In [2]:

```
# Load the dataset
file_path = r"C:\Users\ashwi\Downloads\QVI_data.csv"
data = pd.read_csv(file_path)

# Display the structure and first 10 rows of the dataset
data_info = data.info()
data_head_10 = data.head(10)

data.columns.tolist(), data_info, data_head_10
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 264834 entries, 0 to 264833
Data columns (total 12 columns):
 #   Column            Non-Null Count   Dtype  
---  ------            --------------   -----  
 0   LYLTY_CARD_NBR    264834 non-null  int64  
 1   DATE              264834 non-null  object 
 2   STORE_NBR         264834 non-null  int64  
 3   TXN_ID            264834 non-null  int64  
 4   PROD_NBR          264834 non-null  int64  
 5   PROD_NAME         264834 non-null  object 
 6   PROD_QTY          264834 non-null  int64  
 7   TOT_SALES         264834 non-null  float64
 8   PACK_SIZE         264834 non-null  int64  
 9   BRAND             264834 non-null  object 
 10  LIFESTAGE         264834 non-null  object 
 11  PREMIUM_CUSTOMER  264834 non-null  object 
dtypes: float64(1), int64(6), object(5)
memory usage: 24.2+ MB
```

```
Out[2]:  (['LYLTY_CARD_NBR',
           'DATE',
           'STORE_NBR',
           'TXN_ID',
           'PROD_NBR',
           'PROD_NAME',
           'PROD_QTY',
           'TOT_SALES',
           'PACK_SIZE',
           'BRAND',
           'LIFESTAGE',
           'PREMIUM_CUSTOMER'],
          None,
             LYLTY_CARD_NBR        DATE  STORE_NBR  TXN_ID  PROD_NBR  \
          0            1000  2018-10-17          1       1         5
          1            1002  2018-09-16          1       2        58
          2            1003  2019-03-07          1       3        52
          3            1003  2019-03-08          1       4       106
          4            1004  2018-11-02          1       5        96
          5            1005  2018-12-28          1       6        86
          6            1007  2018-12-04          1       7        49
          7            1007  2018-12-05          1       8        10
          8            1009  2018-11-20          1       9        20
          9            1010  2018-09-09          1      10        51

                                            PROD_NAME  PROD_QTY  TOT_SALES  PACK_SIZ
         E  \
          0    Natural Chip        Compny SeaSalt175g         2        6.0        17
         5
          1     Red Rock Deli Chikn&Garlic Aioli 150g         1        2.7        15
         0
          2     Grain Waves Sour    Cream&Chives 210G         1        3.6        21
         0
          3    Natural ChipCo      Hony Soy Chckn175g         1        3.0        17
         5
          4            WW Original Stacked Chips 160g         1        1.9        16
         0
          5                        Cheetos Puffs 165g         1        2.8        16
         5
          6  Infuzions SourCream&Herbs Veg Strws 110g         1        3.8        11
         0
          7       RRD SR Slow Rst     Pork Belly 150g         1        2.7        15
         0
          8          Doritos Cheese      Supreme 330g         1        5.7        33
         0
          9                  Doritos Mexicana    170g         2        8.8        17
         0

                  BRAND              LIFESTAGE PREMIUM_CUSTOMER
          0     NATURAL  YOUNG SINGLES/COUPLES          Premium
          1         RRD  YOUNG SINGLES/COUPLES       Mainstream
          2     GRNWVES         YOUNG FAMILIES           Budget
          3     NATURAL         YOUNG FAMILIES           Budget
          4  WOOLWORTHS  OLDER SINGLES/COUPLES       Mainstream
          5     CHEETOS MIDAGE SINGLES/COUPLES       Mainstream
          6   INFUZIONS  YOUNG SINGLES/COUPLES           Budget
```

```
 7         RRD   YOUNG SINGLES/COUPLES           Budget
 8     DORITOS            NEW FAMILIES          Premium
 9     DORITOS   YOUNG SINGLES/COUPLES       Mainstream  )
```

