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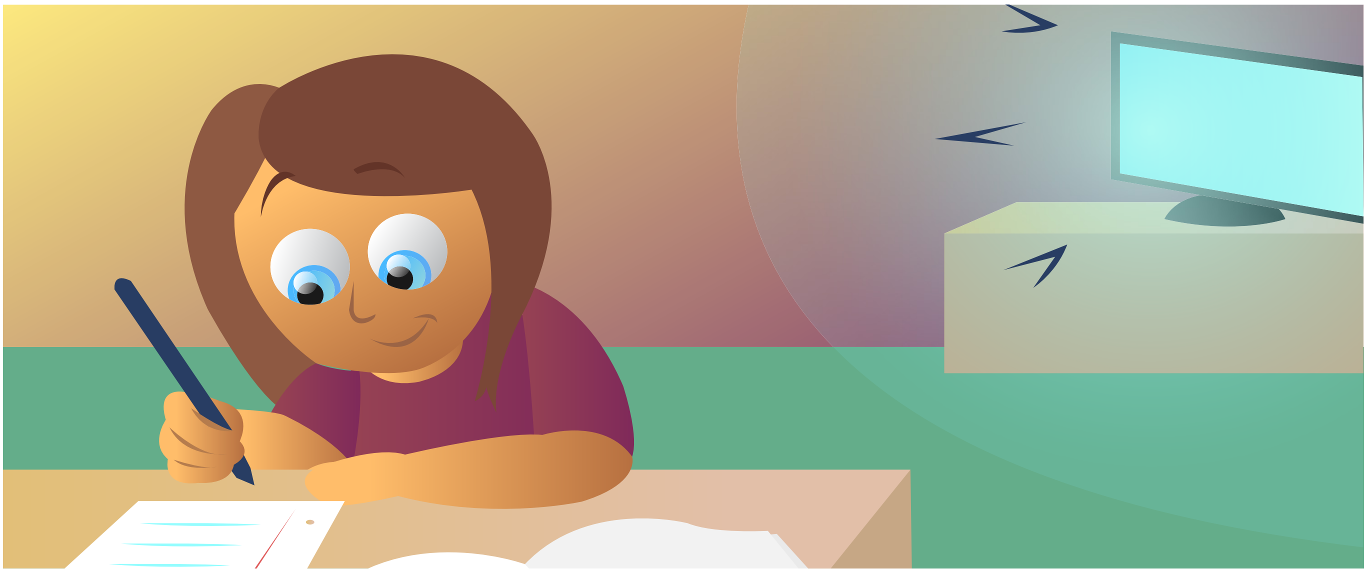

HOW DO KIDS AND GROWN-UPS GET DISTRACTED IN EVERYDAY SITUATIONS?

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The world is a distracting place—full of shapes and colors, sounds, and smells that constantly excite our senses. Sometimes, things that distract us can stimulate multiple senses at once. When the TV is switched on while we are trying to read, moving images on the screen are accompanied by sounds. But you may have noticed that, as you grow older, you become better at ignoring distractions, and staying focused on what you are doing. Especially if what you are doing is difficult, like reading a Young Minds article. Would you have done as well when you were 6? Our ability to pay attention improves with age; however, adults get distracted, too. We found that, surprisingly, adults are worse at ignoring distractions involving both shapes and sounds than 6-year olds are. By studying distractions that involve multiple senses, we can better understand how our attention works in everyday situations and how our ability to pay attention grows as we grow.

WHY DO WE GET DISTRACTED?

