OBJECTIVES: To understand how children perceive severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in relation to public representations and to evaluate their interpretations.

METHODS: Children’s perceptions of SARS-CoV-2 were evaluated by asking 103 French children, aged 5 to 17 years old, first to draw a coronavirus and then to identify SARS-CoV-2 in a series of 16 images during summer 2020.

RESULTS: One hundred three children were included in the study, either during outpatient visits at the hospital (in Marseille and Paris) or through the authors’ social network, and were grouped in terms of age, parents’ occupation, mode of recruitment, and recollection of having previously seen a representation of a coronavirus. Half of the children drew the coronavirus as circular in shape, and almost all included a crownlike feature. One-third of the drawings had anthropomorphic features. Although the pictorial representations of the virus were fairly accurate overall, the children’s interpretations of the crownlike structure were imaginative. The explanations the children gave for their drawings were in some cases surprising. Among the 16 pictures they were shown, the children correctly identified those of SARS-CoV-2, other than the electron micrograph, in more than two-thirds of cases.

CONCLUSIONS: Children of all ages, even the youngest, and both sexes had a relatively accurate perception of SARS-CoV-2, as evaluated through their drawings and their ability to recognize it among other pictures. The children’s drawings of the coronavirus were colorful and had a less frightening tone than expected in the light of media coverage, suggesting that they had developed coping mechanisms.
Although children tend to have milder forms of coronavirus disease 2019, the pandemic and the lockdowns imposed to control it have dramatically altered their lifestyles and well-being. School closures have severely limited children’s social interactions. In France, schools were closed for 2 months in spring 2020, and the lockdown has since been replaced by specific infection prevention measures and general unease, notably in schools, where the wearing of face masks is mandatory, hand-washing is performed at regular intervals, and physical distancing rules include a ban on direct contact, even for the youngest children. These new behavioral requirements have all arisen because of an invisible threat that children may struggle to conceptualize. One way to help children make sense of difficult concepts is through drawing: “S’il vous plaît...dessine-moi un mouton!” asks The Little Prince in the famous novella. Drawing is a natural and, perhaps, the most fundamental form of human expression and can be used to explore concepts and experience, to promote self-analysis and dialogue, and as an investigative tool. Illustrations of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) have been a ubiquitous feature of the coronavirus disease 2019 pandemic, as exemplified by the widely reproduced image released by the Centers for Disease Control and Prevention (CDC). Drawing can be used to give shape to the virus and grasp the realities underlying the pandemic. On the other hand, Byrne found that young children seldom represent microorganisms accurately and often give them an animal or fantastical appearance. How did the children envision SARS-CoV-2 Was it still a natural object, or had it become more mythical? It therefore seemed interesting to study how children depicted the coronavirus in relation to public representations and to evaluate their interpretations of the pandemic. The objective of the study was to evaluate children’s knowledge and understanding of SARS-CoV-2 through their drawings.

METHODS

In the following sections, the term “coronavirus” refers to the children’s representations, whereas “SARS-CoV-2” refers to the virus itself.

Participants

Children aged 5 to 17 years were recruited either during outpatient visits to 2 pediatric hospitals in France (La Timone Enfants in Marseille and Robert Debré in Paris) or through the authors’ social network.

Participants were recruited from July 15, 2020, to August 31, 2020.

Procedure

Children were enrolled in the study after they and their parents had provided informed consent. The purpose of the study, as explained to the children and their parents, was to evaluate the children’s understanding and representations of SARS-CoV-2 through their drawings and their ability to recognize images of the virus.