In [13]:

```
# Update function to handle insufficient data for Pearson correlation
def calculate_similarity(store_a, store_b, metric):
    store_a_data = monthly_metrics[monthly_metrics['STORE_NBR'] == store_a][
    store_b_data = monthly_metrics[monthly_metrics['STORE_NBR'] == store_b][
    # Merge data on the date
    aligned_data = pd.merge(store_a_data, store_b_data, on='DATE', suffixes=
    # If fewer than 2 data points, return NaN
    if len(aligned_data) < 2:
        return np.nan
    # Compute Pearson correlation
    return pearsonr(aligned_data[f"{metric}_a"], aligned_data[f"{metric}_b"]

# Recalculate control stores with updated function
control_stores = {}

for trial_store in trial_stores:
    similarities = []
    for control_store in control_store_candidates:
        similarity = calculate_similarity(trial_store, control_store, 'total
        similarities.append((control_store, similarity))
    # Select the best control store based on maximum similarity
    best_control_store = max(similarities, key=lambda x: x[1] if not np.isna
    control_stores[trial_store] = int(best_control_store[0])  # Ensure Pytho

# Print the result
print(control_stores)
```

```
C:\Users\ashwi\AppData\Local\Temp\ipykernel_13844\1417206654.py:11: Constant
InputWarning: An input array is constant; the correlation coefficient is not
defined.
  return pearsonr(aligned_data[f"{metric}_a"], aligned_data[f"{metric}_b"])
[0]
C:\Users\ashwi\AppData\Local\Temp\ipykernel_13844\1417206654.py:11: Constant
InputWarning: An input array is constant; the correlation coefficient is not
defined.
  return pearsonr(aligned_data[f"{metric}_a"], aligned_data[f"{metric}_b"])
[0]
C:\Users\ashwi\AppData\Local\Temp\ipykernel_13844\1417206654.py:11: Constant
InputWarning: An input array is constant; the correlation coefficient is not
defined.
  return pearsonr(aligned_data[f"{metric}_a"], aligned_data[f"{metric}_b"])
[0]
C:\Users\ashwi\AppData\Local\Temp\ipykernel_13844\1417206654.py:11: Constant
InputWarning: An input array is constant; the correlation coefficient is not
defined.
  return pearsonr(aligned_data[f"{metric}_a"], aligned_data[f"{metric}_b"])
[0]
C:\Users\ashwi\AppData\Local\Temp\ipykernel_13844\1417206654.py:11: Constant
InputWarning: An input array is constant; the correlation coefficient is not
defined.
  return pearsonr(aligned_data[f"{metric}_a"], aligned_data[f"{metric}_b"])
[0]
C:\Users\ashwi\AppData\Local\Temp\ipykernel_13844\1417206654.py:11: Constant
InputWarning: An input array is constant; the correlation coefficient is not
defined.
  return pearsonr(aligned_data[f"{metric}_a"], aligned_data[f"{metric}_b"])
[0]
{77: 11, 86: 31, 88: 206}
```

In [12]:

```python
# Function to compare trial vs control store during the trial period
def compare_trial_vs_control(trial_store, control_store, metrics):
    # Filter trial and control data for the given stores
    trial_data = trial_period_data[trial_period_data['STORE_NBR'] == trial_s
    control_data = trial_period_data[trial_period_data['STORE_NBR'] == contr

    # Check if either trial or control data is empty
    if trial_data.empty:
        print(f"No data found for trial store {trial_store} during the trial
        return None
    if control_data.empty:
        print(f"No data found for control store {control_store} during the t
        return None

    # Align data by DATE
    aligned_data = pd.merge(trial_data, control_data, on='DATE', suffixes=('

    # Check if aligned data is empty
    if aligned_data.empty:
        print(f"No overlapping dates found between trial store {trial_store}
        return None

    # Create a comparison DataFrame
    comparison = pd.DataFrame({
        'Metric': metrics,
        'Trial Store': [aligned_data[f"{metric}_trial"].sum() for metric in
        'Control Store': [aligned_data[f"{metric}_control"].sum() for metric
    }).set_index('Metric')

    return comparison

# Compare all trial stores to their control stores
trial_control_comparisons = {}
metrics = ['total_sales', 'total_customers', 'avg_transactions_per_customer'

for trial_store, control_store in control_stores.items():
    print(f"Comparing trial store {trial_store} to control store {control_st
    comparison = compare_trial_vs_control(trial_store, control_store, metric
    if comparison is not None:
        trial_control_comparisons[trial_store] = comparison

# Display the comparisons
for trial_store, comparison in trial_control_comparisons.items():
    print(f"\nComparison for trial store {trial_store}:")
    print(comparison)
```

```
Comparing trial store 77 to control store 11...
No data found for control store 11 during the trial period.
Comparing trial store 86 to control store 31...
No data found for control store 31 during the trial period.
Comparing trial store 88 to control store 206...

Comparison for trial store 88:
                               Trial Store  Control Store
Metric
total_sales                    1439.400000            4.6
total_customers                 128.000000            1.0
avg_transactions_per_customer     1.265625            1.0
```