Imagine that you are 7 years old and need to read four sentences from a book to do your homework. The first two sentences are on a page full of text, while the other two sentences appear by themselves on the next page, with no other text around them. Which sentences do you think you would read faster and with less effort? Would your older sister, who is 11, read these sentences faster than you? What about your dad? Now imagine that you are doing your homework in a different situation. First, you are doing your homework on the table where you have other notebooks with words written on them in large print. Would you get distracted looking at the notebooks? Then, your mom puts a children's program on the radio and they are singing the alphabet—you can hear the speakers saying "a," "b," "c," and other letters. Are you more distracted by this than you were by the notebooks? Which sentences are you now reading more slowly—the ones that are alone on the page or the ones surrounded by other text? Do you think your sister or your dad would have problems like you, or maybe more or less? Finally, your mom switches off the radio to puts on a TV show for kids where you can both hear *and* see "a," "b," and "c." Who in your family is the most distracted now? And which text is now read most slowly?

SELECTIVE ATTENTION

How well we are able to keep our focus on what is currently important to us without getting distracted.

MULTISENSORY

Something that we notice with more than one ("multi") sense, and not just with one ("uni") sense. Usually, almost everything around us is multisensory. For example, people, animals, cars, TV, and mobile phones are things we see *and* hear and are thus "audio-visual" or "multisensory." Also, we can often touch, smell, or taste things around us, especially food.

DISTRACTOR

Something in the world around us that can grab our attention away from what we are doing. So, something that can *distract* us.

Selective attention (focusing on one thing) is important for any everyday task—reading, writing, or playing video games (for more detailed definitions of the new terms, see the Glossary). Nevertheless, we all get distracted from time to time. What causes distraction? Research on attention suggests that distraction is strongly influenced by the task we are trying to do, by what is distracting us (which of our senses are excited), and by how old we are. All three factors are important, but separately they cannot explain how selective attention works outside the laboratory, in real-life settings, where distractions usually involve many senses at once (called **multisensory distractors**). In this article, we first discuss the three factors that influence how distracted we get (Figure 1). Then, we describe our study, where we linked these factors together to understand how distraction works in everyday situations.

FACTOR 1: DIFFICULTY OF THE TASK

Professor Nilli Lavie helped us understand that how hard is the task that we are doing is important to whether we will be distracted by anything (called a distractor). Prof. Lavie asked participants in her study [1] to search for one of two letters (X or N) in a group of letters in the center of a computer screen. A distractor letter (X or N) appeared on the far side of the screen. When there were only a few letters (easy search task), people were slower to find the target letter when the distractor was the opposite letter than when it was the same letter. As this task demanded only a small amount of the participant's attention, there was plenty of attention left for noticing

