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ORIGINAL PAPER

Appreciation of Slapstick Humour and Expressivity in Response to Amusing Stimuli in Individuals with Williams Syndrome

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Abstract

Objectives Previous studies on the comprehension and appreciation of humour in individuals with Williams syndrome (WS) have only included complex types of humour that required complex cognitive abilities. Additionally, although individuals with WS have been described as having a bias towards positive emotions, no study has investigated their expressive responses to humour.

Methods The present study examined basic humour processing skills, as well as expressive responses to simple humorous and non-humorous stimuli in individuals with WS (N = 8) compared to mental-age matched typically developing (TD) children (N = 9). Participants were shown short funny and non-funny excerpts of the movies "Ice Age" and "Madagascar" and were asked to rate their level of amusement. Their expressive responses, namely smiles and laughs, were coded and analysed.

Results Individuals with WS seem to be able to discriminate between humorous and non-humorous conditions and appreciate simple humorous content as much as TD individuals. As such, they are equally able to process simple types of humour as their mental-age matched counterparts. Additionally, and in line with their positivity bias, individuals with WS expressed more frequent and more intense laughter than the control group.

Conclusion Individuals with WS appreciate simple humour as much as TD individuals, and they seem to display a particularly high expressivity in response to humorous stimuli.

Keywords Williams syndrome · Humour · Laughter · Expressivity · Positivity bias

Williams syndrome (WS) is a rare genetic disorder (it concerns 1 in 7,500 life births, Strømme et al., 2002) caused by a deletion of chromosome 7q11.23. Individuals with WS have mild to moderate intellectual or learning disabilities and specific cognitive strengths (notably relative to some aspects of language) and weaknesses (especially with visuospatial construction) (Mervis & Klein-Tasman, 2000). They are characterised by a very gregarious personality: They show high motivation to interact with others (Little et al., 2013), are generally described as being very cheerful (Tager-Flusberg & Sullivan, 2000), and have a bias towards positive affect (Järvinen et al., 2013). Despite their hypersociability, individuals with WS also present with difficulties in the socio-emotional domain: typically, they have been reported as having difficulties with the cognitive aspects of theory of mind (Porter et al., 2008), with some aspects of social communication such as joint attention (Laing et al., 2002), and with inhibiting their spontaneous behavioural responses (Menghini et al., 2010). These particularities notably lead individuals with WS to show more difficulties in sustaining friendships (Gillooly et al., 2022). The syndrome is also associated with an increased risk to develop mental health problems such as anxieties, fears and phobias, as well as attention deficits and hyperactivity (Leyfer et al., 2006).

At first sight, their cheerful and gregarious personality would suggest individuals with WS would particularly enjoy and master humour. However, their intellectual disabilities

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might rather generate difficulties in processing humour, which is actually a quite challenging cognitive task. Indeed, humour relies on resolving an incongruity (Suls, 1972). It is generally held that any type of humour is based on the existence of an incongruity, i.e., on a (benign) violation of expectations, and that this incongruity has to be solved and be given a humorous meaning. This incongruity processing involves three steps, each of which requires specific cognitive abilities: First, to detect the incongruity, one has to have knowledge about the norms and expectations that have actually been violated. Second, making sense of the incongruity (i.e., resolving the incongruity) requires high cognitive flexibility to be able to switch from one perception to another, that is: To find the right cognitive rule that would give a logical and humorous explanation to the incongruity (Klos, 2021; Martin & Ford, 2018). Third, one has to be able to involve all the contextual information necessary to understand that the sense of the incongruity relies on a humorous basis and is not merely a problem to be solved, or a lie (Ruch, 2008). Humour processing is thus cognitively quite challenging and not necessarily an easy task to accomplish, especially for individuals who might have cognitive impairments or difficulties with cognitive flexibility, such as individuals with WS (Rhodes et al., 2010).

Considering the importance of humour in our everyday life and all the positive benefits it bestows, it is important to better understand how it is understood and appreciated by individuals with different conditions. Indeed, humour (Kuiper et al., 2004) can enhance well-being (Curran et al., 2021; Martin et al., 2003) and contribute to build and maintain social interactions (Nezlek & Derks, 2001; Treger et al., 2013). Humour has also been shown to be an efficient strategy to regulate one's own or others' negative emotions (Horn et al., 2018; Kugler & Kuhbandner, 2015; Samson & Gross, 2012) and is therefore notably used in interventions (Ruch & McGhee, 2014). Recent findings have even provided evidence that interventions based on humour can reduce fears in individuals with WS (Klein-Tasman et al., 2022). Thus, such research can lead to a better understanding of affective and cognitive processes of individuals with WS, but also of humour itself.