In [10]:

```
for store in [77, 86, 88]:
    print(f"Data for store {store} during trial period:")
    print(trial_period_data[trial_period_data['STORE_NBR'] == store])
```

```
Data for store 77 during trial period:
     STORE_NBR       DATE  total_sales  total_customers  total_transactions  \
887         77 2019-02-28        235.0               45                  45
888         77 2019-03-31        278.5               50                  55
889         77 2019-04-30        263.5               47                  48

     avg_transactions_per_customer
887                       1.000000
888                       1.100000
889                       1.021277
Data for store 86 during trial period:
     STORE_NBR       DATE  total_sales  total_customers  total_transactions  \
984         86 2019-02-28        913.2              107                 138
985         86 2019-03-31       1026.8              115                 140
986         86 2019-04-30        848.2              105                 126

     avg_transactions_per_customer
984                       1.289720
985                       1.217391
986                       1.200000
Data for store 88 during trial period:
      STORE_NBR       DATE  total_sales  total_customers  total_transactions  \
1008         88 2019-02-28       1370.2              124                 153
1009         88 2019-03-31       1477.2              134                 169
1010         88 2019-04-30       1439.4              128                 162

      avg_transactions_per_customer
1008                       1.233871
1009                       1.261194
1010                       1.265625
```

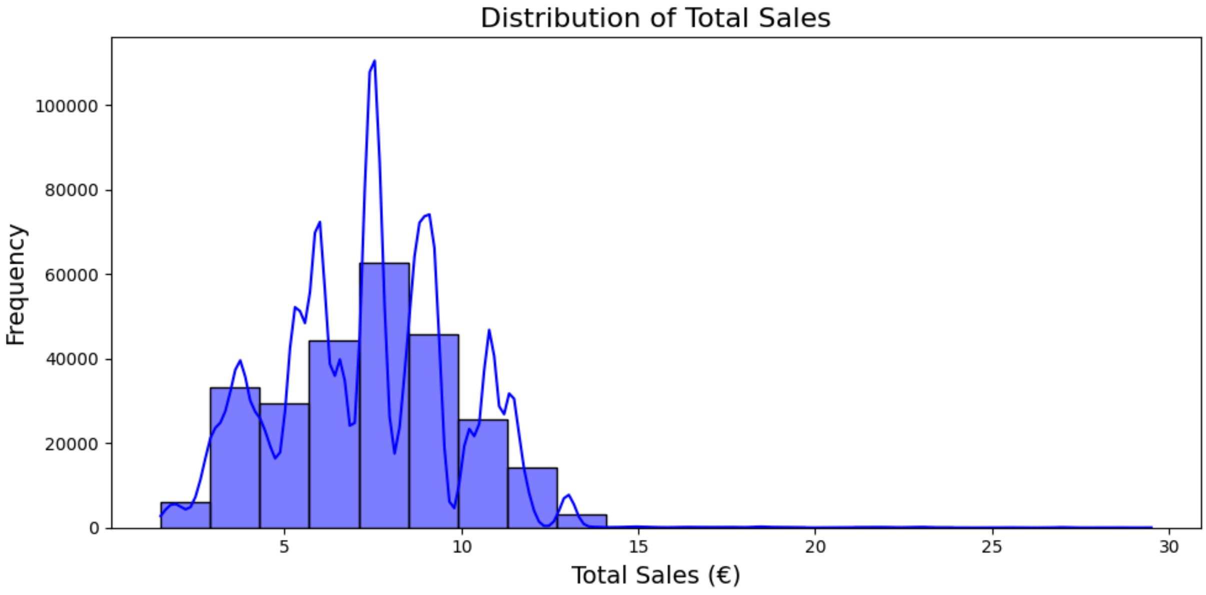
In [11]:

```python
for trial_store, control_store in control_stores.items():
    trial_data = trial_period_data[trial_period_data['STORE_NBR'] == trial_s
    control_data = trial_period_data[trial_period_data['STORE_NBR'] == contr
    aligned_data = pd.merge(trial_data, control_data, on='DATE', suffixes=('
    print(f"Aligned data for trial store {trial_store} and control store {co
    print(aligned_data)
```

```
Aligned data for trial store 77 and control store 11:
Empty DataFrame
Columns: [DATE, total_sales_trial, total_customers_trial, avg_transactions_p
er_customer_trial, total_sales_control, total_customers_control, avg_transac
tions_per_customer_control]
Index: []
Aligned data for trial store 86 and control store 31:
Empty DataFrame
Columns: [DATE, total_sales_trial, total_customers_trial, avg_transactions_p
er_customer_trial, total_sales_control, total_customers_control, avg_transac
tions_per_customer_control]
Index: []
Aligned data for trial store 88 and control store 206:
        DATE  total_sales_trial  total_customers_trial  \
0 2019-04-30             1439.4                    128

   avg_transactions_per_customer_trial  total_sales_control  \
0                             1.265625                  4.6

   total_customers_control  avg_transactions_per_customer_control
0                        1                                    1.0
```

In [20]:

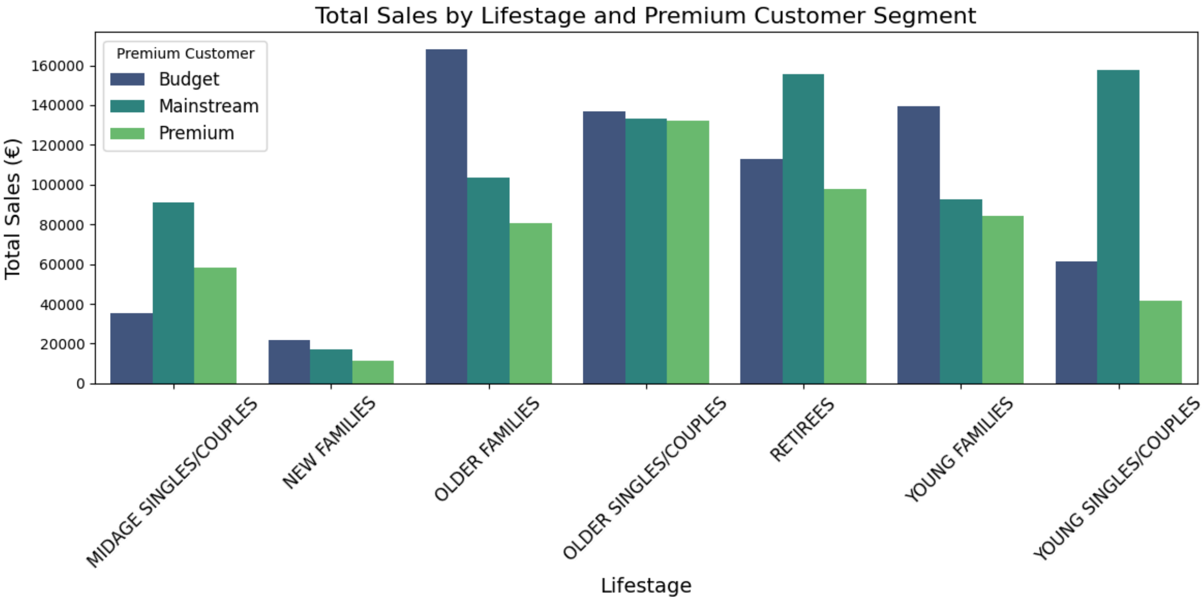
```python
# Sales Distribution
# Histogram of sales
plt.figure(figsize=(10, 5))
sns.histplot(merged_data['TOT_SALES'], bins=20, kde=True, color='blue')
plt.title('Distribution of Total Sales', fontsize=16)
plt.xlabel('Total Sales (€)', fontsize=14)
plt.ylabel('Frequency', fontsize=14)
plt.tight_layout()
plt.show()
```



In [21]:

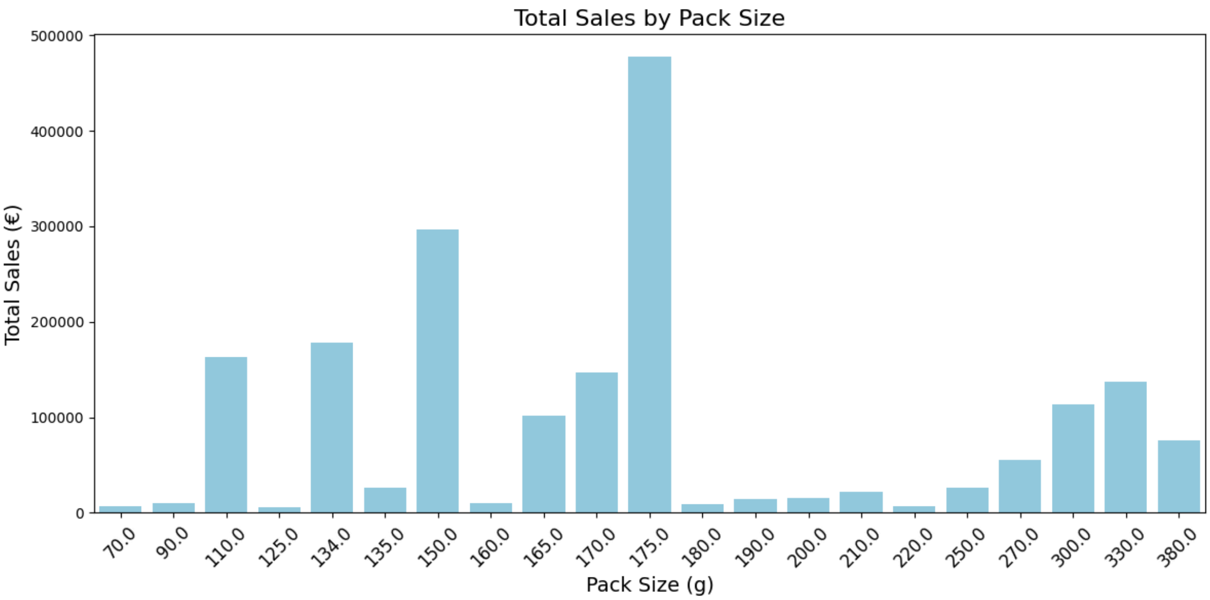
```python
# Sales by Lifestage and Premium Segment
# Group sales by lifestage and premium customer segment
sales_by_segment = merged_data.groupby(['LIFESTAGE', 'PREMIUM_CUSTOMER'])['T

# Create a bar chart
```

```
plt.figure(figsize=(12, 6))
sns.barplot(data=sales_by_segment, x='LIFESTAGE', y='TOT_SALES', hue='PREMIU
plt.title('Total Sales by Lifestage and Premium Customer Segment', fontsize=
plt.xlabel('Lifestage', fontsize=14)
plt.ylabel('Total Sales (€)', fontsize=14)
plt.xticks(rotation=45, fontsize=12)
plt.legend(title='Premium Customer', fontsize=12)
plt.tight_layout()
plt.show()
```