Separate consent was requested from the children and their parents to publish their drawings. The 7 parameters recorded were department (département) of residence; mode of recruitment; whether a parent was a health care worker; parents’ occupation, categorized according to the Institut National de la Statistique et des Études Economiques (INSEE) (the French national statistics institute) occupational classification; self-reported age; self-reported sex; and whether the children remembered having seen a coronavirus (in a picture, movie, video, etc). Children’s perceptions of SARS-CoV-2 were evaluated in 2 ways. They were first asked to draw a coronavirus in a 170 × 160-mm frame. The children were given the following written instructions: “Draw a coronavirus, as you imagine it, without any model or example (draw it large enough, even if it really is very small).” They were invited to comment on their drawing. For the second evaluation, they were shown a series of 16 images simultaneously and were asked to indicate which images represented a coronavirus (by circling them) and which did not (by crossing them out) or if they did not know. The 16 pictures were the red and gray three-dimensional (3D) illustration of a SARS-CoV-2 virion released by the CDC; a black bacteriophage; a brown bat; a silver sardine; a cartoon picture of a green anthropomorphic coronavirus particle; a black and white electron microscopy image of an HIV virion; a brown pangolin; a purple and blue 3D image of a SARS-CoV-2 virion; a red and blue 3D representation of an HIV virion; a green olive tree; a brown and green 3D illustration of a SARS-CoV-2 virion; a black and white electron microscopy image of a human papillomavirus (HPV) virion; a blue on red background electron microscopy image of an Ebola virus particle; a gray and red cartoon picture of a SARS-CoV-2 virion; a red on yellow background electron microscopy image of a Salmonella typhimurium bacterium; a red, yellow, and green on black background electron microscopy image of a SARS-CoV-2 virion; and a silver sardine. All images except for the cartoon representation of a green anthropomorphic coronavirus particle were obtained from Wikimedia commons (list and origin in Supplemental Fig 5 and Supplemental Table 3). These
images were chosen either randomly among images representing SARS-CoV-2, randomly among other viruses, because they were similar in shape to SARS-CoV-2 virions, or because they had another factor in common with the virus. Finally, the children were asked to give their opinions of the questionnaire. No predetermined time limit was imposed; the only restriction was on the 5 colors used for the drawings: black, red, green, yellow, and blue. To avoid interactions between participants (in particular, between siblings), the instructions were given and the tests were conducted in a private area, and the children could therefore not see the other drawings or exchange with other participants about what they wanted to draw.

**Data Analyses**

The drawings were analyzed by using the method developed by Reiss et al and used by Byrne. The drawings were first analyzed qualitatively to identify a set of characteristic features, and these parameters were then analyzed quantitatively (frequency and percentage) in the drawings. The parameters considered were the number of virus particles; body shape (circular, oval, humanlike, or other); presence of a crown, defined as a structure around the central shape; when present, the characteristic features of the crown (lines, spikes, circles, mushroomlike, halo, or square) and whether it had a single (simple) or multiple components (complex); presence of anthropomorphic features; 3D effects; main (>50%) color of the body (red, green, yellow, blue, black, or multiple); main (>50%) color of the crown (red, green, yellow, blue, black, or multiple); presence of text; and presence of components other than the virus in the drawing. The children’s comments explaining their drawings were analyzed qualitatively.

Parameters were compared between 6 subgroups defined by sex (girl or boy), age (5–6, 7–8, 9–10, 11–12, and 13–17 years), parents’ occupation (health care worker or other), mode of recruitment (social network or outpatient visit), and recollection of having previously seen a representation of a coronavirus (yes or no).

**Statistical Analyses**

Statistical analyses was performed with R (http://biostatgv.sentiweb.fr/) by using nonparametric tests (Wilcoxon rank test and Kruskal-Wallis test). Results were considered statistically significant at \( P < .05 \).

**Patients and Public Involvement**

Parents could leave their e-mail address (on a separate sheet to preserve anonymity) if they wished to receive the results of the study. They will receive an abstract written in French for the layperson.

**Ethical Approval**

This study was registered locally under 20_265. All children and their parents, or legal representative with parental authority, provided informed consent to participate in the survey. Because the study was completely anonymous and involved no biomedical data, no ethics committee approval was required under French law.

**RESULTS**

The results of the study are presented in 4 parts: the characteristics of the study population, the characteristics of the drawings, the results of the image identification tests, and, finally, the children’s assessment of the study.

**Population**

All eligible participants agreed to participate in the study. One hundred three children from 73 families participated in the study. The participants came from 20 of the 101 French departments, mostly from the areas around Marseille (35 children) and Paris (24 children), with on average 5.2 children per department (SD 7.4). The mean age of the participants was 9.1 years; 59 (57.3%) reported their sex as male and 44 (42.7%) as female. Thirty-five (33.9%) had a parent who was a health care worker, and 38 (36.9%) of the children were enrolled during outpatient visits. Two hundred parents provided their occupation (Table 1). The distribution between INSEE categories differed significantly from that of the general population, both for the study group as a whole (\( P < .001 \)) and for each of the subgroups considered (data not shown), except for outpatients (\( P = .14 \)).