So far, only a few studies have investigated how individuals with WS understand, appreciate and use humour (for an overview, see Chadwick and Platt, 2018; Treichel et al., 2023). Sullivan et al. (2003) showed that participants with WS seemed to have difficulties discriminating between a lie and a joke when they were presented with scenarios where the joke depended on the understanding of a character's mental state. Krishan et al. (2017) confirmed the difficulty that individuals with WS had with understanding humorous content based on theory of mind, compared to chronological age-matched typically developing (TD) individuals, but they did not differ from mental age-matched control participants, or from individuals with Down syndrome. Finally, Godbee and Porter (2013) showed that individuals with WS had more difficulties than chronological age-matched TD individuals (but did not differ from the mental age-matched control group) in understanding non-literal language such as sarcasm, metaphors and similes.

Although a certain level of cognitive flexibility and abstraction is necessary to process humour in general, it seems that, so far, studies on humour in WS have mainly focused on types of humour that required quite advanced cognitive skills, such as mentalizing skills (Krishan et al., 2017; Sullivan et al., 2003) or functions, such as verbal working memory or inferential reasoning (Godbee & Porter, 2013). It is important to emphasise, however, that according to the content of a joke, different reasoning can be involved in humour processing (Attardo & Raskin, 1991), as well as different levels of difficulties. Thus, humour can necessitate a variety of cognitive abilities. Some types of humour, such as slapstick humour, turn out to be quite straight forward, without involving important social, verbal, or reasoning skills. Studying how individuals with WS process such simple types of humour would help understand whether their difficulties are related to the complexity of the jokes and cartoons they were presented in previous studies, or whether they also have difficulties with basic humour processing.

In addition to the cognitive aspects, humour also involves an affective dimension, that is: A subjective emotional experience that is most often positive (e.g., amusement, mirth, or exhilaration) and results in physiological (Lackner et al., 2014; Shiota et al., 2011), bodily, and facial expressive responses, i.e., smiling and laughing) (Ruch, 2008). To the best of our knowledge, no studies have thus far investigated the emotional expressive response to humorous stimuli in individuals with WS. They are commonly described as frequently smiling and laughing, but this statement has yet to be investigated more thoroughly. As mentioned, individuals with WS have been described as having a bias towards positive emotions and as being rather cheerful (Treichel et al., 2023). Studies have investigated their bias towards positive expressions (Dodd & Porter, 2010) and their difficulties detecting negative expressions in others (Santos et al., 2010), but to our knowledge, no study has directly investigated individuals with WS' *own* facial expressions in response to non-social positive stimuli.

In order to examine the comprehension, appreciation and expressive response to simple types of humour in individuals with WS, the present study used a similar design to Weiss et al. (2013), which examined such phenomena in children with autism spectrum disorder (ASD) without intellectual disabilities. In that study, participants were presented a series of short videos extracted from the movies

"Madagascar" and "Ice Age", half of which were meant to be humorous and trigger amusement, while the other half were supposed to be non-humorous, neutral. The amusing excerpts were based on slapstick humour and did not require theory of mind, verbal skills, or inferential reasoning to be understood. The participants were then asked to evaluate their level of amusement on a 5-point scale. Results showed that children with ASD enjoyed the humorous material as much as TD participants and were able to discriminate between funny and non-funny videos. Finally, the authors looked at the occurrences of smiles and laughter. Autistic individuals seemed to have expressions that did not always match their subjective ratings, suggesting a lower emotional coherence (i.e., the match between different emotional components, such as the subjective experience and outward expression of an emotion) than TD participants.

The present study was based on the same experiment, using the same stimuli, but the scale was adapted from a 5-points to a 4-points scale to make it more accessible for individuals with intellectual disabilities. The subjective rating (i.e., the level of amusement) was compared between individuals with WS and TD individuals. Given their bias towards positive emotions, we expected individuals with WS to experience and report a higher level of amusement (i.e., of a positive emotion) than TD individuals in the non-humorous condition and an equal level of amusement in the humorous condition. As such, on the assumption that the individuals with WS would show greater difficulty understanding when the content is supposed to be humorous or not compared to the TD group, we expected there to be less difference in their ratings of the humorous and non-humorous conditions. Moreover, the facial expressions of amusement were also examined. More specifically, the intensity and duration of laughter and smiling in response to each stimulus were examined. Again, considering their positivity bias and since they are described as being rather cheerful, it was hypothesised that individuals with WS would express longer and more intense smiles and laughter than TD individuals, independently of the condition.

Methods

Participants

All participants were recruited in Switzerland. Informed consent was obtained for each participant ad the study was approved by the Swiss Ethical Committee Board of Geneva (No.2017 − 01435). Seventeen participants successfully took part in the study: Eight individuals with WS, aged between 18 and 47 years old ($M = 27.26$, $SD = 9.23$, $Mdn = 24.21$), and a comparison group of 9 mental age-matched TD children, aged between 6 and 9 years-old ($M = 7.12$, $SD = 1.03$, $Mdn = 6.58$). The two groups were matched according to their non-verbal intellectual abilities, based on the mean scores of each group: The raw scores of the Raven's Colored Progressive Matrices (RCPM, Raven et al., 1990) for the WS group ($M = 21.62$, $SD = 7.96$, $Mdn = 21$) and the TD group ($M = 21.89$, $SD = 5.67$, $Mdn = 22$) did not differ ($U = 34$, z = -0.193, p = .847). The two groups differed significantly in chronological age (U = 0.000, z = -3.47, p = .001, r = -842). There was a clear difference in the gender distribution between the WS group (6 cisgendered females and 2 cisgendered males) and the TD group (2 cisgendered females and 7 cisgendered males), although a Fisher's exact test did not reveal a significant difference between the groups (2-tailed p = .057), which can be explained by the small sample size (rendering a Chi-square analysis unsuitable).