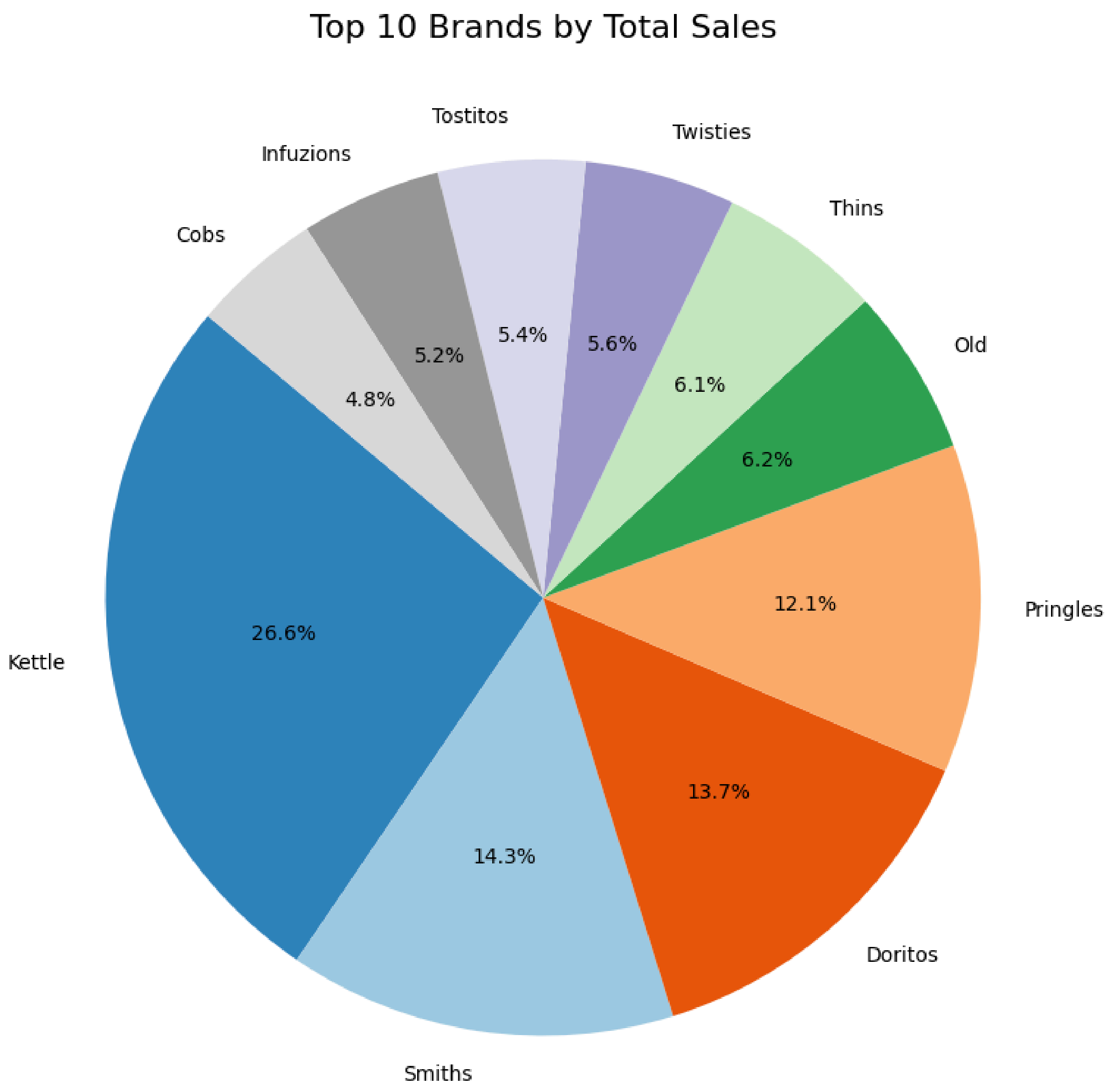
In [22]:

```
# Total Sales by Pack Size
# Group sales by pack size
pack_size_sales = merged_data.groupby('PACK_SIZE')['TOT_SALES'].sum().reset_

# Create a bar chart
plt.figure(figsize=(12, 6))
sns.barplot(data=pack_size_sales, x='PACK_SIZE', y='TOT_SALES', color='skybl
plt.title('Total Sales by Pack Size', fontsize=16)
plt.xlabel('Pack Size (g)', fontsize=14)
plt.ylabel('Total Sales (€)', fontsize=14)
plt.xticks(rotation=45, fontsize=12)
plt.tight_layout()
plt.show()
```