The subgroups girl and boy, age (categorized into 5 subgroups: 5–6 years old, 7–8 years old, 9–10 years old, 11–12 years old, 13–17 years old), children with at least 1 health care worker parent and other children, social network-enrolled children and outpatients, and self-reported antecedent of seeing a representation of a coronavirus and no self-reported antecedent of seeing a representation of a coronavirus did not differ significantly in terms of age or self-reported sex. As expected, the children of health care workers were more likely to have been recruited through the authors’ social network (\( P = .011 \)), and their parents’ occupational profile differed significantly from the rest of the study group (\( P < .001 \)), as did occupational distributions of the outpatient-recruited and social network-recruited subgroups (\( P < .001 \) (Supplemental Table 4).

**Characteristics of the Drawings**

The median number of virus particles drawn was 1 (range, 1–60), the most frequently occurring shape was a circle (52.4% of drawings),
and 88.4% of the drawings featured virus particles with a crown, the majority of which (56.1%) had mushroom-shaped spikes. The mean size of the coronaviruses was 95.5 mm (SD 44.8); 20 of the 103 drawings (19.4%) were excluded from the size analysis because they had been done on a nonstandardized sheet of paper. The most common color for the body and crown was green (in 27 and 29 drawings respectively). Four children, 3 of whom were above the average age of the group (3 boys aged 8, 10, and 13 years and 1 girl aged 12 years), drew the virus with a nucleus, one of which had a double helix. The coronavirus had anthropomorphic features in 37% of cases, and 3D effects were present in 23.3% of cases. The most commonly occurring anthropomorphic feature was a face. The coronavirus was represented with a sad mouth in 7 cases (18.4%), with sharp teeth in 8 cases (21.1%), was pulling a face in 10 cases (26.3%), was smiling in 10 cases (26.3%), and without a mouth in 3 cases (7.9%). Thirteen of the drawings (12.6%) featured text (mostly “coronavirus” or “the coronavirus”), and 20 (19.4%) had extra drawn elements (in 6 cases, this was a human being). Interestingly, the virus was represented as the Devil in 6 drawings (5.8%; Table 2, Figs 1 and 2).

Older children were significantly more likely to add 3D effects ($P = .047$), which appeared in 10.5% of drawings by 5- to 6-year-olds and 37.7% of drawings done by 13- to 17-year-olds (Table 2). Conversely, anthropomorphic features were drawn by 47.4% of 5- to 6-year-olds and just 28.6% of 13- to 17-year-olds ($P = .03$). There were no other significant associations with age (Table 2) or with any of the other grouping variables (Supplemental Table 5) in terms of the characteristics of the drawings (Table 2).

### Image Identification Tests

In the image recognition part of the study, 6 of the 16 images represented SARS-CoV-2. Five of these 6 SARS-CoV-2 illustrations were correctly identified by >70% of the children, the only exception being the electron micrograph, which was only correctly recognized by half of the children (Fig 3). The other non-SARS-CoV-2 images were improperly identified as SARS-CoV-2 in <10% of cases, except for the red and blue 3D illustration of an HIV virion (in 64.1% of cases) and the black and white electron microscopy image of an HPV virion (in 35.9% of cases). These success rates were not significantly associated with sex (data not shown), but there were significant differences in terms of the different age groups (Fig 3). The proportion of children who correctly identified the red and gray 3D illustration of SARS-CoV-2 was 63.2% among 5- to 6-year-olds versus 92.9% among 13- to 17-year-olds ($P = .0021$), whereas the corresponding proportions who incorrectly identified the brown bat were 0% and 35.7%, respectively ($P = .0022$), and for the silver sardine, 0% and 21.4%, respectively ($P = .008$) (Fig 3).

### Children’s Comments on Their Own Drawings

Forty-two children provided explanations of their drawings. The explanations involved 5 main themes. There were comments on the way they had represented the virus itself: the coronavirus was...
Seven drawings had a 20 of the 103 drawings were excluded from the size analysis because they had been done on a nonstandardized sheet of paper.

For purposes of clarity, parameters according to sex are not represented because they were never statistically different.

