. In all disorders, the majority of pictures showed children in the age group 6–12 years (Table 3). Independent sample t-test showed that models in pictures of depression (except for those on 'Istock') were significantly younger than the estimated age from the published articles (9.6 ± 3.6 years versus 14.9 ± 1.2 years, $p < 0.001$). Conversely, influenza images contained models with a mean age of 7.34 years old (i.e. child). This is significantly older than the 4.22 years (i.e. toddler) estimated from our review ($p < 0.001$). In all other diseases, no significant difference was found between the expected values from articles and the mean ages of models.

3.5. Emotional load

Figure 2 presents the distributions of emotional load per disease state. There was a significant difference in the pictures of ASD from Adobe compared to the other sources. These have therefore been analyzed separately. Pictures of depression were rated most negatively (72,8%), whereas pictures of ASD – except for those from the 'Adobe' database – were the most positive (46,3%). There were more positive than negative pictures for ASD, Asthma and Diabetes. In contrast, there were more negative images for ADHD, Depression and Influenza. The three somatic diseases had the highest frequency of neutral pictures.

3.6. Ordinal regression

Single ordinal regression for emotional load indicated a more positive emotional load associated with images of babies (odds ratio, OR = 1.95, 95% confidence interval, CI 1.13–3.37, $p < 0.001$), toddlers (OR = 2.45, 95% CI 1.85–3.23, $p = 0.017$) or children (OR = 1.58, 95% CI 1.24–2.02, $p < 0.001$) than adolescents (Table 5). Mental disorders were perceived as more negative (OR = 0.50, 95% CI 0.43–0.58, $p < 0.001$) than somatic diseases. Overall, disease entity had the most important contribution to the prediction of perception (Cox-Snell R^2: 0.176). 'Istock' had the highest frequency of positive images (OR = 1.42, 95% CI 1.15–1.75, $p < 0.001$, when compared to Adobe), whereas there were no differences between the other sources. Disease category was not investigated in the multiple ordinal regression because of its multicollinearity with disease entity. In this multiple regression, images of babies and children no longer held a significantly higher positive emotional load. Furthermore, a more negative perception of images with male photo models (OR = 0.76, 95% CI 0.64–0.90, $p < 0.001$) became apparent, which was not present in the single ordinal regression.

Multiple ordinal regression stratified by disease category exposed that in psychiatric disorders but not in somatic diseases, there was a significant influence of age, gender, and image source (Table 6). In this cohort, images of babies (OR = 5.74, 95% CI 1.52–21.73, $p = 0.010$), toddlers (OR = 4.68, 95% CI 3.16–6.94, $p < 0.001$) or children (OR = 2.00, 95% CI 1.42–2.82, $p < 0.001$) were perceived more positively than adolescents. Male models were also associated with a more positive emotional load (CI = 1.29, 95% CI 1.02–1.62, $p = 0.31$). Once more, 'Istock' provided the most positive images (CI = 1.67, 95% CI 1.23–2.27, $p = 0.001$).

Stratification of the mental disorders revealed that, in the case of ADHD, images from 'Istock' (OR = 1.72, 95% CI 1.02–2.89, $p = 0.042$) or of toddlers (OR = 3.46, 95% CI 1.48–8.10, $p = 0.004$) were associated with more positive perceptions (Table 7). The only significant influence for ASD was image source. For depression, toddlers had a more positive evaluation (OR = 2.20, 95% CI 1.07–4.52, $p = 0.032$) and male models were perceived more negatively (OR = 0.61, 95% CI 0.38–0.988, $p = 0.044$). Stratification of the somatic disorders revealed no association between emotional load and the factors studied (Table 8).

4. Discussion

4.1. Principal findings

Online media exert a huge influence on modern civilization. They hold the power to shape our perception of human experiences, particularly of medical conditions. This is not a novel observation. Almost a century ago, in his seminal work on public opinion, Lippmann proposed that societal perception of a topic may be shaped by stereotypes – which

Table 2. Gender from the articles.

