Inform Network Support

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At **www.simonssearchlight.org** there is an online community for families affected by 16p11.2 deletions and duplications, a short fact sheet about the 16p11.2 duplication and summaries of relevant recent journal articles.

Join Unique for family links, information and support.

Unique is a charity without government funding, existing entirely on donations and grants. If you can please make a donation via our website at www.rarechromo.org/donate Please help us to help you!

Unique mentions other organisations' message boards and websites to help families looking for information. This does not imply that we endorse their content or have any responsibility for it.

This guide is not a substitute for personal medical advice. Families should consult a medically qualified clinician in all matters relating to genetic diagnosis, management and health. The information is believed to be the best available at the time of publication. Information on genetic changes is a very fast-moving field and while the information in this guide is believed to be the best available at the time of publication, some facts may later change. *Unique* does its best to keep abreast of changing information and to review its published guides as needed. It was compiled by *Unique* and reviewed by Dr David Miller, MD PhD Clinical Geneticist and Clinical Molecular Geneticist, Children's Hospital, Boston, USA and by Professor Maj Hultén, Professor of Reproductive Genetics, University of Warwick, UK. This guide was updated and reviewed by Professor MBM van den Bree, Dr Maria Niarchou and Dr Samuel Chawner, Division of Psychological Medicine and Clinical Neurosciences, Medical Research Council Centre for Neuropsychiatric Genetics and Genomics, Cardiff University, Cardiff, UK and (AP) Unique in 2020.

The CAKUT (congenital anomalies of kidney and urinary tract) information in this guide was updated in 2021 by Dr. Emily Groopman, MD/PhD (Broad Institute of MIT and Harvard, Cambridge, MA, USA; Boston Children's Hospital, Boston, MA, USA)

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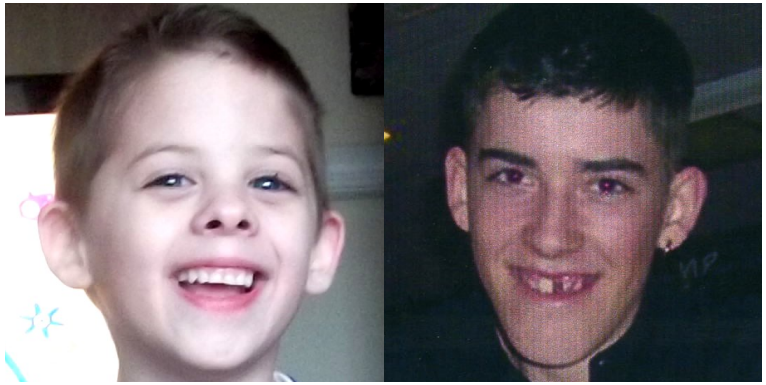
Understanding Chromosome & Gene Disorders

16p11.2 microduplications



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Sources & references

The information in this guide is drawn from what has been published in the medical literature about people with a duplication of 16p11.2. The first-named author and publication date are given to allow you to look for the abstracts or original articles on the internet in PubMed (www.ncbi.nlm.nih.gov/pubmed). If you wish, you can obtain articles from *Unique*. The leaflet also draws on information on *Unique*'s database. When the guide was first published in 2011, *Unique* had 7 members with a 16p11.2 duplication. In 2020, Unique had over 200 members with a 16p11.2 duplication. (Marshall 2008; Weiss 2008; McCarthy 2009; Bedoyan 2010; Bochukova 2010; Fernandez 2010; Jacquemont 2010; Rosenfeld 2010; Shinawi 2010; Schaaf 2011; Walsh 2011; Sanna-Cherchi 2012; Westland 2015; Verbitsky 2015 & 2019; Niarchou 2019, Cunningham 2019, *Unique*).

❝ She is a joy to be around. She has taught us so much. The way she sees the world with no worries and no fear is inspiring!

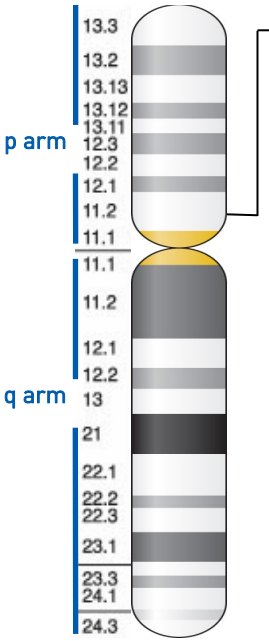
❝ As a child, he had the most beautiful, honest nature about him. Although he had mental setbacks, he had such a sweet nature with no comprehension or ability to be mean.