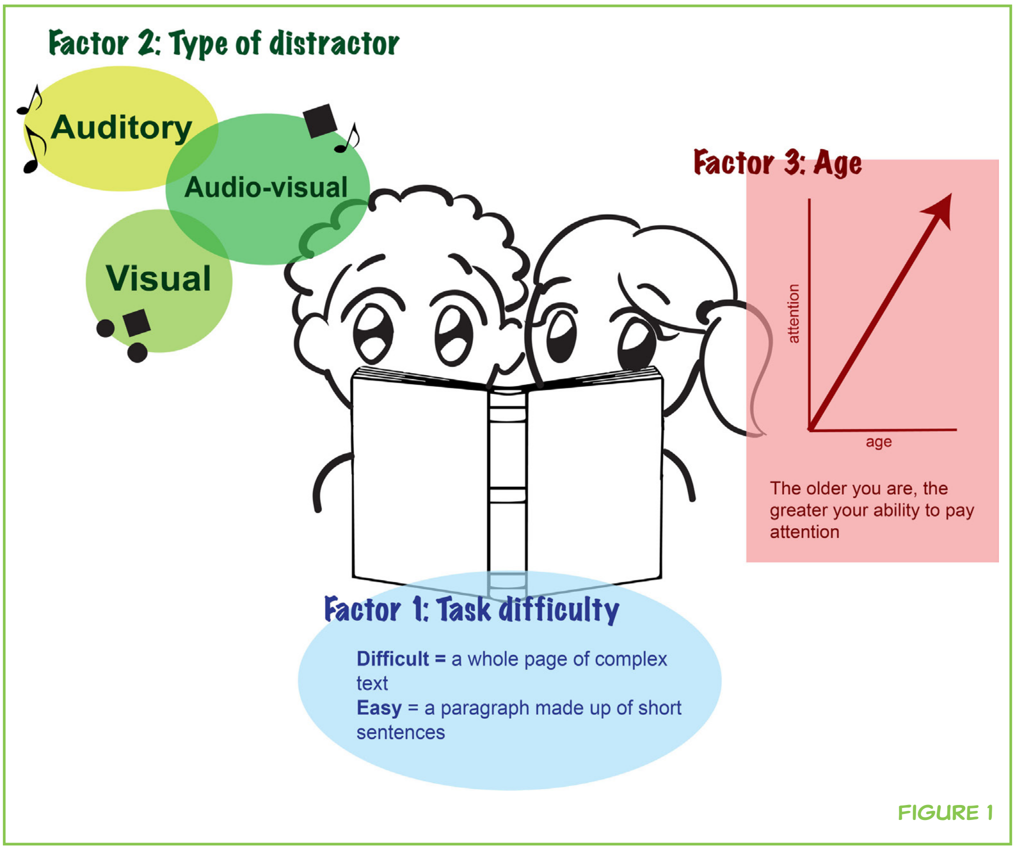

FIGURE 1

A diagram of the three factors that influence attention and distraction. The example shows children performing a visual task that requires a lot of paying attention: reading a book.

distractors. When there were many letters in the group (difficult search task), the distractor letters stopped influencing how quickly people found the target letters. So, the harder the task, the more attention we have to focus on it. The more attention we spend on the task, the less attention is left to spend on distractors.

Does that mean we can avoid distraction simply by doing more difficult tasks? Not necessarily.

FACTOR 2: TYPE OF DISTRACTOR

Prof. Lavie's experiment only tested one type of distractor—a visual distractor (something the participants could see). But sounds, smells, and other distractors present in real life may distract us more than visual things when we perform a visual task. Researchers tested this idea using a version of Prof. Lavie's experiment in which distractors were *only* sounds [2]. They found that distracting sounds made people slower at finding the letters in *both* the easy and difficult version of the find-the-letter task. Compare this with the original experiment—in the difficult version of the task, people were no longer distracted by visual distractors. But, people were distracted by the distracting *sounds* independently of how hard the visual task was.

One possible explanation for this finding is that our brains have separate ways of paying attention to information from each of our senses. So, if vision uses up a lot of our attention, we can still be distracted by sounds because we have plenty of other attention for those. However, some scientists found the opposite results—in difficult visual tasks, distracting sounds were also ignored! These opposite results suggest that our brains have a fixed amount of attention distributed across *all* of our senses. So, if seeing is demanding too much attention, there will not be attention enough left for hearing. One way to figure out which of these two possibilities is correct might be to study distractors that affect many senses at the same time. Why?

First, in real life, our senses are usually bombarded with information from many sources around us, and often this information is multisensory, meaning that it excites many senses at once. Second, multisensory information is usually processed differently than purely visual or purely auditory (hearing) information [3]. Research we have done has shown that people naturally pay more attention to multisensory information than to purely visual information [4]. For example, when your pet cat suddenly jumps at you when you walk through your kitchen, you will be able to catch him faster if he meows when jumping. However, nobody knows if *all people* in *all situations* pay attention to multisensory things in the same way. Because multisensory things might involve sound, they might affect attention in both easy and difficult visual tasks, like we just described above. However, because the brain naturally pays more attention to multisensory distractors, these may affect selective attention even more strongly than distractors that are just auditory or just visual, no matter how easy or difficult the task is.