			Article 1	Article 2	Article 3	Article 4	Article 5	Article 6	Article 7	Article 8	Article 9	Article 10	Total proportion
Mental	ADHD	Male (n)	1321	252	29243	1345	1033	11352	3837	39314	25	342	62.55
		Female (n)	252	84	9957	314	153	4452	693	36701	11	116	37.45
	ASD	Male (n)	43972	4378	2493	1650	4	8119	75	658	68	9123	81.76
		Female (n)	9740	1095	513	425	1	1804	11	202	13	1935	18.42
	Depression	Male (n)	127	82	36	9832	8	616	476	1323	12686	292	34.18
		Female (n)	163	178	115	29842	8	662	903	1227	15587	371	65.82
Somatic	Asthma	Male (n)	3461	2779800	1154	407220	111	35	74	810	236	58	58.43
		Female (n)	2671	1943400	834	323945	62	36	94	807	136	65	41.57
	Diabetes	Male (n)	909795	872	26	1762	7360	1004	12	3809	5816	22297	51.08
		Female (n)	871465	786	24	1762	7360	1322	14	3886	4921	20931	48.92
	Influenza	Male (n)	325	226	1280	425	1581	417030	1423	1951	249846	221	52.30
		Female (n)	362	222	1316	384	1390	380314	948	1801	228156	173	47.70

ADHD, Attention Deficit Hyperactivity Disorder; ASD, Autism Spectrum Disorder.

Table 3. Age from the collected pictures compared to articles.

		Pictures					Articles	P-value[a]
		Baby (n)	Toddler (n)	Child (n)	Adolescent (n)	Estimated age (mean ± SD)	Estimated age (mean ± SD)	
Mental	ADHD (Shutterstock)	1	31	64	4	7.47 ± 3.09	9.36 ± 2.01	0.095
	ADHD (Other)	0	36	239	25	8.88 ± 2.68		0.786
	ASD (Google)	3	43	50	4	6.64 ± 3.38	6.51 ± 2.79	0.848
	ASD (Other)	1	80	192	27	8.09 ± 3.36		0.109
	Depression (Istock)	0	15	32	53	11.62 ± 4.50	14.93 ± 1.21	0.080
	Depression (Other)	4	35	201	60	9.55 ± 3.56		<0.001*
Somatic	Asthma	4	50	233	113	7.49 ± 2.39	8.85 ± 2.03	0.185
	Diabetes (Istock)	1	10	68	21	9.73 ± 3.49	10.39 ± 2.53	0.830
	Diabetes (Other)	12	59	201	28	8.19 ± 3.49		0.079
	Influenza	17	112	256	15	7.34 ± 2.65	4.22 ± 2.28	<0.001*

ADHD, Attention Deficit Hyperactivity Disorder; ASD, Autism Spectrum Disorder; SD: standard deviation.
*P < 0.05 was considered significant.
[a] Independent samples t-test.

Table 4. Age from the articles.

		Article 1	Article 2	Article 3	Article 4	Article 5	Article 6	Article 7	Article 8	Article 9	Article 10	Estimated age (mean ± SD)
Mental	ADHD	10.80	9.00	7.70	13.60	8.20	10.40	8.69	9.00	6.20	10.00	9.36 ± 2.01
	ASD	7.45	4.80	4.38	4.46	11.10	10.47	5.00	5.40	3.10	8.93	6.51 ± 2.79
	Depression	13.80	15.80	15.21	14.70	16.60	15.00	16.23	13.60	12.83	15.50	14.93 ± 1.21
Somatic	Asthma	11.96	8.21	9.50	8.50	9.56	5.78	8.70	6.00	8.50	11.75	8.85 ± 2.03
	Diabetes	13.10	6.60	10.60	10.93	11.05	12.80	8.20	7.80	14.20	8.60	10.39 ± 2.53
	Influenza	3.71	2.50	7.60	3.40	7.00	3.50	2.00	7.00	4.45	1.00	4.22 ± 2.28

ADHD, Attention Deficit Hyperactivity Disorder; ASD, Autism Spectrum Disorder; SD: standard deviation.