Procedure

Participants started by taking the RCPM test, which consists of a series of puzzles, to evaluate general non-verbal cognitive abilities. This test has been proven as an effective tool to match individuals with WS to a control group (Van Herwegen et al., 2011). The test was presented by an experimenter on printed paper sheets.

Then, the experimenters made sure the participants were able to understand a 4-point rating scale, as used in this study. Based on Cummins (1997) and Cuskelly et al. (2013), the experimenter tested (1) the tendency of the participant to use acquiescent responding, by asking a few questions such as "do you craft your clothes yourself?" (2) the ability to form opinions, by asking questions such as "do you like funny movies and why?", (3) the potential tendency of the participant to remember only the beginning or the end of a list (recency and primary effects), and, (4) discriminative competencies, by showing a physical model of the scale (i.e., four boxes of different sizes on which were printed the four smiley-faces that were later used in the task's scale). For this last step, participants were first asked to put the boxes in the right size order (from smaller to bigger and reverse). Then, the experimenter would make sure the participant understood the meaning of the scale and of each smiley-face, by giving examples, and then asking the participants to give some on their own. The experimenter then asked the participant to point to the smiley-face representing the neutral, small, medium and high levels of amusement.

Finally, participants would do the *simple humour comprehension and appreciation task*, adapted from the study by Weiss et al. (2013). Participants were shown 20 short scenes of 7 to 12 s each ($M = 8.9$, $S\ D = 1.41$), extracted from the movies "Ice Age" and "Madagascar". 10 funny

videos constituted the humorous condition, and 10 non-humorous ones were selected for the control condition. The videos were carefully selected by the authors of the study by Weiss et al. (2013) for their level of amusement and comprehensibility. Indeed, all the humorous videos are constituted of scenes based on simple slapstick humour, and the non-humorous videos were estimated as being rather neutral (not triggering any particular positive or negative emotion) by the authors. The task was presented on a laptop computer and was programmed on PsychoPy. After the instructions, the participants saw two examples to get familiar with the task. Then, the videos were presented in a pseudo-random order, with the coded instruction that the same condition (humorous or non-humorous) could not be presented more than twice in a row. Before each video, a fixation cross of 4 s appeared. After each video, the participant was given the possibility to watch it a second time or not. Finally, the participant would be asked the question "how amusing did you find this video?", with a 4-point rating scale illustrated by four smiley-faces that were of four different sizes (from smaller to bigger), four different colour intensities (from lighter to stronger) and four different smile intensities (from softer to broader). The scale was presented as followed: 1 = not funny, 2 = just a little bit funny, 3 = funny, 4 = very funny. During the whole procedure, participants were videotaped with a webcam and an additional back-up camera. An experimenter was always present during the procedure, to make sure that the program ran smoothly and that the participant was able to use it properly. However, the experimenter interacted as little as possible (usually not at all) with the participants during the experiment.

Because of the risk of in-person testing due to the pandemic, slight adaptations had to be made to the procedure for two participants who participated online. Therefore, they would be videotaped via Zoom and one experimenter would present the task on a Powerpoint (randomization of the videos was done beforehand). Since it was not possible for the participants to interact with the experiment alone, they would orally respond to the questions. In both cases (one TD child and one adult with WS), their mother would start the Zoom meeting, check that the sound and image were good enough for the child, and then leave the room in order not to influence their child's responses.

Measures

Subjective ratings of amusement were calculated per group (ASD, DS, WS), ranging from a mean score between 1 (no funniness) and 4 (high funniness).

The expressions of mirth were coded with the program ELAN which allows a precise evaluation of their duration and the time they occur. Since participants had a tendency to laugh or smile also *after* the video was presented, the occurrences of smiles and laughs were coded for each stimulus from the moment the video started (after the fixation cross) until the end of the participant's amusement evaluation (when the next fixation cross appeared). Smiles or laughs occurring at the beginning of a stimulus that were obviously the continuity of a reaction to the stimulus before were not coded: Only *new* laughs and smiles were taken into consideration. In addition, smiles and laughs that were clearly directed at the experimenter or someone else in the room rather than in relation to the stimuli, were not considered in the analysis.