FACTOR 3: AGE OF THE PERSON DOING THE TASK

Young children are known to be worse than adults at paying attention to *visual* information—both the important and the unimportant pieces. A version of Prof. Lavie's experiment was conducted on 7-year olds [5]. When the task was most easy, both children and adults were distracted by visual letter distractors. When the task was most difficult, both 7-year-old children and adults were no longer distracted by the visual letter distractors. However, the 7-year-old children were not distracted already when the task was a bit harder than its easiest version. This tells us that children have overall a smaller amount of attention to pay than do adults. So, as children grow into adults, their amount of attention grows too, and they are able to process more information (including distractors). Clearly, the growth of the ability to pay attention changes how our brains process visual distractors. But, could this also change the way we process multisensory distractors?

In our study, we wanted to understand how our brains deal with multisensory (audio-visual) distractors, and how this changes with task difficulty, as well as with the age of the participants. We believe that existing theories of attention cannot explain how the brain handles multisensory distractors. This is because these theories are based on studies using mainly visual, sometimes

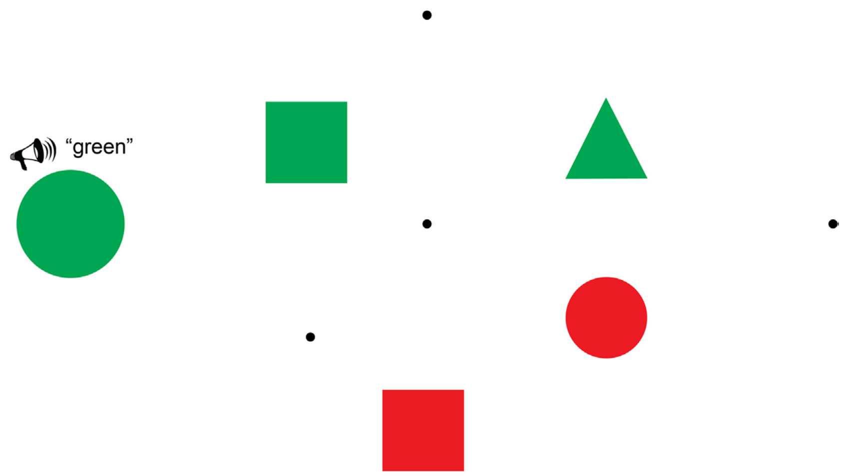

FIGURE 2

FIGURE 2

An example of a difficult visual search task, in which the target and multisensory distractor did not match. The target was a red square, and the distractor was a green circle, shown on the far left, with a voice recording of the word "green." The distractor shape was more distracting than the other shapes because it was further away from the center of the screen and was slightly larger. The black dots show where other shapes and the distractor could appear.

auditory, distractors. If the way we pay attention is shared across the senses, a difficult visual task may use up resources necessary to deal with multi-sensory distractors. However, if the ways we pay attention are separate for each sense, audio-visual distractors should still distract even when a difficult visual task is being performed. Age is yet another factor to consider. Could it be that children's more limited ability to pay attention makes them less distracted by multisensory distractors as well as by single-sense distractors?

HOW WE STUDIED DISTRACTION IN MULTISENSORY ENVIRONMENTS?

We tested 30 young children (6-year old), 33 older children (11-year olds), and 30 adults (20-year olds). These participants had to press a button on the keyboard when they found either a red square or a green circle on the computer screen (Figure 2 shows exactly what the participants saw). For each of these two target shapes, participants were also shown three types of distractors on the far end of the screen: a red square or a green circle shape (visual distractors), a voice recording of the words "red" or "green" (auditory distractors), or the shape and the voice recording together (multisensory distractors). The distractor could match the target (a red square distractor for a red square target), or not match the target (a red square distractor for a green circle target). This was repeated 10 times: 5 of those times, participants always saw just one shape, which was the one they were supposed to find (easy task); in the other 5 times, they saw three additional shapes along with the one they were supposed to find (difficult task).

RESPONSE TIME

The time it takes a participant to respond (for example, press a keyboard button) in a task. In this article, response time means the time it takes to press the button when they find the correct target.

HOW DIFFERENT TYPES OF DISTRACTORS AFFECTED ATTENTION?