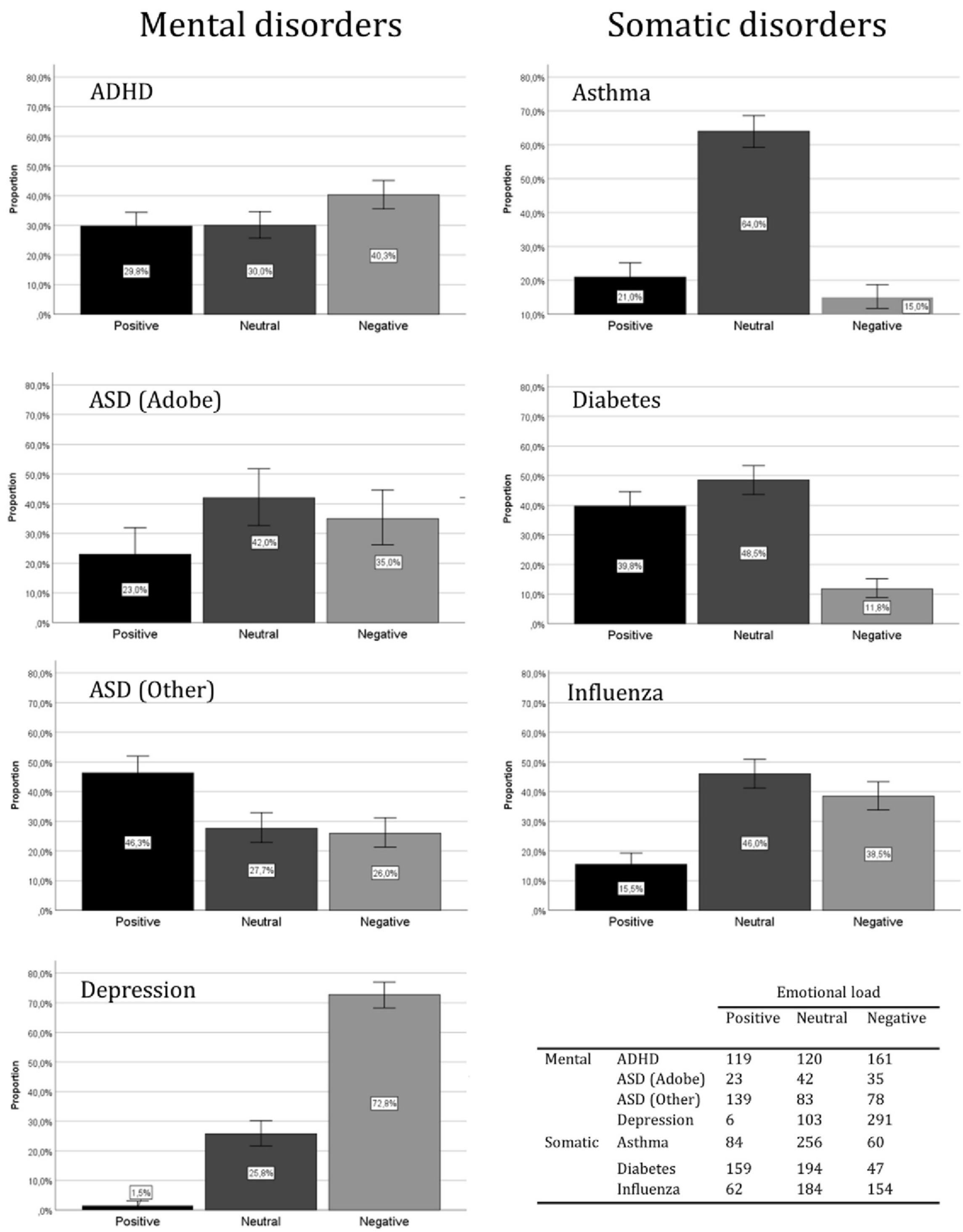
he termed ‘pictures in the head’ (Lippmann, 1922). Medical disorders are seldom relatable to lay people due to the lack of personal experience with the conditions. Many rely on heuristics, which are themselves constructs of modern culture. This is particularly true for mental disorders, commonly described as one of the most stigmatized conditions in our society (Stout et al., 2004). In this study we intended to determine if this remained true for pediatric mental disorders. We investigated ADHD, ASD and depression.