❝ He has a dry sense of humour, loving in his own little way, wouldn't change him one bit. His bravery and courage is amazing.

Finding out

What does it mean when someone in your family has a 16p11.2 microduplication? The person with the microduplication has a tiny bit of duplicated (extra) genetic material in the cells of their body. Generally speaking, for development to proceed as expected, the right amount of genetic material is needed – not too little and not too much.

Some people with a 16p11.2 microduplication have difficulties with speech, behaviour and learning; health and development may also be affected. Other people however seem unaffected by the extra genetic material, the reasons for this are not entirely understood but are likely to be related to a person's own unique genetic makeup.

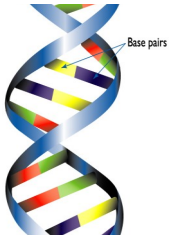


Chromosome 16

What does 16p11.2 microduplication mean?

A 16p11.2 microduplication is a duplication of genetic material from a region called 11.2 on the p arm of chromosome 16.

Most of our cells contain chromosomes. We normally have 23 pairs of chromosomes. Pairs are numbered 1 to 22 and the 23rd pair comprises either two X chromosomes (female) or an X and a Y chromosome (male).



Chromosomes are made from really long strands of tightly packed DNA. The position and size of pieces of DNA that are found to be duplicated are counted in 'base pairs'. Base pairs are often shown like the 'rungs' of a DNA ladder like the image here.

Possible tendency to be underweight

Preliminary data suggests that people with 16p11.2 microduplication syndrome have a tendency to be underweight. Early information from *Unique* supports this, with individuals described as being relatively tall but proportionately thin or 'lacking in body mass'.

By contrast, a tendency to overweight and obesity has been identified in almost half the children and adults with the equivalent 16p11.2 micro*deletion*, making the microdeletion the second most common genetic cause of obesity (Bochukova 2010; Jacquemont 2010; *Unique*).

Possible vulnerability to seizures

Most children with 16p11.2 microduplication syndrome have never had a seizure or a seizure-like episode. All the same, a minority - up to around 15% - have. This has led to the suggestion that there is an association between the microduplication and a vulnerability to seizures, although seizure types and severity vary widely.

Typically, seizures start under 12 months of age, are easily controlled with anti-epileptic medication and tend to resolve or decrease in severity during childhood. One baby was diagnosed with a rare type of epilepsy called malignant migrating partial seizures of infancy. His seizures started on his first day of life; at first they were hard to treat but they were successfully treated by around 5 months. Another child has clusters of simple partial seizures which are controlled with anti-epileptic medications.

Among the genes that are duplicated in 16p11.2 microduplication syndrome, three have been suggested as being involved in the brain and possibly involved with seizures. These genes are *QPRT, DOC2A* and *SEZ6L2* (Bedoyan 2010; Rosenfeld 2010; Shinawi 2010; *Unique*).

Sizures have also been reported in a few children with a 16p11.2 distal microduplication.

Suggested screening and management

It's recommended that anyone with a 16p11.2 microduplication should have a clinical examination; a general review of all their organ systems; and a developmental assessment. If there are symptoms that suggest seizures, a consultation with a neurologist and EEG is recommended. If there are any neurological symptoms related to the spine, the spine can also be imaged by MRI (Schaaf 2011), but this is not a general recommendation for all.

Therapies introduced early will usually help children reach their full potential. Speech therapy in particular should be introduced early and assisted or augmentative communication started if needed. Routine developmental assessment and screening should follow.

Adults.

Recent research studying medical effects of DNA duplications observed in later life (age 40-69) in unaffected microduplication carriers (Crawford 2019) identified thirteen 16p11.2 microduplication syndrome duplication carriers as having irritable bowel syndrome (about three times more than would be expected) and 28 people with sciatica (about twice as many people as expected based on the frequency of diagnosis in the entire research group). No significant late onset findings were found for carriers of the 16p11.2 distal microduplication.