We assessed the effect of distractors on attention by measuring **response time**, meaning how long it took the participants to find the target and press the button. If the participants took a long time to find the target, they were probably paying attention to a distractor—this is how the response time told us if the participants were distracted. Overall, younger children responded the slowest, followed by older children, and adults responded the fastest.

Next, we found that distraction was higher with easy tasks than with difficult tasks, but this depended on both the type of distractor and the age of the participants (see Figure 3 for a summary of these results):

- Visual distractors: when the task was easy, younger children and older children were more distracted than adults. When the task was difficult, no one was distracted.
- Auditory distractors: everyone was distracted similarly during both easy and difficult tasks.
- Multisensory (audio-visual) distractors: again, younger and older children were more distracted than adults when the task was easy. However, adults were still similarly distracted when the task became difficult. So, adults were still affected by the multisensory distractors, even though the task now required more attention. Older children were less distracted in the difficult task than in the easy task. Younger children were not distracted at all when the task was difficult.

WHAT HAVE WE LEARNT ABOUT DISTRACTION IN EVERYDAY LIFE?

To summarize, our study found that

- Distractions that involve the same sense as the one important for the task distract us only when the task is easy. When the task is hard, we do not get distracted. This happens at all ages.
- Distractions that involve a different sense than the one important to the task can distract us regardless of whether the task is hard or easy. This also happens at all ages.
- Distractions that involve multiple senses at the same time, including the one important for the task, distract us no matter how old we are when

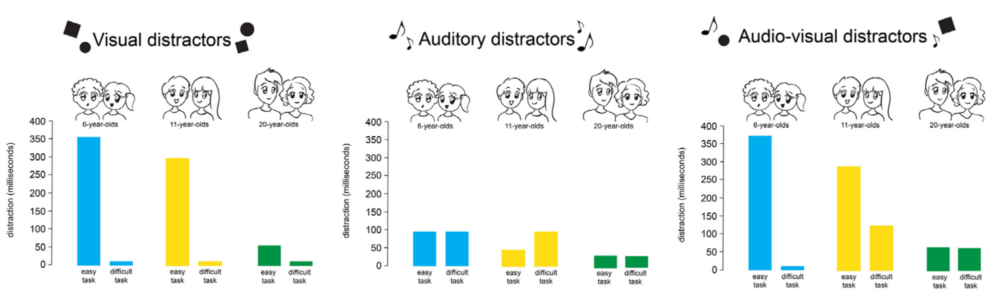

FIGURE 3

FIGURE 3

Distraction results for each type of distractor, difficulty of the task, and age of the participants. The bars represent response time in milliseconds (1/1,000 of a second), indicating how distracted the participants were while trying to find the target. Long response times meant people were slow to find the target, because they were distracted, while short response times meant fast responding and little or no distraction. So, the shorter the bar, the "better" the performance. The figure clearly shows that, in difficult tasks, distraction was generally the strongest for multisensory (audio-visual) distractors, but 6-year olds were the only ones not strongly distracted and succeeding at paying attention mainly to the find-the-letter task.

the task is easy. When the task is hard, our age influences our distraction. When we are young children, multisensory distractions only affect us little. But, as we grow older, multisensory distractions begin to affect us more like they affect adults. When we are adults, multisensory distractions can distract us even when the task we perform is difficult.

The findings related to multisensory distractors give us an idea of how the brain pays attention. Even when the task uses up visual attention, there is still some attention available that can be distracted by audio-visual distractors. This is true even for older children, who have less ability to pay attention than adults do. However, young children were not distracted by multisensory distractors when the task became difficult. Why?

We think this happens because the way we pay attention changes as we get older. Our findings suggest that the brains of adults and older children have separate pools of attention for each of the senses, but this might not be true until around the age of 7. Before then, because young children have less ability to pay attention overall, their attention can all be focused on stimuli in just one sense. So, sometimes, if young children have to pay a lot of attention to something visual, that will make them less distracted by multisensory information, because they do not have enough leftover attention to pay to the distractor. To use our example, having to read two sentences written on a page full of text should make you as a 7-year olds less distracted by a TV show than reading two sentences printed on an empty page. We did not know this before.