An ideal experiment would directly study the images displayed on the online media platforms which serve as information providers for the general public. However, a systematic quantification of the vast multitude of websites and online news outlets available is unrealistic. Therefore, we opted to study the images found in stock photographic databases. These are the most intensely used resources for journalists, website editors, and even academic institutions (Frosh, 2001; Goodstein et al., 2018). They are used to obtain illustrative medical images for conditions including pediatric mental disorders. This study included databases that were amongst the most popular commonly used, that were freely accessible, and that could be readily searched with easy search strings. We also included the resource ‘Google Images’ because it is both the most commonly used web browser (Sullivan, 2016) and orders its results based on image popularity. Figure 3 shows a representative picture for each disorder, according to our findings. They illustrate the talent of the photographers to create ‘conceptual images’ that encapsulate the subject of the picture using techniques that invoke contextual meaning. By carefully choosing the model (age, gender, expression, gesticulation), the décor (home, hospital,…) and other elements (color schemes, filters, …) the photographers are able to construct a visual metaphor for a medical disorder or disease that is universally identified (a ‘visual trope’).

Our search string aimed to represent the terms non-medically trained persons would use. We assumed a lay person would choose an illustrative image from a database rather than basing their visual representation on data related to the disease demographics. Consequently, the frequency of the characteristics in the database images (photo model age, gender, the image's emotional load) would likely impact the frequency of representation in online publications. For example, young teenage female and male models may be equally depicted in database searches for depression. This may influence online publications. In turn, this would bias the public into assuming depression affects genders equally; in reality, girls are more often affected by depression than boys.

We performed an extensive Pubmed search to compare the gender ratios and age categories of the models in the retrieved images with current epidemiological data. We identified large studies from the last decade concerning the six selected pediatric mental and somatic diseases. Using data from these studies, we calculated gender ratios and age categories. These were contrasted against ratios constructed from image database searches.

ADHD has previously been identified as a predominantly male disorder in children of 6–12 years old. This is depicted in the database images, but with a greater distortion of the gender ratio. The gender ratio in the images was 1:0.38 (M:F), whilst the real gender ratio is closer to 1:0.63. The higher prevalence of male models in the stock databases might act inadvertently as a stereotype. Conversely, the images were fairly representative of the age range identified by epidemiology. The images available to illustrate ADHD often held a negative emotional load. One reason for this may be the higher proportion of male models, which acted as a predictor for negative appreciation. However, this was not statistically significant in ordinal regression (Table 7). In addition, pictures of a child with ADHD were more often considered negative than those of a toddler. The images that elicited this negativity were, for example, a screaming boy destroying a toy with an unhappy parent observing him. Thus, our data indicates ADHD's online representation could be skewed towards the stereotype of a young boy with a negative emotional connotation (Figure 3). It is of note that this is a common discrediting stereotype currently assumed by lay people with respect to ADHD (Mueller et al., 2012).



		Emotional load		
		Positive	Neutral	Negative
Mental	ADHD	119	120	161
	ASD (Adobe)	23	42	35
	ASD (Other)	139	83	78
	Depression	6	103	291
Somatic	Asthma	84	256	60
	Diabetes	159	194	47
	Influenza	62	184	154

Figure 2. Emotional load of the collected pictures for both mental and somatic disorders.

ASD is a mental disorder mainly found in younger boys (mean of 6.5 years old), as estimated from our systematic review. This is accurately represented by the images found on stock databases. Unlike ADHD, the difference in male and female representation of ASD is less pronounced than that which is found in the general population (M:F ratio of 1:0.33 versus 1:0.22 respectively). ASD searches elicited more positive images than ADHD (46,3% for ASD versus 29,8% for ADHD). It should be noted this was not true for ASD images found in 'Adobe', which had more negative than positive images (35% versus 23%, respectively). Altogether, we may conclude that ASD is depicted as a condition that mainly affects boys around the age of 7–8 years. It is represented with more positive than negative visual connotations (Figure 3).