Smiling and laughter were defined based on Ekman's facial action coding system (FACS, Ekman and Friesen, 1978) which distinguishes between different action units (AUs) that are related to the activation of specific facial muscles. A smile was operationalised as follows: The corners of the lips (AU12, *Zygomatic Major*) make an upward movement and there is also an activation of AU6 (cheek raiser, *Orbicularis oculi, pars orbitalis*). Smiles could be of intensity 1 or 2: For a smile of intensity 1, it was specified that the participant expresses a slight smile, that the corners of the lips make a slight upwards movement, and that the activation of AU6 can be very slight. For a smile of intensity 2, it was specified that the participant expresses a medium or large smile and that the corners of the lips make a noticeable movement up. In addition, it was specified that an occurrence should start when the smile starts until it completely stops, even if there are intensity variations during the smile (the peak intensity of each occurrence counts).

A laugh was operationalised as follows: The slight laugh (intensity 1) is an extension of a slight/medium smile that is always accompanied by a sound, which can be either a puff (sound exhalation) from the nose or accompanied by a vocal sound ("hm", "ha"), or seen by a movement of the shoulder. The slight laugh is often rather short. The medium/high laugh (intensity 2) is an extension of a medium/large smile that is always accompanied by a vocal sound ("hm", "ha"). The laugh is often longer and generally ends with an inhalation (after the last laughing exhilaration). It was also specified that an occurrence should start when the laugh starts until it completely stops, even if there are intensity variations during the smile (the peak intensity of each occurrence counts).

It is important to note that the coding process was *inspired* by FACS, but as we were looking only at one specific emotional behaviour, a complete FACS coding and analysis were not conducted in this study by FACS trained coders. Instead, the specific AUs were used in the *description* of what is considered a smile or a laugh, to make the coders aware of what can be considered as a genuine smile or laugh (to reject occurrences of phony smiles or laughs

related to discomfort, for example). However, the coders did not code the AUs separately. As such, all the analysis was based on the occurrence of smiles and laughs with respect to their global duration and level of intensity. Studies focusing on smiling and laughing behaviours in a specific population such as autism have typically not defined precisely what was considered as a smile or a laugh (Filliter et al., 2015; Reddy et al., 2002; Weiss et al., 2013). As such, this study has a more precise and replicable coding system, although not as precise as a complete FACS coding.

Traditionally, the analysis of expressions of mirth relies on three levels of observation: frequency (number of occurrences), intensity, and duration, although most research on such expressions in autism, typically, have focused on frequency and duration (Filliter et al., 2015; Reddy et al., 2002; Stagg et al., 2014; Weiss et al., 2013). In the present study, we focused on the analysis of intensity and duration, and not frequency, because it was necessary to be selective in the number of variables analysed, considering our small sample size. Conducting analysis for the three levels of observation in two small groups would have increased the family-wise error rate of the analysis. Considering that these three levels investigate different components of the same behaviour, it means that no relevant behavioural response was set aside, but a choice was made in the approach angles. The same line of thought underlay our choice of the number of intensity levels that were coded and analyzed, which is not as precise as the five levels defined by Ekman et al. (2002). The reason for this less granular scale is that, due to the small number of participants, a more refined scale would substantially complexify the analysis, making the number of variables too high to reach a reliable group-comparison analysis.

Twelve recordings of the participants (6 WS, 6 TD), which accounts for 70.59% of all recordings, were randomly selected and coded in their entirety (all conditions included) by a second rater in addition to the main rater, to ensure the reliability of the coding system. Rosenberg and Ekman (1994, 2020) suggested using the following formula to calculate a ratio of reliability between two raters' coding, based on a second-by-second coding (Wexler, 1972): the number of occurrences on which both coders agreed multiplied by 2, and then divided by the total number of both coders' occurrences. This formula allows a more refined and appropriate interrater reliability measure, because it focuses only on the actual occurrences of the investigated behaviours (i.e., smile = 1, smile = 2, laughter = 1, and laughter = 2) and does not consider the neutral passages (i.e., smile = 0, and laughter = 0). Based on this formula, an interrater reliability reached an overall substantial strength (Landis & Koch, 1977) for both smiles (0.733) and laughter (0.746). The coding of the main rater was kept for further analysis.

Data Analyses

The duration of smiles and laughs was calculated as a percentage of the total time of each stimulus (from the end of the fixation cross to the end of the evaluation process) since some participants would watch the video a second time, and due to the high variability of time participants took to rate each video. As such, for each stimulus, a percentage of the time spent laughing or smiling at different intensities was calculated, based on which, for each participant, a mean duration of smiles and laughs (of intensities 1 and 2), per condition (humorous and non-humorous) was calculated. The analysis was also run with the mean raw durations (measured in seconds, not proportional to the total time), but since there was no difference in the resulting effects with the measures in percentage, these data were then not reported in the results section. Additionally, for each participant and stimulus, the maximum intensity (0, 1 or 2) of smiling and laughter was noted. Furthermore, the mean level of maximum intensity was calculated for each group and each condition.

Considering that the duration is implicitly part of the definition of laughter in the coding process, as explained in the previous section, intensity of laughter also partly covers the duration in our study. As such, it should be kept in mind that the different behaviours analysed are not completely independent, but rather, they measure different aspects of a similar phenomenon and can influence each other. This can have an important impact on the results of the analyses of these specific behavioural responses, and interpretation of the results should be done cautiously.