### TABLE 2 Characteristics of the Drawings

<table>
<thead>
<tr>
<th></th>
<th>All (N = 103)</th>
<th>5–6 y Old (n = 19)</th>
<th>7–8 y Old (n = 31)</th>
<th>9–10 y Old (n = 20)</th>
<th>11–12 y Old (n = 19)</th>
<th>≥13 y Old (n = 14)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. viruses represented, n (minimum to maximum)</td>
<td>1 (1–60)</td>
<td>1 (1–2)</td>
<td>1 (1–38)</td>
<td>1 (1–1)</td>
<td>1 (1–60)</td>
<td>1 (1–1)</td>
<td>—</td>
</tr>
<tr>
<td>Shape of the virus(es), n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.37</td>
</tr>
<tr>
<td>Circle</td>
<td>54 (52)</td>
<td>9 (48)</td>
<td>13 (42)</td>
<td>12 (60)</td>
<td>11 (58)</td>
<td>9 (65)</td>
<td></td>
</tr>
<tr>
<td>Oval</td>
<td>38 (37)</td>
<td>8 (42)</td>
<td>13 (42)</td>
<td>8 (40)</td>
<td>7 (37)</td>
<td>2 (14)</td>
<td></td>
</tr>
<tr>
<td>Humanlike (body)</td>
<td>5 (5)</td>
<td>1 (5)</td>
<td>3 (10)</td>
<td>0</td>
<td>0</td>
<td>1 (7)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
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<td>1 (5)</td>
<td>2 (6)</td>
<td>0</td>
<td>1 (5)</td>
<td>2 (14)</td>
<td></td>
</tr>
<tr>
<td>Body color, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.73</td>
</tr>
<tr>
<td>Red</td>
<td>18 (17)</td>
<td>3 (16)</td>
<td>7 (23)</td>
<td>5 (25)</td>
<td>2 (11)</td>
<td>1 (7)</td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>27 (28)</td>
<td>3 (16)</td>
<td>9 (29)</td>
<td>4 (20)</td>
<td>4 (21)</td>
<td>7 (50)</td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td>7 (7)</td>
<td>2 (10)</td>
<td>2 (6)</td>
<td>1 (5)</td>
<td>2 (11)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td>4 (4)</td>
<td>0</td>
<td>3 (10)</td>
<td>0</td>
<td>0</td>
<td>1 (7)</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>11 (11)</td>
<td>2 (10)</td>
<td>4 (13)</td>
<td>2 (10)</td>
<td>3 (16)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Multiple</td>
<td>6 (6)</td>
<td>1 (5)</td>
<td>2 (6)</td>
<td>2 (10)</td>
<td>0</td>
<td>1 (7)</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>30 (29)</td>
<td>8 (43)</td>
<td>4 (13)</td>
<td>6 (30)</td>
<td>8 (43)</td>
<td>4 (29)</td>
<td></td>
</tr>
<tr>
<td>3D representation, n (%)</td>
<td>23 (22)</td>
<td>0</td>
<td>5 (16)</td>
<td>6 (30)</td>
<td>5 (26)</td>
<td>5 (38)</td>
<td>.047</td>
</tr>
<tr>
<td>Anthropomorphic feature, n (%)</td>
<td>38 (37)</td>
<td>5 (22)</td>
<td>14 (45)</td>
<td>9 (45)</td>
<td>2 (10)</td>
<td>4 (28)</td>
<td>.032</td>
</tr>
<tr>
<td>Elements drawn other than the virus, n (%)</td>
<td>20 (19)</td>
<td>4 (21)</td>
<td>6 (19)</td>
<td>2 (10)</td>
<td>5 (26)</td>
<td>3 (21)</td>
<td>.86</td>
</tr>
<tr>
<td>Text accompanying the drawing, n (%)</td>
<td>13 (13)</td>
<td>0</td>
<td>4 (13)</td>
<td>3 (15)</td>