❝ When she was 2½, she loved to mouth things and craved oral stimulation. She had no fears and loved water, was beginning to pretend play and was very sociable, waving to everybody and wanting to be the centre of attention. By 4, she had developed ADHD and takes medication (Focalin/ dexmethylphenidate) to help her focus on activities – *4 years*

❝ As a child, he lacked social interactions with other children and played alongside them rather than with them, even into adolescence. These days, at 22, other family members consider him obsessive/ compulsive. He used to take ADHD medications – Strattera/atomoxetine and Ritalin/ methylphenidate but has stopped, as he says they make him feel 'weird'.

❝ He enjoys listening to music, watching TV, the computer and reading and spends a lot of time on the computer, living in imaginary worlds and imagining himself to be a professional sports character. He is also now exhibiting some unusual, very trying social behaviours including constantly repeating the same questions, standing very close to others when asking questions, loud speech, talking to himself and repetitive use of 'bad' words reminiscent of Tourette's syndrome – *22 years*

Increased susceptibility to autism or an autism spectrum disorder

16p11.2 microduplication syndrome is often found in children and adults diagnosed with autism or a disorder on the autistic spectrum such as Asperger syndrome than among the general population. Yet only a minority of people with this 16p11.2 microduplication has autism or autistic features. Autistic traits were observed in around half of *Unique* members, all male, in 2014.

Rearrangements of 16p11.2 – both deletions and duplications – represent the second most frequent chromosomal disorder associated with autism but so far no specific genes responsible have been identified.

It is currently believed that having 16p11.2 microduplication syndrome increases the risk of autism but additional factors are likely to be needed for autism to develop. This is also true for people, especially boys and men, with a 16p11.2 microdeletion. The underlying suggestion for them is that a network of genes within the microdeletion/duplication region is disrupted, possibly causing changes in brain development that may manifest as developmental delay or autism. These genes include genes involved in cell-to-cell signalling and other types of cellular interaction (Marshall 2008; Weiss 2008; Fernandez 2010; Rosenfeld 2010; Shinawi 2010; *Unique*).

❝ Autism has never been diagnosed but family members agree that he shows signs.

Increased susceptibility to other mental health conditions

16p11.2 microduplication syndrome is found more often among children and adults diagnosed with mental health conditions than among the general population. Yet only a minority of people with the microduplication has a mental health condition. Anxiety, depression, bipolar disorder and schizophrenia have been found.

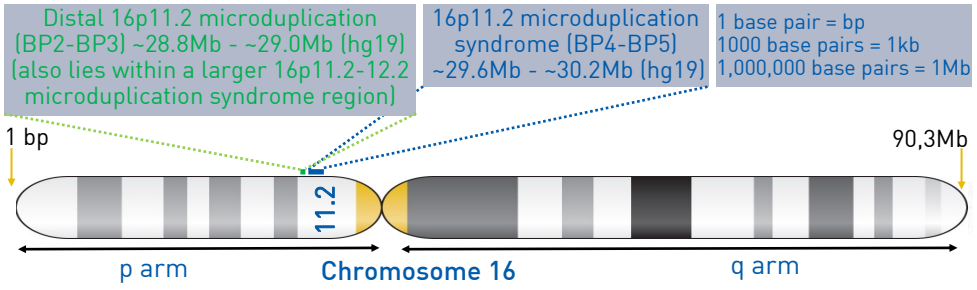
It's currently believed that having 16p11.2 microduplication syndrome increases the risk of mental health conditions but other factors are needed for mental health problems to develop (McCarthy 2009; Marshall 2017; Kushima 2018; *Unique*).

Does everybody with a 16p11.2 microduplication have exactly the same piece of extra genetic material?

No, people have been identified as having different duplications in 16p11.2. Some duplications appear to be unique, but others have been found in a number of different people. There are currently two different 16p11.2 microduplications that have been identified in many people.

A lot of people have extra genetic material consisting of DNA that was estimated to lie roughly between base pair number 29,670,000 and 30,200,000 on chromosome 16 according to the information that was available when this guide was first written. Since the sequence of the human genome still contains gaps and is continuously updated, base pair coordinates change over time. The position of this duplication according to the 2020 information (build 19 of the human genome (hg19), also known as GRCh37) was between 29,606,852 and 30,199,855 base pairs. This piece of DNA includes 27 known genes, we know what some of the genes do but research is ongoing). People with this particular microduplication are now known as having **16p11.2 microduplication syndrome**. Many people have a different syndrome known as a 16p11.2 micro*deletion* syndrome, where this segment of chromosome 16 is not duplicated but is missing. *Unique* publishes a separate information guide to 16p11.2 microdeletions.