We should also note that distraction did not mean that participants could not perform the task *at all*. It just means that they were paying *less* attention to their find-the-letter task when they searched for shapes in presence of a strong distractor, for example, when the colored shape distractor in the periphery was presented together with a sound.

Our study shows that the brain processes of paying attention (and being distracted) are complicated. Our ability to pay attention without distraction depends on whether the distraction is visual, auditory, or both, and also if the task is easy or difficult, and whether we are younger or older. Next time you are trying to read something in class and are having trouble concentrating because someone in the room is chatting loudly, you may now understand better why. At the same time, what we investigated in our study was only one of many ways in which children and adults may differ in how they pay attention in real life. We hope to discover them too.

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ORIGINAL SOURCE ARTICLE

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REFERENCES

1. Lavie, N., and Cox, S. 1997. On the efficiency of visual selective attention: efficient visual search leads to inefficient distractor rejection. *Psychol. Sci.* 8(5):395–6. doi:10.1111/j.1467-9280.1997.tb00432.x
2. Tellinghuisen, D. J., and Nowak, E. J. 2003. The inability to ignore auditory distractors as a function of visual task perceptual load. *Percept. Psychophys.* 65:817–28. doi:10.3758/BF03194817
3. Murray, M. M., and Wallace, M. T. 2011. *The Neural Bases of Multisensory Processes.* Boca Raton, FL: Taylor & Francis Group.
4. Matusz, P. J., and Eimer, M. 2011. Multisensory enhancement of attentional capture in visual search. *Psychon. Bull. Rev.* 18(5):904–9. doi:10.3758/s13423-011-0131-8
5. Huang-Pollock, C. L., Carr, T. H., and Nigg, J. T. 2002. Development of selective attention: perceptual load influences early versus late attentional selection in children and adults. *Dev. Psychol.* 38:363–75. doi:10.1037//0012-1649.38.3.363

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CONFLICT OF INTEREST STATEMENT: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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HEBREW UNIVERSITY HIGH SCHOOL, 14–15 YEARS OLD

We are a group of junior high school students who share a common interest in, and passion for, science. In our school next to the Hebrew University in Jerusalem, we study physics, chemistry, biology, and computer science and spend a lot of time together having fun and exploring the world.

AUTHORS

NORA TUROMAN

I am interested in how our senses work together to influence skills important for everyday behaviors, such as attention, learning, memory, and language. I am also interested in using this knowledge to help people with damaged abilities to see or to pay attention. In my spare time, I enjoy traveling, photography, and singing very very badly.

REBECCA MERKLEY

I am interested in how young children learn and, more specifically, how different factors, such as attention, influence learning. I am currently a postdoctoral researcher in developmental psychology at the University of Western Ontario in London, Canada. My other passions include traveling, waterskiing, and playing with other peoples' dogs.

GAIA SCERIF

I study the development of attention and attention difficulties, from how they are created in the brain to how they shape our abilities to learn to read and do basic mathematics as children. This is important because attention influences how we learn and behave in everyday situations, and it is particularly relevant in the classroom. Many developmental disorders are characterized by attention difficulties, and I aim to understand how they are similar, how they differ, and how difficulties matter to learning.

PAWEL J. MATUSZ

I study the various ways the brain puts together information stimulating multiple senses. What fascinates me is what mechanisms makes some multisensory objects especially easy to see, attention grabbing, and easy to remember, and how these mechanisms change depending on the person—how old they are and how much experience they have with some objects. I want to use this knowledge to help children who have problems with reading or basic math, and those who cannot see very well. In my spare time, you will find me reading random books, trying new dishes, or cycling around Lac Léman. *pawel.matusz@gmail.com