Considering the small sample size and confirmation by additional tests that normality could not be reached for all variables, non-parametric tests were run to compare the means between the different conditions (humour and non-humour), groups (WS and TD) and levels of coding (smile and laughs, intensities 1 and 2). Within group comparisons of means were executed using Wilcoxon signed ranked tests, and between groups comparisons of means were run with Mann-Whitney U tests. To overcome possible false positive results due to multiple testing, Holm-Bonferroni alpha corrections were applied (Hemmerich, 2016; Hochberg, 1988; Holm, 1979), to correct each p-value. The correction was applied for each step of the analyses separately: i.e., for amusement rating within groups, the correction was applied based on three p-values for the within groups and two p-values for the between groups analyses. For smile and laughter intensities, the corrections were applied for three p-values in the within groups and two p-values in the between groups analyses; for smile and laughter durations, the corrections were applied for nine p-values in the within groups and six p-values in the between groups analyses.

Results

Amusement Ratings

When both groups were considered together, a significant difference in the ratings of the humorous and non-humorous conditions appeared, $z = -3.46$, $p = .003$, $r = -0.59$. This difference in the ratings of both conditions was confirmed when the groups were considered separately. The WS group rated the humorous condition as funnier than the non-humorous condition, $z = -2.52$, $p = .024$, $r = .63$, as did the TD group, $z = -2.37$, $p = .024$, $r = -56$. These results confirm the quality of the videos selected for both conditions and the ability of both groups to differentiate between humorous and non-humorous content. See the descriptive data in Table 1.

No significant differences in the amusement rating of the humorous content ($U = 21.5$, $z = -1.4$, $p = .322$, $r = -0.34$) or of the non-humorous content ($U = 31$, $z = -0.49$, $p = .628$, $r = -0.46$) were revealed between individuals with WS and TD individuals. See the descriptive data in Table 1.

Smile Intensity

A significant difference appeared in the maximum intensity of smiling (0–2) between the humorous and the non-humorous conditions when both groups are considered together ($z = -3.63$, $p < .001$, $r = -0.88$), as well as individually in the WS group ($z = -2.54$, $p = .016$, $r = -0.89$), and the TD group ($z = -2.67$, $p = .016$, $r = -0.89$). These results show that the humorous condition triggered more intense smiles than the non-humorous condition in both groups. See the descriptive data in Table 1.

When looking at the mean maximum intensity of smiling (0–2) in each condition, results showed no significant group differences in the humorous condition ($U = 31$, $z = -0.48$, $p > .999$, $r = -0.12$) or in the non-humorous condition ($U = 33.5$, $z = 0.24$, $p > .999$, $r = .06$), revealing no difference between individuals with WS and TD individuals in the maximum intensity of their smiles. See the descriptive data in Table 1.

Table 1 Mean scores of measures of subjective rating, laughter, and smiling, per group

	All ($n = 17$)		WS ($n = 8$)		TD ($n = 9$)	
	M (SD)	*Mdn*	*M (SD)*	*Mdn*	*M (SD)*	*Mdn*
Mean amusement ratings, on a scale from 1 to 4, per condition						
Humorous condition	2.89 (0.79)	3.2	2.69 (0.6)	2.75	3.07 (0.92)	3.5
Non-humorous condition	1.82 (0.81)	1.4	1.63 (0.5)	1.4	1.99 (1.01)	1.5
Mean maximum level of smile intensity (0–2) reached per condition.						
Humorous condition	1.46 (0.47)	1.5	1.49 (0.57)	1.6	1.43 (0.4)	1.5
Non-humorous condition	0.72 (0.47)	0.7	0.73 (0.55)	0.55	0.72 (0.41)	1.5
Mean percentage of time smiles from different intensities were displayed per condition						
Humorous condition						
Smile 1	11.55 (8.97)	10.71	9.26 (5.29)	10.68	13.59 (11.25)	10.71
Smile 2	24.53 (16.18)	21.28	32.64 (16.12)	35.42	17.33 (13.13)	13.82
Smile 1 & 2	36.09 (15.19)	36.89	41.9 (16.16)	45.17	30.92 (12.99)	27.36
Non-humorous condition						
Smile 1	6.95 (6.15)	10.71	5.52 (4.68)	3.64	8.22 (7.25)	6.79
Smile 2	5.76 (6.88)	21.28	5.68 (7.2)	2.79	5.82 (7.02)	3.64
Smile 1 & 2	12.7 (10.73)	36.89	11.21 (11.62)	5.91	14.03 (10.38)	14.69
Mean maximum level of laughter intensity (0–2) reached per condition						
Humorous condition	0.76 (0.62)	0.8	1.09 (0.55)	0.9	0.47 (0.55)	0.3
Non-humorous condition	0.14 (0.23)	0	0.188 (0.3)	0.05	0.1 (0.15)	0
Mean percentage of time laughs from different intensities were displayed per condition						
Humorous condition						
Laughter 1	1.88 (2.17)	0.73	1.64 (1.97)	0.8	2.09 (2.44)	0.6
Laughter 2	7.35 (8.9)	2.27	13.92 (8.77)	14.31	1.52 (3.09)	0
Laughter 1 & 2	9.23 (9.03)	5.78	15.56 (8.37)	14.95	3.6 (5.13)	0.6
Non-humorous condition						
Laughter 1	0.88 (1.84)	0.27	0.38 (0.44)	0.29	1.32 (2.47)	0
Laughter 2	0.1 (0.3)	0	0.06 (0.18)	0	0.13 (0.39)	0
Laughter 1 & 2	0.98 (1.98)	0.27	0.45 (0.47)	0.38	1.45 (2.66)	0