Many other people have been identified as having a microduplication of a different part of 16p11.2 (see image below). This duplication is now referred to as **16p11.2 distal microduplication** (distal means closer to the end of the chromosome). In 2020, the 16p11.2 distal microduplication was located between base pairs 28,824,857 and 29,051,191 (according to build hg19/GRCh37).



You can tell if you and/or your child has a '16p11.2 microduplication syndrome' duplication, a '16p11.2 distal microduplication' or a different duplication by checking the information provided on your child's genetic report or by asking *Unique* or your geneticist. While not much was known about the distal duplication when this guide was first written, more information is becoming available, and more people are being given this genetic test result.

Position of 16p11.2 microduplications

This guide mainly covers 16p11.2 microduplication syndrome (which is also sometimes referred to as BP4-BP5 in the medical literature, since there are common 'breakpoints' in the chromosome where the duplication commonly arises). *Unique* aims to report further information specific to the distal microduplication

when possible (this duplication is sometimes referred to as BP2-BP3). In 2020, over 50 people with a 16p11.2 distal microduplication (and no additional genetic diagnosis) had been reported in DECIPHER, a database used by the clinical community to share and compare features associated with different genetic test results (https://decipher.sanger.ac.uk/). Using this information, associated features have been noted on page 6.

In your family, is the 16p11.2 microduplication inherited or not?

16p11.2 microduplications can occur out of the blue or they can be inherited from a parent. Studies in 2010 suggested that most are inherited from a parent (Fernandez 2010; Rosenfeld 2010; Niarchou 2019). The only way to be certain is to check the chromosomes of both parents, even if they are not themselves affected. If one parent has the same microduplication, it can be assumed that it has been passed on.

If both parents have unaffected chromosomes, the 16p11.2 microduplication is in all likelihood a new occurrence. The genetic term for this is *de novo* (*dn*). A new 16p11.2 microduplication occurred either when the parents' sperm or egg cells were formed or in the very earliest days after fertilisation.

Microduplications are a natural occurrence, small changes to chromosomes occur in everyone, it's only when important genes are affected that effects on health and development are observed. As a parent there is nothing you could have done to prevent this from happening. No environmental, dietary or lifestyle factors are known to cause 16p11.2 microduplications. There is nothing that either parent did before or during pregnancy that caused the microduplication – no one is to blame and there is no reason for anyone to feel guilty.

Are there people with a 16p11.2 microduplication who have no speech, behaviour, learning or health difficulties?

Yes, there are. 16p11.2 microduplications can be 'silent'. Some family members of children with a 16p11.2 microduplication have the same microduplication but do not have any obvious unusual features or delayed development (Fernandez 2010). The signs in others with the duplication can also be so subtle that you would hardly notice. For reasons that are not fully understood, the effect on development, health and behaviour of many genetic disorders range from being barely perceptible to being quite obvious, 16p11.2 duplications are no exception. Geneticists call this 'variable expressivity', meaning symptoms can vary and 'incomplete penetrance', meaning not everyone is affected.

Recent research studying cognitive, occupational and social abilities of carriers of duplications in the 'general public' (Kendall 2019) found that a significant number of people with the 16p11.2 microduplication syndrome duplication, who are assumed to be unaffected, do have subtle difficulties and disadvantages in educational attainment and ability to earn income in adult life. Similar associations were found for people who carry the 16p11.2 distal microduplication, but to a lesser extent and in fewer people.

If one person in a family with the 16p11.2 microduplication is mildly affected, will others in the same family also be mildly affected?

Not necessarily. There is a lot of variation between different members of the same family who have the same microduplication. We know that if one person is mildly affected, others may be more severely and obviously affected.