Epidemiological studies indicate that pediatric depression is most frequent amongst adolescent girls (Tables 2 and 4). The ratio of 1:1.8 male to female pediatric depressed patients contrasts with that of stock images, where the ratio is 1:1.2. The mean age of models from the databases (excluding 'Istock') was 9.55 years old. This is significantly lower than the mean age of patients documented by our reviewed articles

Table 5. Single and multiple ordinal regression for emotional load.

		Single ordinal regression				Multiple ordinal regression		
		Beta	OR	p-value	Cox-Snell R^2	Beta	OR	p-value
Age[a]	Baby	0.667 (0.120; 1.215)	1.948 (1.127; 3.37)	<0.001*	0.018	0.436 (-0.254; 1.126)	1.546 (0.776; 3.083)	0.216
	Toddler	0.895 (0.617; 1.172)	2.447 (1.853; 3.228)	0.017*		0.55 (0.244; 0.856)	1.733 (1.276; 2.353)	<0.001*
	Child	0.459 (0.213; 0.705)	1.582 (1.237; 2.024)	<0.001*		0.144 (-0.129; 0.417)	1.155 (0.879; 1.517)	0.301
Gender[b]	Unclear	-0.262 (-0.729; 0.205)	0.770 (0.482; 1.228)	0.271	0.001	-0.484 (-1.101; 0.133)	0.616 (0.332; 1.143)	0.124
	Male	-0.009 (-0.160; 0.143)	0.991 (0.852; 1.154)	0.910		-0.274 (-0.441;-0.108)	0.76 (0.644; 0.898)	0.001*
Disease category[c]	Mental	-0.702 (-0.853;-0.552)	0.496 (0.426; 0.576)	<0.001*	0.034			
Disease entities[d]	ADHD	0.283 (0.023; 0.543)	1.327 (1.023; 1.721)	0.033*	0.176	0.425 (0.155; 0.694)	1.529 (1.168; 2.003)	0.002*
	ASD	0.935 (0.672; 1.197)	2.547 (1.958; 3.31)	<0.001*		1.05 (0.778; 1.323)	2.858 (2.176; 3.754)	<0.001*
	Asthma	0.723 (0.462; 0.984)	2.061 (1.587; 2.675)	<0.001*		0.772 (0.508; 1.036)	2.164 (1.661; 2.819)	<0.001*
	Depression	-1.453 (-1.741;-1.164)	0.234 (0.175; 0.312)	<0.001*		-1.365 (-1.664;-1.065)	0.255 (0.189; 0.345)	<0.001*
	Diabetes	1.283 (1.018; 1.549)	3.607 (2.768; 4.707)	<0.001*		1.415 (1.144; 1.687)	4.118 (3.14; 5.401)	<0.001*
Source[e]	Google	0.165 (-0.044; 0.375)	1.179 (0.957; 1.455)	0.122	0.005	0.197 (-0.023; 0.417)	1.218 (0.978; 1.517)	0.079
	Istock	0.35 (0.14; 0.56)	1.419 (1.15; 1.751)	0.001*		0.462 (0.242; 0.683)	1.588 (1.273; 1.98)	<0.001*
	Shutterstock	0.056 (-0.154; 0.266)	1.058 (0.857; 1.305)	0.600		0.061 (-0.159; 0.28)	1.062 (0.853; 1.323)	0.589

ADHD, Attention Deficit Hyperactivity Disorder; ASD, Autism Spectrum Disorder; OR, Odds ratio.
*P < 0.05 was considered significant.
[a] Reference: adolescent.
[b] Reference: female.
[c] Reference: somatic.
[d] Reference: influenza.
[e] Reference: Adobe.

Table 6. Multiple ordinal regression for emotional load, stratified by disease category: mental versus somatic.