Note: WS = Williams syndrome, TD = typically developing; All = both groups considered together

Smile Duration

When both groups were considered together, there was no significant difference between the conditions in the percentage of time participants displayed a smile of intensity 1 (z = -1.97, p = .147, r = -0.48). However, there were significant differences in the percentage of time they displayed a smile of intensity 2 (z = -3.48, p = .008, r = -.84) and of both intensities considered (z = -3.57, p = .003, r =-.87). In the WS group, there were no significant difference between both conditions in the percentage of time they would display a smile of intensity 1 (z = -1.26, p = .22, r = -0.45), of intensity 2 (z = -2.38, p = .077, r = -0.84) and of both intensities considered together (z = -2.52, p = .077, r = -0.89). Similarly, the TD group displayed no significant difference between conditions in the percentage of time they would express a smile of intensity 1 (z = -1.6, p = .22, r = -0.54), of intensity 2 (z = -2.55, p = .077, r = -0.85) and of intensities 1 and 2 together (z = -2.55, p = .077, r = -0.85). These results show that neither individuals with WS nor TD individuals showed a difference in the duration of their smiles of any intensity between the humorous than the non-humorous condition. See the descriptive data in Table 1.

For the humorous condition, no significant difference was revealed between individuals with WS and TD individuals in the percentage of time they displayed a smile of intensity 1 (U = 34, z = -0.19, p > .999, r = -0.05), of intensity 2 (U = 16, z = -1.93, p = .324, r = -0.47) or of both intensities combined (U = 22, z = -1.347, p = .89, r = -0.33). For the non-humorous condition, results also revealed no significant difference between individuals with WS and TD individuals in the percentage of time they displayed a smile of intensity 1 (U = 28, z = -0.77, p > .999, r = -0.19), of intensity 2 (U = 33, z = -0.29, p > .999, r = -0.07) or of both intensities combined (U = 29, z = -0.67, p > .999, r = -0.16). As such, it appears that in both conditions, there is no difference in the duration of smiling between individuals with WS and TD individuals. See the descriptive data in Table 1.

Laughter Intensity

When both groups are considered, there was a significant difference between the humorous condition and the non-humorous condition in the maximum intensity of laughter (z = -3.12, p = .006, r = -0.76). Similarly, significant differences appeared in the WS group (z = -2.37, p = .036, r = -0.84) and the TD group (z = -2.01, p = .044, r = -0.67). These results show that for all participants, the humorous condition triggered laughs of a higher intensity for the humorous than the non-humorous condition. See the descriptive data in Table 1.

There were no significant group differences in the maximum intensity of the laughs for the humorous condition (U = 13.5, z = -2.19, p = .058, r = -0.53) or the non-humorous condition (U = 32, z = -0.42, p = .675, r = -0.1). These results suggest that the maximum level of intensity of laughter appeared to be similar in individuals with WS and TD individuals. See the descriptive data in Table 1.

Laughter Duration

When both groups are considered together, there were significant differences between the conditions in the percentage of time they would display a laugh of intensity 2 (z = -2.93, p = .027, r = -0.71), and of both intensities considered (z = -2.98, p = .027, r = -0.72), but there was no such difference for the percentage of laughs of intensity 1 (z = -1.92, p = .275, r = -0.47). For the WS group, however, no difference appeared between the humorous and non-humorous conditions for the percentage of laughs of intensity 1 (z = -1.52, p = .384, r = - 0.54), of intensity 2 (z = -2.37, p = .108, r = -0.84), and of both intensities (z = -2.52, p = .084, r = -0.89). For the TD group, there were also no significant differences between the humorous and the non-humorous condition in any of the measures of laughter; the percentage of time they would express a laugh of intensity 1 (z = -1.15, p = .498, r = -1.83, p = .275, r = -0.61), or of both intensities together (z = -1.15, p = .498, r = -0.39). These results suggest that neither individuals with WS nor TD individuals displayed a difference in the duration of their laughs between the humorous and the non-humorous conditions. However, when both groups were considered (i.e., independently of groups), individuals seemed to laugh longer and more intensively in response to humorous stimuli compared to non-humorous stimuli. See the descriptive data in Table 1.