> ❝ As a child he had extremely erect posture but as an adult it's normal. He still has low muscle tone, has never been active or shown any desire to be. When walking outdoors he has a somewhat unusual 'stomp' like gait that isn't noticeable indoors. He can't ride a bike – *22 years*

A more recent study (Cunningham 2019) identified all children affected by their 16p11.2 duplication experienced difficulties in a range of gross (and fine) motor functions

Some need for support with learning

There is a broad spectrum of need for special support with learning. Typically, ability ranges from normal to a mild delay and where an IQ has been measured it has fallen within the 50-110 range, with 100 representing the average for the general population. However, this probably underestimates the range of ability, since IQ testing would be more likely for people with developmental delays than for people with the microduplication and no delays. *Unique*'s experience is that most children can learn to read, write and use a computer. A recent study (Niarchou 2019) identified 34% of children affected by 16p11.2 duplication syndrome as having intellectual disability.

Depending on local schools, some children start their education in a mainstream setting, usually working within a small group and moving to a more supportive learning environment to complete their education (Fernandez 2010; Rosenfeld 2010; Shinawi 2010; *Unique*).

> ❝ She has a great memory and is helped to learn by being stubborn and determined – *4 years*

> ❝ He has an exceptional memory, writes, reads newspapers, the internet and magazines and makes meticulous drawings. He also navigates the computer very well. He attended life skills classes after school but left because he was physically afraid of another student – *22 years*

Increased likelihood of a mental health condition

Various studies have found mood or behaviour difficulties in a minority of young people with 16p11.2 microduplication syndrome. Most commonly, those who are affected, are overactive with a short attention span (ADHD/ attention deficit hyperactivity disorder) but other types of behaviour difficulty have been found. When this guide was first written, ADHD had been identified in 2/7 *Unique* children. One boy out of a group of 15 had an anxiety disorder that responded well to medication and in one study 4 youngsters (out of a group of 10) had outbursts of aggression (Weiss 2008, Fernandez 2010; Rosenfeld 2010; Shinawi 2010; *Unique*).

More recently, a larger study of mental health conditions associated with 16p11.2 duplication syndrome found that 63% of children affected by their extra copy of this part of chromosome 16p11.2, have at least one disorder associated with mental health [e.g. ASD, ADHD, OCD (obsessive compulsive disorder) or an anxiety disorder], supporting the importance and the need for early recognition, diagnosis and treatment early in development (Niarchou 2019). The same study found that 42% of children affected by their microduplication had an attention deficit hyperactivity disorder (ADHD) diagnosis.

When this guide was initially compiled, two babies were known to have been born with a hernia and two were born with a cleft palate (an opening in the roof of the mouth, usually closed surgically).

Urogenital anomalies have also been identified in a number of people with a 16p11.2 microduplication (Sanna-Cherchi 2012; Westland 2015; Verbitsky 2015 & 2019). The anomalies reported include: absent kidney/s (renal agenesis); small kidneys (renal hypoplasia), which can also have abnormal tissue (renal hypodysplasia); horseshoe kidney, where the two, usually separate kidneys are joined together at the bottom; posterior urethral valves, extra flaps of tissue in the urethra (the tube that drains urine from the bladder), which can block urine from flowing out (from the urethra into the bladder); duplicated collecting system, where instead of having the (usual) one ureter (the tube that carries urine from the kidney to the bladder), a kidney has two ureters; and vesicoureteral reflux, where urine flows backwards, from the bladder towards the kidneys.

A few babies were born with unusually-shaped chests [hollowed (pectus excavatum) or 'pigeon chest' (pectus carinatum)]. In a few others, the spine is affected, but in different ways. Scoliosis may also develop in later years. A number of 16p11.2 duplication syndrome duplication carriers have a sacral dimple [a small indentation in the lower back (Steinman 2016)]. A number of people affected by their 16p11.2 duplication also experience tremors (involuntary muscle contractions that lead to shaking). (Bedoyan 2010; Fernandez 2010; Rosenfeld 2010; Shinawi 2010; Schaaf 2011; Steinman 2016, *Unique*)

Some delay in learning to sit, move and walk

Delay in reaching baby milestones is apparently common although not among *Unique* members when this guide was first written. Families reported that their children generally sat, crawled and walked close to the expected age. It is likely that the more severely affected children are the ones who go to hospital, so the information in the early medical literature may be slightly biased toward more developmental delays. So far everyone with the microduplication has walked, often only slightly later than a typically developing child.

Some babies, although not all, have a low muscle tone and feel floppy to hold; this is known as hypotonia and is one of the causes of their slow progress in reaching their mobility milestones. Hypotonia has also been linked to difficulties with agility. Unusually bendy (lax) joints which may need support have also been reported.