		Mental disorders			Somatic diseases		
		Beta	OR	p-value	Beta	OR	p-value
Age[a]	Baby	1.748 (0.416; 3.079)	5.74 (1.516; 21.728)	0.010*	-0.271 (-1.134; 0.591)	0.762 (0.322; 1.807)	0.538
	Toddler	1.543 (1.149; 1.937)	4.678 (3.155; 6.937)	<0.001*	-0.22 (-0.673; 0.233)	0.803 (0.51; 1.262)	0.342
	Child	0.695 (0.353; 1.037)	2.003 (1.423; 2.82)	<0.001*	-0.225 (-0.643; 0.193)	0.799 (0.526; 1.213)	0.292
Gender[b]	Unclear	-0.5 (-1.34; 0.34)	0.607 (0.262; 1.405)	0.244	-0.281 (-1.108; 0.546)	0.755 (0.33; 1.727)	0.506
	Male	0.253 (0.022; 0.483)	1.288 (1.023; 1.621)	0.031*	-0.078 (-0.298; 0.143)	0.925 (0.742; 1.153)	0.490
Source[c]	Google	0.107 (-0.199; 0.414)	1.113 (0.819; 1.513)	0.492	0.119 (-0.187; 0.426)	1.127 (0.829; 1.531)	0.446
	Istock	0.512 (0.203; 0.821)	1.669 (1.225; 2.272)	0.001*	0.253 (-0.055; 0.56)	1.287 (0.946; 1.751)	0.108
	Shutterstock	0.095 (-0.212; 0.403)	1.1 (0.809; 1.496)	0.543	-0.05 (-0.356; 0.257)	0.952 (0.7; 1.293)	0.751

OR, Odds ratio.
P < 0.05 was considered significant.
[a] Reference: adolescent.
[b] Reference: female.
[c] Reference: Adobe.

(14.93 years). Images identified often held a negative emotional load, which was particularly pronounced for male models, less so in younger models (Table 7).

Our evidence regarding representation of psychiatric disorders contrasted with that of somatic diseases. Images concerning somatic diseases broadly had less negative connotations, except for influenza.

The gender ratio of asthma images seemed to be realistic, as it was similar to that found in epidemiological studies (ratio 1:0.8 versus 1:0.7, respectively). The mean age of the models was also similar to what would be expected (7.49 in the pictures versus 8.85 in the studies). There were slightly more positive than negative pictures (21% versus 15%), although 64,0% of the pictures were neutral. From this, we may infer that asthma is unassociated with gender or age stereotyping. It appears to be a more unprejudiced disease.

According to studies (Table 2), diabetes images should be fairly equally divided between male and female models (with a gender ratio of 1:0.9). In contrast, most stock databases had significantly more male models (M:F of 1:0.73). This was not true for 'Google Images', where the gender ratio was inverted (1:1.1). There was no significant difference between image databases and articles with respect to age (10.39 years in the articles). Images mostly induced neutral or positive emotional loads (39.8% positive and 48.5% neutral versus 11.8% negative images). It is noteworthy that most pediatric patients experience type 1 diabetes. Only a small number of children suffer from obesity-related type 2 diabetes, which is associated with a high societal stigma. To integrate this knowledge into our study, we analyzed the models' body images. Indeed, the majority of models had a normal BMI (data not shown). This implies that stock image databases mostly provide images related to type 1 diabetes. Yet we must consider that individuals using the database may not be aware of the different demographics of pediatric diabetes. It is therefore possible an image of a child with a higher BMI may be used in an article concerning type I diabetes.

The results concerning influenza differed significantly from the two other somatic diseases. This was true for all three characteristics assessed. Images contained approximately 16% more females than the studies predicted (1:1.7 versus 1:0.9). According to publications, influenza has a

Table 7. Multiple ordinal regression for emotional load, stratified by disease: mental diseases.