For the humorous condition, a significant difference was found in the percentage of time individuals with WS and TD individuals express laughs of intensity 2 (U = 7.5, z = -2.8, p = .03, r = -0.68). A significant effect was also found when looking at the percentage of time both groups would express laughs of both intensities combined (U = 8, z = -2.71, p = .035, r = -0.66). However, no significant effect was found between both groups in expressing laughs of intensity 1 (U = 33, z = -0.29, p > .999, r = -0.07). For the non-humorous condition, no significant difference was found between the two groups in displaying laughs of intensity 1 (U = 34.5, z = -0.15, p > .999, r = -0.04), of intensity 2 (U = 36, z = 0, p > .999, r = 0), or both intensities combined (U = 32.5, z = -0.36, p > .999, r = -0.09). These results suggest that individuals with WS express longer and more intense laughs than TD individuals in response to humorous stimuli, but

this difference does not appear in the non-humorous condition. See the descriptive data in Table 1.

Discussion

The present exploratory study examined (1) basic humour processing skills, and (2) expressive responses (smiles and laughs) to simple, humorous and non-humorous stimuli in individuals with WS. These were compared to mental age-matched typically developing children.

Humour Processing Skills

Results suggest that, on average, individuals with WS appreciate simple types of humour in much the same way as TD individuals. Indeed, both groups evaluated the humorous condition as more amusing than the non-humorous condition. We had expected that the positivity bias common in individuals with WS (Järvinen et al., 2013) might prevent them from adequately differentiating between humorous and non-humorous stimuli, but they showed a clear ability to distinguish between the conditions and to report their level of amusement accordingly. These results suggest that even if individuals with WS experience more positive emotions generally, they do not do so unconditionally and indiscriminately, at least with respect to non-socially shared humour. Such findings add to our comprehension of the cognitive abilities of individuals with WS: Despite their intellectual disabilities, it seems that individuals with WS have the cognitive flexibility necessary to successfully achieve incongruity resolution involved in the comprehension of humour (Ruch, 2008; Suls, 1972). While previous studies highlighted the difficulties individuals with WS have with complex conceptual representations involved in some types of humour, such as ToM or inferential reasoning (Godbee & Porter, 2013; Krishan et al., 2017; Sullivan et al., 2003), the present study shows that they understand humour in much the same way as TD individuals when it is non-verbal and simple.

Expressive Responses

The fact that a positivity bias appears to influence the attention and appraisal of social stimuli in individuals with WS has been widely described: it is mainly marked by comparatively high approachability, hypersociability (Jones et al., 2000), and a lower sensitivity to negative socio-emotional information (Mervis & John, 2010). This bias also reveals itself with respect to positive faces, in that individuals with WS show a greater amount of attention to happy faces than chronological and mental age-matched groups do (Dodd & Porter, 2010). However, to date and to our knowledge, no study has investigated their expressive responses to positive and neutral stimuli. The present study adds to the understanding of their particular social and emotional profile since it suggests that individuals with WS also display a particularly high level of expressivity in response to positive stimuli, compared to TD individuals. In both groups, the maximum intensity of smiles and laughs were higher in the humorous than in the non-humorous conditions, but no group differences appeared. Moreover, both groups did not differ in the duration of the smiles they displayed, and none of them generally expressed longer smiles or laughs in one condition compared to the other. However, individuals with WS expressed laughs of a higher duration than the TD comparison group, but only for the humorous condition. In other words, in response to amusing stimuli, individuals with WS would more easily laugh out loud for a longer time than TD individuals. When considering laughter as an expression of positive emotions of a higher intensity than smiling, these results suggest that individuals with WS differ from mental age-matched TD children in terms of the intensity of expressions of positivity.

Individuals with WS have also been described as having difficulties with response inhibition, i.e. the ability to restrain a spontaneous response (Greer et al., 2013; Little et al., 2013; Menghini et al., 2010). This seems to be related to individuals with WS' higher promptness to approach others, including strangers (Mervis & Klein-Tasman, 2000; Little et al., 2013), as well as to their lower tendency to inhibit their expressive responses to regulate their emotions (Samson et al., 2022). The lower tendency to inhibit spontaneous responses might drive individuals with WS to be less concerned than TD individuals about laughing loudly in the presence of others, even if the laughter is not socially shared as it usually is (Provine, 2017; Reddy et al., 2002). In general, the present results might be a first exploratory step to actually confirm that individuals with WS smile and laugh more than their TD counterparts, even in contexts that seem less appropriate. However, this should be investigated further in order to reach clearer conclusions.

Limitations and Future Research

Future studies should more thoroughly investigate the comprehension and appreciation of different types of jokes in individuals with WS, including the underlying cognitive processes, to build on what is currently known about the understanding and appreciation of humour and the cognitive profile of individuals with WS (see, for example, the study of Samson and Hegenloh, 2010) .