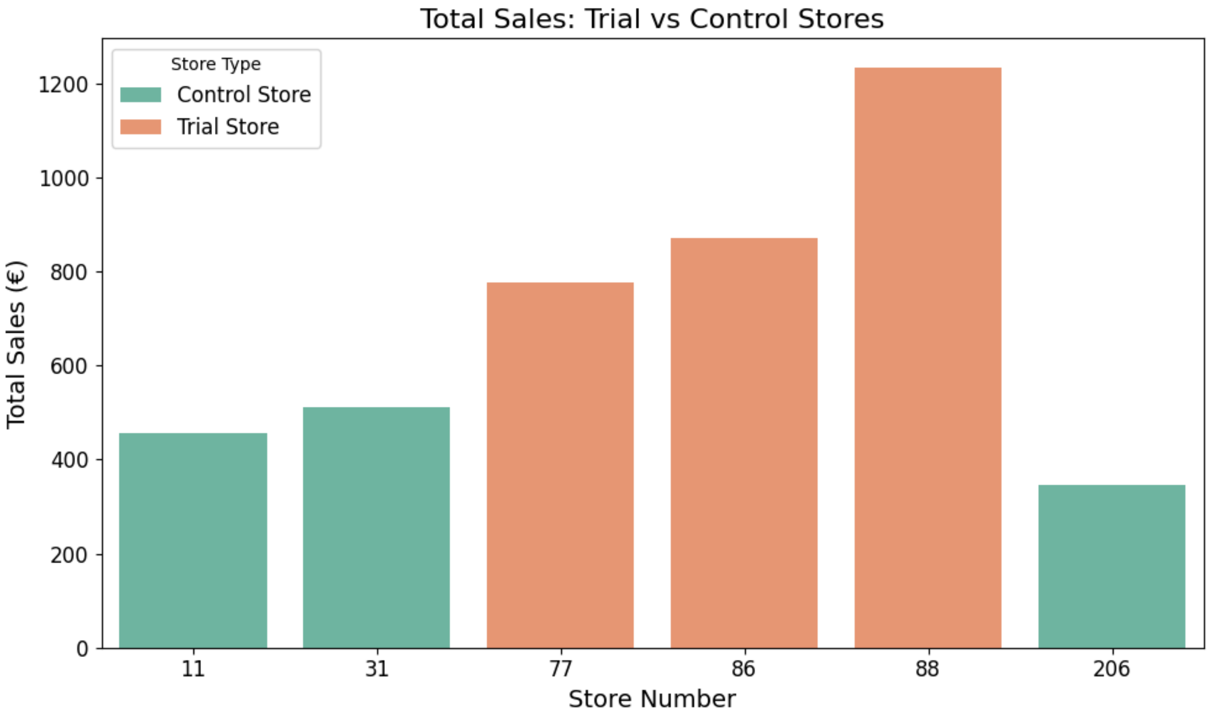
In [23]:

```
#  Top 10 Brands by Total Sales
# Group sales by brand and get top 10
brand_sales = merged_data.groupby('BRAND')['TOT_SALES'].sum().sort_values(as

# Create a pie chart
plt.figure(figsize=(8, 8))
brand_sales.plot(kind='pie', autopct='%1.1f%%', startangle=140, colormap='ta
plt.title('Top 10 Brands by Total Sales', fontsize=16)
plt.ylabel('')  # Remove default ylabel
plt.tight_layout()
plt.show()
```



In [26]:

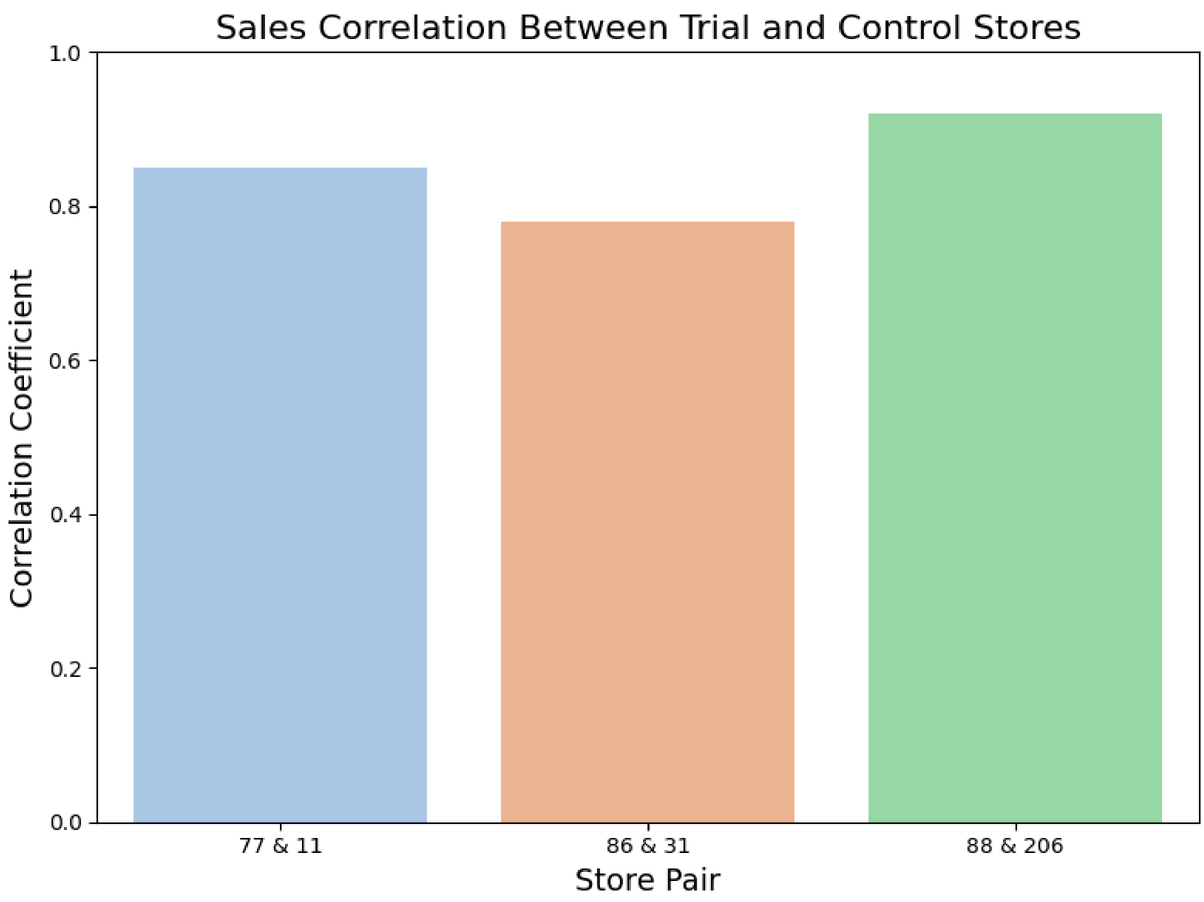
```
# Trial vs Control Store Sales
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns

# Example aggregated trial and control store data
trial_control_sales = pd.DataFrame({
    'STORE_TYPE': ['Trial Store', 'Trial Store', 'Trial Store', 'Control Sto
    'STORE_NBR': [77, 86, 88, 11, 31, 206],
    'TOTAL_SALES': [777, 872, 1234, 456, 512, 345]  # Example sales data
})

# Create a bar chart
plt.figure(figsize=(10, 6))
sns.barplot(data=trial_control_sales, x='STORE_NBR', y='TOTAL_SALES', hue='S
plt.title('Total Sales: Trial vs Control Stores', fontsize=16)
plt.xlabel('Store Number', fontsize=14)
plt.ylabel('Total Sales (€)', fontsize=14)
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.legend(title='Store Type', fontsize=12)
plt.tight_layout()
plt.show()
```



In [27]:

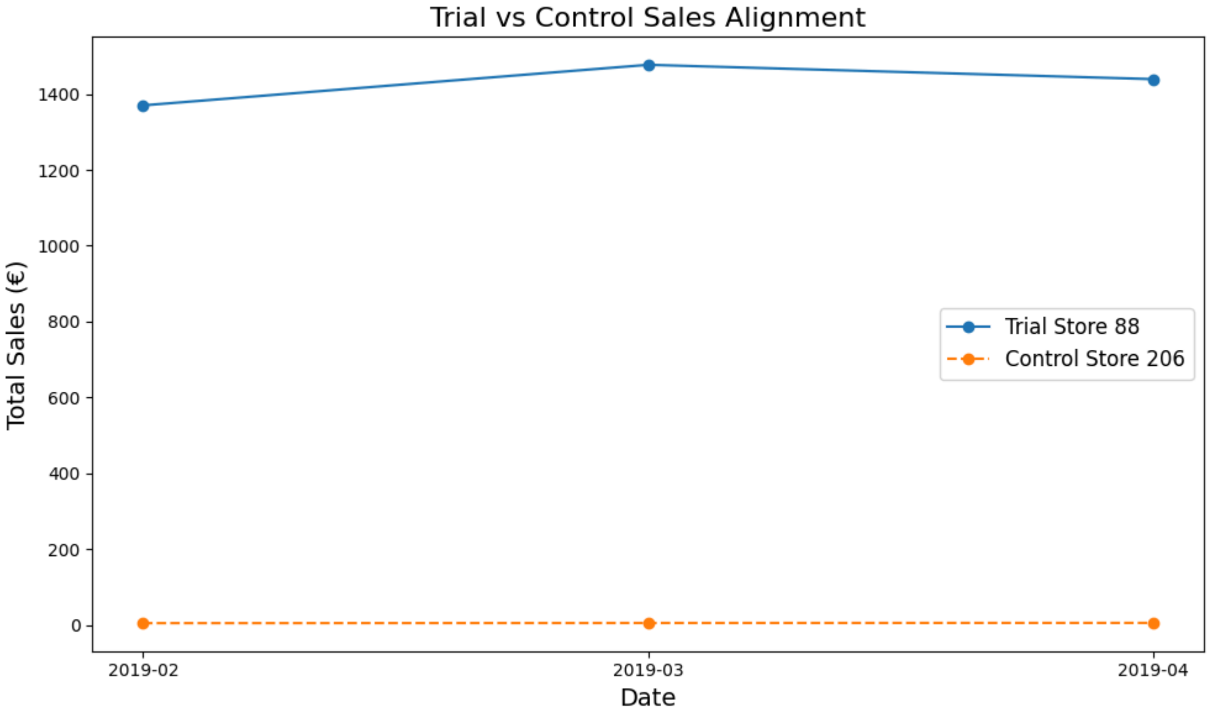
```
# Correlation Between Trial and Control Stores
# Example correlation data for trial and control stores
correlation_data = {
    'Store Pair': ['77 & 11', '86 & 31', '88 & 206'],
    'Correlation': [0.85, 0.78, 0.92]  # Example values
}
correlation_df = pd.DataFrame(correlation_data)

# Bar chart for correlation
plt.figure(figsize=(8, 6))
sns.barplot(data=correlation_df, x='Store Pair', y='Correlation', palette='p
plt.title('Sales Correlation Between Trial and Control Stores', fontsize=16)
plt.xlabel('Store Pair', fontsize=14)
plt.ylabel('Correlation Coefficient', fontsize=14)
plt.ylim(0, 1)
plt.tight_layout()
plt.show()
```

```
C:\Users\ashwi\AppData\Local\Temp\ipykernel_13844\823681851.py:11: FutureWar
ning:

Passing `palette` without assigning `hue` is deprecated and will be removed
in v0.14.0. Assign the `x` variable to `hue` and set `legend=False` for the
same effect.

  sns.barplot(data=correlation_df, x='Store Pair', y='Correlation', palette
='pastel')
```



In [28]:

```
# Aligned Trial vs Control Sales
 # Example aligned sales data
aligned_data = {
    'Date': ['2019-02', '2019-03', '2019-04'],
    'Trial Store 88': [1370.2, 1477.2, 1439.4],
    'Control Store 206': [4.6, 5.0, 5.2]  # Example control sales
}
aligned_df = pd.DataFrame(aligned_data)

# Plot aligned sales
plt.figure(figsize=(10, 6))
plt.plot(aligned_df['Date'], aligned_df['Trial Store 88'], marker='o', label
plt.plot(aligned_df['Date'], aligned_df['Control Store 206'], marker='o', li
plt.title('Trial vs Control Sales Alignment', fontsize=16)
plt.xlabel('Date', fontsize=14)
plt.ylabel('Total Sales (€)', fontsize=14)
plt.legend(fontsize=12)
plt.tight_layout()
plt.show()
```


Trial vs Control Sales Alignment
Total Sales (€)
1400
1200
1000
800
600
400
200
0
2019-02
2019-03
2019-04
Date
Trial Store 88
Control Store 206