		ADHD			ASD			Depression		
		Beta	OR	p-value	Beta	OR	p-value	Beta	OR	p-value
Age[a]	Baby	/	/	/	0.432 (-1.671; 2.535)	1.54 (0.188; 12.615)	0.687	0.99 (-1.148; 3.128)	2.69 (0.317; 22.818)	0.364
	Toddler	1.242 (0.393; 2.092)	3.463 (1.481; 8.097)	0.004*	0.725 (-0.021; 1.472)	2.065 (0.979; 4.357)	0.057	0.788 (0.068; 1.508)	2.199 (1.071; 4.517)	0.032*
	Child	0.621 (-0.119; 1.362)	1.861 (0.888; 3.903)	0.100	0.061 (-0.633; 0.755)	1.063 (0.531; 2.128)	0.863	0.111 (-0.448; 0.669)	1.117 (0.639; 1.952)	0.698
Gender[b]	Unclear	/	/	/	-0.377 (-1.955; 1.202)	0.686 (0.142; 3.325)	0.640	0.063 (-1.001; 1.126)	1.065 (0.368; 3.084)	0.908
	Male	-0.354 (-0.776; 0.069)	0.702 (0.46; 1.071)	0.101	-0.054 (-0.487; 0.378)	0.947 (0.615; 1.459)	0.805	-0.492 (-0.972;-0.013)	0.611 (0.378; 0.988)	0.044*
Source[c]	Google	-0.023 (-0.543; 0.496)	0.977 (0.581; 1.643)	0.930	0.872 (0.34; 1.403)	2.391 (1.405; 4.068)	0.001*	-0.243 (-0.894; 0.409)	0.785 (0.409; 1.506)	0.466
	Istock	0.541 (0.02; 1.062)	1.718 (1.02; 2.893)	0.042*	0.679 (0.16; 1.198)	1.971 (1.173; 3.313)	0.010*	0.438 (-0.192; 1.069)	1.55 (0.825; 2.912)	0.173
	Shutterstock	-0.082 (-0.613; 0.448)	0.921 (0.542; 1.565)	0.761	0.563 (0.047; 1.08)	1.756 (1.048; 2.944)	0.033*	-0.279 (-0.943; 0.385)	0.757 (0.39; 1.47)	0.411

OR, Odds ratio.
*P < 0.05 was considered significant.
[a] Reference: adolescent.
[b] Reference: female.
[c] Reference: Adobe.

Table 8. Multiple ordinal regression for emotional load, stratified by disease: somatic diseases.

		Asthma			Diabetes			Influenza		
		Beta	OR	p-value	Beta	OR	p-value	Beta	OR	p-value
Age[a]	Baby	0.13 (-1.282; 1.542)	1.139 (0.277; 4.672)	0.857	-0.17 (-2.248; 1.907)	0.843 (0.106; 6.735)	0.872	0.601 (-1.125; 2.327)	1.824 (0.325; 10.246)	0.495
	Toddler	0.6 (-0.269; 1.469)	1.822 (0.764; 4.343)	0.176	0.24 (-0.479; 0.958)	1.271 (0.619; 2.607)	0.514	-0.832 (-1.869; 0.205)	0.435 (0.154; 1.227)	0.116
	Child	0.379 (-0.449; 1.207)	1.461 (0.638; 3.342)	0.370	0.274 (-0.317; 0.865)	1.315 (0.729; 2.375)	0.363	-0.958 (-1.96; 0.044)	0.384 (0.141; 1.045)	0.061
Gender[b]	Unclear	-0.539 (-1.9; 0.823)	0.584 (0.15; 2.277)	0.438	-0.588 (-2.311; 1.135)	0.555 (0.099; 3.111)	0.504	-1.765 (-3.637; 0.108)	0.171 (0.026; 1.114)	0.065
	Male	-0.244 (-0.658; 0.171)	0.784 (0.518; 1.186)	0.249	-0.376 (-0.773; 0.021)	0.687 (0.462; 1.021)	0.063	-0.27 (-0.666; 0.125)	0.763 (0.514; 1.133)	0.180
Source[c]	Google	0.177 (-0.395; 0.749)	1.193 (0.674; 2.114)	0.545	0.125 (-0.413; 0.662)	1.133 (0.662; 1.939)	0.649	-0.049 (-0.58; 0.482)	0.952 (0.56; 1.619)	0.856
	Istock	0.138 (-0.435; 0.711)	1.148 (0.647; 2.036)	0.637	0.3 (-0.243; 0.843)	1.35 (0.784; 2.324)	0.278	0.377 (-0.155; 0.908)	1.458 (0.857; 2.48)	0.165
	Shutterstock	-0.019 (-0.592; 0.554)	0.981 (0.553; 1.741)	0.948	-0.074 (-0.609; 0.461)	0.929 (0.544; 1.586)	0.787	-0.151 (-0.679; 0.378)	0.86 (0.507; 1.459)	0.576