The expressive responses of individuals with WS to different positive emotions (such as love, awe, or pride) should

be examined to evaluate whether the tendency of their positivity bias to heighten their expressive responses to positive stimuli can be generalised. Moreover, to investigate whether the increased expressive response is syndrome-specific, future studies should investigate the phenomenon in individuals with Down syndrome, who present a similar socio-emotional phenotype (they are also described as hypersociable and particularly cheerful (Grieco et al., 2015; Porter et al., 2007). Moreover, exploring developmental trajectories in TD individuals would ascertain whether a similar expressive response could be present in younger or older TD children, to further explore whether this is really a particularity of WS.

In order to better appreciate the extent to which individuals with WS really engage equally and more easily in socially shared and non-shared laughter, future studies should investigate their expressive response in completely solitary situations (without the presence of an experimenter), as well as in more ecological settings, including the (spontaneous and controlled) interaction with and the expressive response of another person.

Such knowledge about individuals with WS' tendency to show an increased emotional response to positive stimuli would add new information about their particular socio-emotional profiles, which is necessary to build socio-educative programs to help them regulate their emotions and interact in the social world. Indeed, individuals with WS have been described as having difficulties in sustaining long-term friendships, due notably to particular maladaptive and inadequate behaviours as well as emotion regulation difficulties (Gillooly et al., 2022; Samson et al., 2022). Interventions aiming at increasing their abilities to regulate (in this case, *inhibit*) their emotional responses might help them to develop more adapted social behaviours and in turn build more durable relationships.

Laughter and smiling can have various meanings and are not only a behavioural manifestation of positive emotions. Indeed, not only can they have different functions in terms of social interaction (Wood & Niedenthal, 2018), but they can also be a manifestation of other emotions, such as embarrassment, contempt, or fear (Ruch, 2008). As such, it would be unjustified to infer from the present analysis that individuals with WS experience more positive emotions because they seem to laugh more. Some of their smiling and laughing behaviour in their daily lives is likely to be related to trying to initiate or sustain a social interaction, or even to mask negative emotions. Indeed, Sinason (1992) introduced what she called the "handicapped smile", by explaining how individuals with intellectual disabilities' smiles are often misinterpreted as being related to their supposed positive emotions, whereas they often smile as a defence mechanism against negative experiences (see also Lloyd, 2018). Nevertheless, the present study focuses on smiles and laughs as responses to humorous stimuli. Considering the design of this study, it seems highly likely that the positive expressivity of individuals with WS is related to spontaneous amusement rather than anything else, such as masking a negative emotion. Future studies should however investigate different types of laughter in individuals with WS to better grasp the nature of their potential higher tendency to engage in smiling and laughing.

In spite of the explicitly exploratory nature of this study, it is important to highlight four important limitations. First and foremost, due to the rarity of WS, the sample size is small: Results thus have to be read and interpreted carefully. Second, the current study does not include a chronological age-matched control group, but only a mental age-matched one. Previous studies on more cognitively demanding humour in WS often showed differences with the chronological age-matched group but not the mental age-matched group, which can be interpreted as showing a delay rather than a differentiated cognitive pathway. However, the inclusion of, for example, TD adults seemed likely to be less informative here, given that the video clips are taken from movies made for children. Third, the setting of the present study is partially social, since an experimenter was always present, even if they were only there to make sure the session went as planned. Although during the task the participants were almost exclusively interacting with a computer, the setting does not allow us to make conclusions about individuals with WS' strictly solitary laughter. Further study should consider exploring the participants' expressions with and without the presence of an experimenter in order to better understand the influence of the presence of another person on their expressivity. In the present analysis, the laughs and smiles that seemed to be directed to another person were not considered, as they were deemed social rather than solitary laughter. Fourth, while the coding system we used is more precise than previous studies, the coding system of the facial expressions would have been even more reliable and would have allowed more refined data analyses if proper FACS (Rosenberg & Ekman, 1994, 2020) coding was used. Another limitation of our coding system, though, is that our definitions of smiles and laughs on which the coding was based are somewhat intertwined. When it comes to responding to humorous stimuli, smiles and laughs are different manifestations of a similar emotional experience and are thus logically connected to one another. However, having AU12 and AU6 coded separately with more levels of intensity (Ekman et al., 2002) would have allowed to better define laugh and smile intensity and to avoid to use duration as a part of the definition in laughter intensity. Given the small number of participants and the exploratory nature of this study, it was deemed appropriate to proceed

in this manner. Nonetheless, interpretation should thus be done cautiously and future studies should implement a more refined coding system such as FACS. However, as mentioned above, one strong element of our coding system is that it still includes a precisedefinition of what is considered a smile or a laugh, which is sufficiently developed to allow the study to be replicable.

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Data Availability All data are available at the Open Science Framework: https://osf.io/k764t/.

Declarations

Ethics approval and consent to participate This study was approved by the Swiss Ethical Committee Board of Geneva (No.2017 – 01435).

Informed Consent For all participants, an informed consent was received including the signature of the participants and their parents.

Conflict of Interest The authors report there are no competing interests to declare.

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