<td>3 (15)</td>
<td>3 (21)</td>
<td>.074</td>
</tr>
<tr>
<td>Maximum length of the drawing, a</td>
<td>83 (80) (44.8)</td>
<td>14; 101.1 (55.5)</td>
<td>21; 90.9 (41.2)</td>
<td>17; 100.9 (44)</td>
<td>18; 93.2 (46.6)</td>
<td>13; 89.8 (35)</td>
<td>.95</td>
</tr>
<tr>
<td>n, mean (SD), mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presence of a crown, n (%)</td>
<td>91 (88)</td>
<td>18 (95)</td>
<td>25 (81)</td>
<td>18 (90)</td>
<td>17 (89)</td>
<td>13 (93)</td>
<td>.78</td>
</tr>
<tr>
<td>If yes, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.84</td>
</tr>
<tr>
<td>Simple</td>
<td>84 (82)</td>
<td>18 (100)</td>
<td>22 (88)</td>
<td>15 (83)</td>
<td>17 (100)</td>
<td>12 (92)</td>
<td></td>
</tr>
<tr>
<td>Complex</td>
<td>7 (7)</td>
<td>0</td>
<td>3 (22)</td>
<td>3 (17)</td>
<td>0</td>
<td>1 (8)</td>
<td></td>
</tr>
<tr>
<td>Shape of crown, b n</td>
<td>98</td>
<td>18 (100)</td>
<td>28</td>
<td>21</td>
<td>17</td>
<td>14 (100)</td>
<td>.61</td>
</tr>
<tr>
<td>Line, n (%)</td>
<td>13 (13)</td>
<td>3 (17)</td>
<td>3 (11)</td>
<td>3 (14)</td>
<td>2 (12)</td>
<td>2 (14)</td>
<td></td>
</tr>
<tr>
<td>Spike, n (%)</td>
<td>13 (13)</td>
<td>3 (17)</td>
<td>3 (11)</td>
<td>3 (14)</td>
<td>2 (12)</td>
<td>2 (14)</td>
<td></td>
</tr>
<tr>
<td>Circle n (%)</td>
<td>6 (6)</td>
<td>3 (17)</td>
<td>1 (3)</td>
<td>1 (5)</td>
<td>1 (6)</td>
<td>0</td>
<td></td>
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<tr>
<td>Mushroomlike, n (%)</td>
<td>55 (57)</td>
<td>8 (44)</td>
<td>15 (53)</td>
<td>12 (57)</td>
<td>11 (64)</td>
<td>9 (65)</td>
<td></td>
</tr>
<tr>
<td>Halo, n (%)</td>
<td>6 (6)</td>
<td>1 (5)</td>
<td>3 (11)</td>
<td>1 (5)</td>
<td>0</td>
<td>1 (7)</td>
<td></td>
</tr>
<tr>
<td>Square, n (%)</td>
<td>5 (5)</td>
<td>0</td>
<td>3 (11)</td>
<td>1 (5)</td>
<td>1 (6)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Color of crown(s), n</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red, n (%)</td>
<td>16 (18)</td>
<td>2 (11)</td>
<td>5 (20)</td>
<td>1 (5)</td>
<td>5 (29)</td>
<td>3 (23)</td>
<td></td>
</tr>
<tr>
<td>Green, n (%)</td>
<td>28 (29)</td>
<td>6 (33)</td>
<td>8 (32)</td>
<td>5 (28)</td>
<td>6 (35)</td>
<td>4 (21)</td>
<td></td>
</tr>
<tr>
<td>Yellow, n (%)</td>
<td>7 (8)</td>
<td>1 (6)</td>
<td>1 (4)</td>
<td>2 (11)</td>
<td>1 (6)</td>
<td>2 (15)</td>
<td></td>
</tr>
<tr>
<td>Blue, n (%)</td>
<td>10 (11)</td>
<td>2 (11)</td>
<td>4 (16)</td>
<td>1 (6)</td>
<td>1 (6)</td>
<td>2 (15)</td>
<td></td>
</tr>
<tr>
<td>Black, n (%)</td>
<td>16 (18)</td>
<td>2 (11)</td>
<td>3 (12)</td>
<td>6 (33)</td>
<td>4 (24)</td>
<td>1 (8)</td>
<td></td>
</tr>
<tr>
<td>Multiple, n (%)</td>
<td>13 (14)</td>
<td>5 (28)</td>
<td>4 (16)</td>
<td>3 (17)</td>
<td>0 (0)</td>
<td>1 (8)</td>
<td></td>
</tr>
</tbody>
</table>