OR, Odds ratio.
*P < 0.05 was considered significant.
[a] Reference: adolescent.
[b] Reference: female.
[c] Reference: Adobe.

high prevalence in toddlers (mean age 4.22 years old). Conversely, the images contained more models from the category ‘children’ (6–12 years). Yet, for this disease almost all the published studies retrieved involved hospitalized children. Having contracted influenza, younger children are more likely to be hospitalized. Thus, the mean age of these children may be lower than the mean age in community pediatric cases. Influenza searches also contained significantly more negative images (38.5% negative versus 15.5% positive). This was not true for diabetes or asthma. Diabetes and asthma are chronic diseases, whilst influenza is an acute disease with symptoms widely perceived as unpleasant: fever, cough, runny nose, headache. To represent influenza, a ‘sick, febrile or coughing’ model is often used (Figure 3). In contrast, diabetes and asthma may be recognized by more neutral characteristics. This may include injections or glucometers for diabetes and inhalers or nebulizers for asthma.

As illustrated by its relatively high Cox-Snell R2 of 0.176, ‘disease entity’ was the strongest predictor of image emotional load. This indicates that the photographer's personal opinion (‘their mental stereotype’) on a medical condition may influence their representation of it. For psychiatric disorders, age and gender also had a statistically significant impact on emotional load. Our ordinal regression provides evidence that images of depression had a more positive emotional load if the model was female. This correlates with a study, which indicated more positive societal attitude towards depressed female patients (Kaushik et al., 2016). Younger subjects (such as toddlers) also had a more positive perception. In some cases the stock database (source) had an additional independent influence on emotional load.

4.2. Limitations

This study is not without limitations. The scorers all had sufficient hands-on experience in pedagogics or pediatrics; however, assessing age and emotional load of an image remains subjective. Furthermore, whilst we believe the stock image databases acted as an effective proxy, we cannot confirm they identically reflect the image distribution found on websites, nor that the chosen images on the website represent the disease that is mentioned in the text. Similarly, the PubMed articles may not be representative of the general pediatric population. This was discussed previously in the case of influenza. Finally, the search terms that were used to retrieve images from the stock database always contained the search term ‘child’. This filtered out images of adult models. However, it may also have influenced the age range of the models depicted in the images. A search for ‘depression adolescent’ may evince different images than ‘depression child’. We defend this decision, as we believe users are likely to use the more general search term ‘child’ when looking for pediatric-related images than specific age brackets.

Figure 3. Representative pictures of the disorders according to the results. A – ADHD (source: https://www.needpix.com/photo/379310/boy-portrait-blue-free-pictures-free-photos-free-images-royalty-free). B – Asthma (source: https://www.flickr.com/photos/fdaphotos/7163885241). C – ASD (source: https://www.needpix.com/photo/1001914/autism-autistic-asperger-child). D – Depression (source: https://www.pxfuel.com/en/search?q=depression+-+sadness). E – Influenza (source: https://www.pikist.com/free-photo-ildol). F – Diabetes (source: https://pixnio.com/science/medical-science/young-boy-who-was-receiving-an-injection-in-his-left-lateral-thigh-muscle).

4.3. Implications

This study may have broad implications, including providing information that may aid policy decisions concerning stereotyping of pediatric mental disorders. Strategically choosing photo model characteristics that closely resemble the disorder's epidemiological distribution may result in more realistic representation, thus correcting erroneous public perception. Public opinion and stigma may be even more aggressively adjusted. For example, to reduce the negative connotation of mental disorders such as ADHD, images of younger children could be used. This may elicit a more positive emotional load. This holds relevance for health promotion campaigns targeted at amending negative and incorrect public opinion.

5. Conclusion

In conclusion, we have performed the first study investigating online stock database images of mental disorders. We have found that these images may not give a realistic representation of disease in children. Unlike somatic diseases, image-related factors such as age and gender modify the emotional load of pictures concerning mental disorders. These factors may have wider implications for society's perception of pediatric psychiatric disease.

Declarations

Author contribution statement

J. Brassine, J. Van den Eynde: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

T. R. Hubble: Analyzed and interpreted the data; Wrote the paper.

J. Toelen: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

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