Unique children walked independently between 11 months and 18 months and climbed stairs at around 2 years. In the early stages of walking, toddlers were often uncoordinated and tripped easily. Those with low muscle tone tired easily and an unusual way of walking could persist into adulthood. But they went on to enjoy a wide range of physical activities (Fernandez 2010; Rosenfeld 2010; Shinawi 2010; *Unique*).

> ❝ She was sitting up from 8 months but not attempting to crawl by 9 months. She managed this one week before her first birthday. She started walking at 18 months and by 2½ years had mostly caught up physically and could run well but still had trouble going down steps. She now walks very stably and for very long distances and enjoys swinging, climbing, sliding, dancing – 4 years

Can it happen again?

Where both parents have unaffected chromosomes, it is unlikely that another child will be born with a 16p11.2 microduplication in that family. Very rarely (less than 1% of the time), both parents have unaffected chromosomes, identified by a blood test, but a few of their egg or sperm cells carry the 16p11.2 microduplication. This is called germline mosaicism and it means that parents whose chromosomes appear normal when their blood is tested, can have more than one child with the duplication.

In families where the 16p11.2 microduplication has been inherited from a parent, the possibility of having another child, either a girl or a boy, with the 16p11.2 microduplication is 50% in each pregnancy. However, the effect of the microduplication on the child's development, health and behaviour cannot be predicted. Your genetics centre should be able to offer counselling if you are planning on expanding your family. Unique also publishes a 'Planning Your Next Child' guide.

Will my child with a 16p11.2 microduplication have similarly affected children?

As an adult, your child with a 16p11.2 microduplication may plan to have children of their own. It is likely that the microduplication does not affect fertility. In each pregnancy, anyone with the microduplication theoretically has a 50% possibility of passing it on and a 50% possibility of having a child without the duplication.

Array CGH report

The laboratory that finds the 16p11.2 microduplication will send a report that usually looks like something like this for a 16p11.2 microduplication syndrome duplication:

arr(hg19) 16p11.2 (29674061- 30235818)x3

arr	The analysis was by array (arr) comparative genomic hybridisation
hg19	Human Genome build 19. This is the reference DNA sequence that the base pair numbers refer to. As more information about the human genome is found, new 'builds' of the genome are made and the base pair numbers may be adjusted
16p11.2	The chromosome involved is 16 and the position of the duplication is in band p11.2
29674061-30235818	The base pairs between 29674061and 30235818have been shown to be duplicated. Take the first long number from the second and you get 561,757 (or 562kb or 0.562Mb). This is the number of base pairs that are repeated. This is the number of base pairs that are repeated
x3	means there are three of these base pairs, not two – one on each chromosome 16 – as you would normally expect

An array report for a 16p11.2 distal microduplication will look very similar but have different base pair numbers. The numbering will be lower, roughly 28-29 Mb, for example : **arr(hg19) 16p11.2 (28837450-29042118) x3**

How common is it to have a 16p11.2 microduplication?

In 2008 it was estimated that for every 10,000 people in the general population, three have a 16p11.2 microduplication. It was found to be slightly more common among people who have a language or psychiatric disorder, being found in four per 10,000 people (Weiss 2008). More recent large scale genetic analyses of hundreds of

thousands of people in the 'general population' (UK BioBank research: Crawford 2019 and Kendal 2019) provide a similar estimate of just over 3 people for every 10,000.

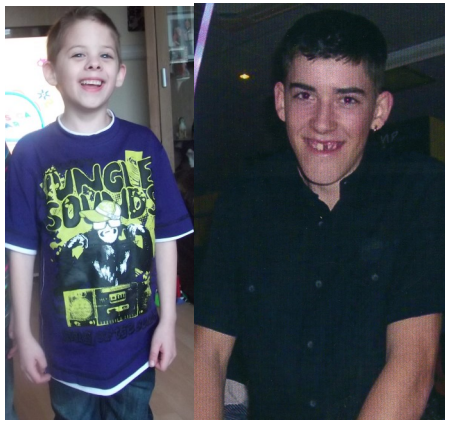
Most likely features (16p11.2 microduplication syndrome)

Features vary, even between members of the same family. They do not affect everyone and in any individual, they can be more or less obvious.
The most common features are:

- Delay in starting to speak and in language development
- Learning difficulties or intellectual disability
- Possibly very minor unusual facial or physical features
- Some delay in learning to sit, move and walk
- Motor coordination difficulties
- Some need for support with learning
- Increased likelihood of difficult behaviour
- Increased susceptibility to mental health problems, including ADHD (attention deficit hyperactivity disorder) and ASD (autism spectrum disorder)
- In a few, a birth anomaly that might cause health problems
- Possible tendency to underweight
- Possible vulnerability to seizures

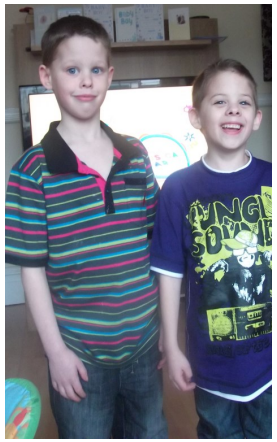
(Bedoyan 2010; Fernandez 2010; Jacquemont 2010; Rosenfeld 2010; Shinawi 2010)

Features reported to be associated with 16p11.2 distal duplications, much like for 16p11.2 microduplication syndrome, include developmental delay, learning difficulties or intellectual disability, ASD, ADD (attention deficit disorder) and speech and language delays and difficulties. However, some children with distal microduplications have also been found to have growth delay and short stature. This is not usually observed in children with 16p11.2 microduplication syndrome.



The boys in the picture above have a distal 16p11.2 microduplication.

The boys in the picture on the right are seven year old twins. The boy on the right-hand side has a 16p11.2 distal microduplication, his twin, who is taller, does not.



Delay in starting to speak and in language development

A delay in speech and language is very common although not universal and may be the first sign of developmental delay. Parents may notice that their baby isn't babbling or their toddler isn't saying words. The delay usually appears to affect talking (expressive language), as much as understanding. *Unique* children generally smiled on time but didn't say their first recognisable words until 16 months to 4-5 years. In some, words may emerge even later. But everyone known to *Unique* has started to talk although some of them use signing, gestures, objects or pictures to reinforce their meaning and their speech may not be completely clear (Fernandez 2010; Rosenfeld 2010; Shinawi 2010; Niarchou 2019, *Unique*).

> ❝ She smiled at 2 months but wasn't babbling at 6 months as most babies do and appeared to be only hearing vowels, not consonants. By 2½, she was making many more consonant sounds and could say *Mama*, *Bye bye*, *Baba* (for Barney) and *book* when asked. Today she can say some single words but also uses signing, gestures and vocal noises to get her meaning across. She isn't really delayed in her receptive language. She understands a lot more than she can say. Sounds she finds difficult to make include anything where the tongue must move to the top of the mouth, like *da*, *ta*, etc – *4 years*

> ❝ As a young child he seemed to understand most of what was said but was unable to convert his thoughts into speech. He smiled when expected but babbled late and didn't start to talk until he was 4 or 5 years old. At first he 'dragged words out'. One relative recalls that he had a vocabulary of 75-200 words before abruptly stopping speaking. Today as a young adult, he understands and responds to speech and has a wide active vocabulary. However, his social communication is impaired: he tends to invade people's personal space and can be annoyingly loud or get stuck on a topic or a question. He also speaks very quickly, making it hard to understand him – *22 years*

Some babies with a 16p11.2 microduplication are born with a structural or functional change to their body, most are not.

Most babies with a 16p11.2 microduplication are born completely healthy. Others are born with a structural and/or functional change to their body which can be minor or more serious, and can affect any part of the body. Most birth anomalies reported with a 16p11.2 microduplication have only occurred in a few babies, there is no consistent pattern so they may not be caused by the duplication.

Researchers have looked into the possible differences in brain structure of people with 16p11.2 microduplication syndrome and some significant MRI (magnetic resonance imaging) findings have been observed. The presence of decreased white matter (the tissue through which brain messages pass), a thin corpus callosum (the nerve tract that connects the left and right hemispheres of the brain) and/or increased ventricle size (the fluid filled cavities in the centre of the brain) have been found and associated with decreased full-scale and verbal IQ scores (Owen 2018).

Commonly reported 'functional' problems associated with 16p11.2 duplications are of a gastrointestinal nature, including gastrointestinal reflux, constipation and diarrhoea. A few babies with a 16p11.2 microduplication have also been born with a heart condition but no consistent diagnosis has been identified.