For purposes of clarity, parameters according to sex are not represented because they were never statistically different. —, not applicable.

a Twenty of the 103 drawings were excluded from the size analysis because they had been done on a nonstandardized sheet of paper.

b Seven drawings had >1 crown; therefore, the number of “shape of crown” (n = 98) is larger than the number of drawings with presence of a crown (n = 91).

compared with a millipede (by a 5-year-old girl), a mushroom (by a 9-year-old boy) and a porcupine (by an 11-year-old boy). They also commented on the way they had imagined the crownlike protrusions: as tentacles (by a 10-year-old boy), branches (by a 13-year-old boy), suction cups (by a girl and 2 boys 7 years of age), mushrooms (by a 7-year-old boy), and spikes (by an 8-year-old boy and 7- and 9-year-old girls). The children also explained how they imagined the function of the crown: the spikes were qualified as sticky (by a 7-year-old girl and 7-, 9-, and 10-year-old boys) and as able to detect humans (by a 13-year-old boy), contaminate (by a 9-year-old girl), or suck blood and project bacteria (by a 7-year-old boy). Finally, some children included more general considerations in their comments, mostly about the virus’s impact on humans. The virus was described as the “king of germs” (by a 7-year-old boy); as the Devil (by a 7-year-old boy and a 9-year-old girl); as being evil (by 2 boys aged 7 and 9 years and 2 girls aged 6 and 9 years); as being mortal (by a 13-year-old girl); as making people sick, incurable, or dead (by a 6-year-old boy); and as floating in the air (by 2 boys aged 7 and 12 years). One girl, aged 5 years, described SARS-CoV-2 as being sad because it had lost its family, and one boy, aged 16 years, said that it had both negative and positive aspects, two of which being population reduction and improved
adherence to infection control guidelines in the general population. Eight drawings showed the coronavirus interacting with humans or the environment (Fig 4). Three of the 4 children who had drawn the coronavirus interacting with humans commented that their aim was to show the coronavirus being defeated or scared.

**Children’s Assessment of the Study**

When asked about their assessment of the study after completing it, 62 of 103 children expressed an opinion. Fifty-seven children answered that they were mostly satisfied: 38 children found the study good; 6, interesting; 4, easy; 3, funny; 1, important; and 1 child described it as extraordinary. Five children said that it was strange. Only a handful expressed a negative opinion: 3 children found the study difficult, 2 did not like it. Finally, one child said, “Thank you to all the health workers.”

**DISCUSSION**

A majority of the children in this study represented SARS-CoV-2 as a red or green circle with a crown composed of mushroomlike surface projections. This is a good approximation of the common representation of SARS-CoV-2 particles in the media and in the scientific literature. Moreover, with the exception of the electron micrograph, the 5 remaining illustrations of SARS-CoV-2 virions were correctly identified by >70% of the children. This suggests that most of the children were aware of the archetypal representation of SARS-CoV-2. Interestingly, although older children were more likely to
correctly identify the simple illustrations of SARS-CoV-2 particles, they were less likely than younger children to identify the anthropomorphic representation as SARS-CoV-2, and only the oldest children identified the brown bat as SARS-CoV-2. This may be because they confused the virus with its presumed animal source. Indeed, the children also identified the pangolin as SARS-CoV-2 in 8.7% of cases, with a nonsignificant increase in this proportion with age. Children who reported having already seen a representation of SARS-CoV-2 correctly recognized a higher proportion of SARS-CoV-2 pictures than the other children did. Regarding the children’s illustrations of SARS-CoV-2, the differences in terms of 3D effects and anthropomorphic features can be linked to the development of the internal mental models associated with visual realism at 8 years of age.11

Although the children’s overall pictorial representations of SARS-CoV-2 were fairly accurate, the different components of the virus were interpreted with imagination. The crownlike spikes, for example, were imagined as suction cups; arms, legs, feet, or tentacles to hang humans; picks to contaminate people or hurt the body; and branches to detect its victims or even pump for blood and bacteria to go into or out of the virus. Furthermore, as reported by Byrne,9 the children did not clearly distinguish the virus from bacteria. In contrast with Byrne’s findings, however, the representations were consistent with the accepted shape of SARS-CoV-2, and no obvious animallike shapes were drawn (whereas one-third of the illustrations in Byrne’s study had animallike features). Some children drew the mode of transmission (airborne) and infection protection measures (hand-washing and face masks).

Viruses come in many different shapes and structures (spheres and rods, icosahedral, helical or complex symmetries, enveloped or not).12 Among the non–SARS-CoV-2 images shown to the children, Ebola and bacteriophage, nonspherical viruses, were identified as SARS-CoV-2 in <5% of cases. Before the pandemic, the archetypal virus in the public imagination was probably HIV, which is pleomorphic (spherical and polygonal) and has an envelope.12 The 3D image of HIV was the only non–SARS-CoV-2 image identified as SARS-CoV-2 by more than half (64%) of the children, much less frequently, nevertheless, than were the 3D representations of SARS-CoV-2 itself (by 84.5%, 80.6%, and 79.6% of the children). Similarly, the electron microscopy image of HIV was less frequently recognized as SARS-CoV-2 than was the electron micrograph of SARS-CoV-2 (5.8% vs 48.5%, respectively). This suggests that, as a rule, the children were able to discriminate between representations of different viruses.

Some children represented the coronavirus as the Devil or as destroying the Earth, highlighting the frightening aspects of the pandemic, and some children described the virus as being a “supervirus” either in discussions or in the drawings themselves (superhero muscles, an actual crown, other viruses being rejected by the coronavirus, the king of viruses with secret weapons, or the virus that blows up the Earth). However, in the 4 drawings that showed interactions between humans and the coronavirus, the latter was only shown in a threatening attitude in 1 case (and even in this case, the face mask is present in the drawing, possibly as a support to fight the virus), whereas in the 3 others, the coronavirus was being chased away either with a face mask, hand-washing, or magic. One-quarter of the children drew the coronavirus smiling, most representations were colorful, and only 11% drew the coronavirus in black, the color typically used for negatively characterized figures.13 It therefore appears that the children seem to be relatively unafraid of the virus.

The main strengths of our study are its size, the wide age range of participants, and (within France) the broad distribution of geographical origins. Nevertheless, the sex ratio is imbalanced, and children >13 years of age are underrepresented. In addition, although all occupational categories are represented in the study group, higher-level occupational backgrounds (INSEE group 3, senior executives and knowledge workers) were overrepresented compared with the general population, probably because recruitment was partly through the authors’ social network. However, because there were no meaningful differences between subgroups (notably between social network–recruited and outpatient-recruited children, whose parents’ occupational distribution is more representative of the general population), our results can be considered representative of how
FIGURE 3
Supervised heat map representing the results of the identification of 16 images by the children of the study. Each column defines a figure that is shown at the top. Each line corresponds to 1 child's answers; lines are grouped according to age and sex. Blue characterizes the figures that were identified as SARS-CoV-2 by children; red, those that were identified as non–SARS-CoV-2; and white, those that were left with no answer. The first 6 images starting from the left are correct representations of SARS-CoV-2. The percentage of figure recognition as SARS-CoV-2 appears at the bottom of each column. As an example, the first image, which represents SARS-CoV-2, was identified as so by 84.5% of the children.
French children perceive SARS-CoV-2. The main limitations of our study are that participants were recruited by convenience, potentially leading to a nonrepresentative sample; that participants included multiple siblings, a possible source of bias; the ad hoc nature of the viral recognition test; the descriptive nature of the analyses; and the absence of semistructured interviews and of a deeper evaluation of the psychological meaning of the drawings. It is also important to remember that this study was realized after the first and before the second wave of SARS-CoV-2 infections throughout Europe.

This study is, to our knowledge, one of just a handful focused on children’s drawings of microorganisms (reviewed by Byrne9) and is the first ever study of children’s representations of viruses. Thus, the results should be considered in light of its exploratory nature. It is unclear, for instance, whether the results are specific to France or similarly representative of other countries or populations. It is notable in this context that even young children identified the main characteristics of SARS-CoV-2. It would be interesting to use similar experiments in schools to foster children’s interest in biology and explain the diversity of viruses, but they could also be used as compelling social and psychological tools, particularly in the ongoing pandemic. We think that pediatricians could use drawings as a starting point to discuss the pandemic with children and its effects on them. This study could indeed be used as a basis for further prospective studies. To better evaluate the psychological effects the pandemic has had on them, children could be offered semistructured interviews to talk about their drawings, which could be analyzed qualitatively, potentially to therapeutic ends, as described previously in other traumatic contexts.14

CONCLUSIONS
We found that children of all ages and of both sexes were able to depict and recognize SARS-CoV-2.
fairly accurately, probably because of the massive media coverage of the pandemic. The children in this study were also able to discriminate representations of SARS-CoV-2 from those of other viruses, animals, and bacteria. Qualitative analysis revealed that although the virus was in some cases represented as a supervirus, the drawings were colorful and less frightening in tone than expected, suggesting that the children may have developed a coping mechanism. Just as The Little Prince ultimately tamed the fox, drawing SARS-CoV-2 may help children better conceptualize the virus and its consequences and thus become less frightened of it.

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REFERENCES


ABBREVIATIONS

3D: three-dimensional
CDC: Centers for Disease Control and Prevention
HPV: human papillomavirus
INSEE: the Institut National de la Statistique et des Études Économiques
SARS-CoV-2: severe acute respiratory syndrome coronavirus 2
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